

A SELF-TRANSPORTABLE PILE DRIVING APPARATUS

This invention relates to a self-transportable pile driving apparatus adapted to be capable of use on a site in a place having limited lateral space and headroom, for example, indoors.

The technology of indoor foundation work and apparatus for that purpose have been known for several decades. However now, the conventional technology for indoor foundation work is frequently unable to cater for modern indoor foundation work requirements.

Such conventional equipment is slow in operation and tends to result in delays to construction deadlines as well as causing pollution to the environment. To meet modern needs the applicant has conducted extensive research and development to produce a highly versatile and reliable compact apparatus in accordance with the present invention.

One known piling method is the drill pile technique. It is a time consuming process and causes environmental pollution. For these and other reasons, it is generally unsuitable for use indoors and in other confined spaces.

A known apparatus for performing foundation work uses a movable pile rig equipped with a miniaturised air hammer or pile breaker. However, this has several disadvantages:

1. Moving the equipment requires significant manpower and is very time consuming.
2. High noise level: The air hammer produces much noise during operation and it is very slow.

3. Limited impact energy. it cannot work on working load capacity equivalent to a 15,241 Kg - 35,562 Kg (15 - 35 tons) pile.

Some conventional pile drivers are known from GB 1 443 349, GB 993 540, GB 936 308 and EP 392 302. However, none of these machines has a hammer construction enabling operation in the presence of overhead obstructions, nor is sufficiently quiet to be used in an indoor environment.

Other prior art includes:- GB-A-2 069 576 (KOEHRING GMBH); EP-A-0 095 801 (NIERSTRASZ); GB-A-2 035 866 (WEST'S PILING & CONSTRUCTION CO. LTD.); and US-A-3 961 672 (STERLING ENGINEERING AND MANUFACTURING COMPANY).

However, none of this prior art is designed to be capable of use in the same way as the present invention.

The Applicant has now devised a new form of apparatus which overcomes the aforementioned problems and is suitable for use indoors or in other confined spaces.

According to the present invention, there is provided a self-transportable pile driving apparatus adapted to be capable of use on a site in a place having limited lateral space and headroom;

said pile driving apparatus comprising a hammer;

said hammer comprising:- a housing; a driven helmet; a weight; hydraulic ram means; and cushion means;

an orifice being provided in a bottom end of said housing;

the driven helmet slidably projecting downwardly through said orifice and being retained, relative to the housing, by helmet retention means; a lower part of the

driven helmet being provided with a first recess for receiving an upper end of a pile which is to be driven by the hammer;

the weight being slidably located within said housing above the helmet, for falling upon, and hitting, a top part of said driven helmet; the weight being provided with a locating means for locating with said top part of the driven helmet, said locating means comprising a second recess for accommodating said top part of the driven helmet;

said cushion means being provided for cushioning the impact of the weight on the driven helmet and/or said cushion means being provided between the driven helmet and the housing;

said hydraulic ram means being adapted and arranged for lifting the weight so it can thereafter be let to fall on the helmet to drive the pile;

said pile driving apparatus further comprising controlled, powered, support means for supporting the hammer selectively either tilted for transport, or upright for use, and for varying the working height of the hammer during use;

said pile driving apparatus further comprising chassis means mounted on a self-powered traction means; the hammer and its support means being mounted on the chassis means; the self-powered traction means being motor-driven for said pile driving apparatus to transport itself around the site;

said pile driving apparatus further comprising retractable anchoring means for anchoring said pile driving apparatus during pile-driving operations.

Preferably, said cushion means is provided in or on the top part of the driven helmet for cushioning the impact of the weight on the driven helmet.

Preferably, said cushion means is provided between the driven helmet and the housing in or on an upwardly facing flange surface of the driven helmet and exterior to said housing.

Preferably, said cushion means is effective to reduce the noise of pile-driving operations indoors to a tolerable level.

Preferably, said powered support means is adapted and arranged to be selectively raised or lowered by being telescopic.

Preferably, said hydraulic ram means of the hammer comprises a pair of hydraulic cylinder rams on or adjacent the housing.

Preferably, the hammer further comprises indicator means for indicating the position of the weight relative to the housing.

Preferably, the indicator means comprises a pointer attached to said weight and visible through or projecting through an elongate slot arranged in the housing.

Preferably, a scale is provided for enabling a quantitative indication of the position of the weight to be obtained.

Preferably, the weight comprises an at least partly hollow body, at least partly filled with a weighting substance.

Preferably, the weight comprises a pair of concentric steel tubes, separated by spacers and defining hollow spaces filled with lead weighting.

Preferably, hydraulic logic valve means is provided for selectively operating at least said hydraulic ram means.

Preferably, the hydraulic logic valve means is incorporated in a single block.

Preferably, the hydraulic logic valve means comprises at least one solenoid valve.

A preferred embodiment of the invention, described hereinbelow and referred to as a "rig", or "piling rig", or "mini-rig", measures 2.5m in length and between 1.2m - 1.5m in width. During operation its length can be extended from 2.8m to as high as 4.5m. During transport its height is only 2.1m. Therefore the whole rig can easily pass through a door somewhat wider than 1.5m and somewhat higher than 2.1m. The weight, in the preferred embodiment, weighs 2032 Kg (2 tons).

This preferred embodiment of the invention, described hereinbelow, incorporates all the above-mentioned preferred features.

The telescopic support of the hammer in the preferred embodiment of the invention can vary the height of the hammer from 2.8m up to 4.5m, or from 4.5m down to 2.8m.

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The preferred embodiment of the invention is designed to be simple and versatile. It can be transported on a truck without being dismantled, thus enabling it to be put to work as soon as it arrives on a new construction site.

The invention will be described by way of example with reference to the drawings, which illustrate the above-mentioned preferred embodiment of the invention.

In the drawings:-

Figure 1A shows a side elevation of a mini-rig forming the above-mentioned preferred embodiment of the present invention;

Figure 1B shows a plan view of the mini-rig shown in Figure 1A;

Figure 2A shows the hydraulic logic valve arrangement for driving the hammer of the mini-rig and Figures 2B and 2C show details of the interconnection of the hydraulics with the hammer, respectively in the down and up positions;

Figure 3A shows the interconnection of the logic valve arrangement of Figures 2A-2C with the diesel engine of

the power unit, Figure 3B shows also the interconnection with the traction unit and leader mast and anchoring legs, and Figures 3C-3I show details of the construction of the valves used therein (Fig. 3C - plan, other views as shown in Figure 3C - A = Fig. 3D, B = Fig. 3E, C, D = Fig. 3F), Fig. 3G pilot flow path diagram in hydraulic block (plan) view, Fig. 3H end elevation corresponding to Figure 3G, Fig. 3I cross section;

Figures 4A-4E show details of the leader section (Figure 4A plan, 4B side view hammer down, 4C side view hammer up, 4D front view hammer up, 4E rear view hammer down, 4F hydraulics for raising/lowering/tilting leader);

Figures 5A-5H show the construction of the piling hammer of the mini-rig shown in Figures 1A and 1B (Figure 5A hammer outer view, 5B axial cross-section, 5C hammer housing, 5D details of hammer construction, 5E details of driven helmet construction, 5F coupling of driven helmet to hammer housing, 5G details of weight construction, 5H pile cap of driven helmet);

Figures 6A-6C show how the telescopic leader allows the driven helmet to fit over a pile when height is limited (Figure 6A hammer retracted (down), 6B hammer extended (up), 6C leader tilted with hammer/helmet fitted over pile);

Figures 7A-7C show pile driving in a limited height environment (Figure 7A on level ground, 7B in a trench hammer lifted, 7C in a trench, hammer down);

Figures 8A-8D show the cooling arrangement (Figure 8A mounting of components on engine unit, 8B front radiator, 8C rear oil cooler, 8D top view); and

Figure 9 is a circuit diagram of the hydraulic control system.

Referring to Figures 1A and 1B, a mini-rig 1 comprises a chassis unit 2 movable on a crawler traction unit 3. The chassis unit supports a power pack 5, a leader mast 7 and a hydraulic reservoir 39. A pile hammer 11 is supported on the mast by means of a guide 12.

The chassis unit 2 consists of an upper chassis 13 and a lower chassis 15. A pair of hydraulic motors are provided to power the traction unit 3. This enables the mini-rig to move along an uneven road.

Retractable anchoring legs 163, 165, 167, 169 respectively at each corner of the chassis are provided for anchoring the mini-rig to the floor or ground during pile driving operations. These legs are hydraulically operable.

The power pack 5 is situated at the rear of the rig. It is powered by a diesel engine 30 (see Figure 3) which powers the first hydraulic pump 16.

Referring now to Figures 2A-2C, a first pump 16 is used to supply power to operate the hammer 11. The first pump is provided with a check valve 14 and a return filter 18. There is also a second hydraulic pump 29. The second pump 29, drives the crawler traction as well as the hydraulics of the retractable anchoring legs 163, 165, 167, 169 and the leader mast hydraulics which will be described in more detail hereinbelow with reference to Figures 4A-4F. The second pump 29 is not used to operate the hammer and so is not shown in Figures 2A-2C. The second pump 29 has a smaller capacity than the first pump 16.

The first pump 16 also drives the hammer and the second pump 29 operates hydraulic cylinders of the rig leader mast as described in more detail hereinbelow. On the

return to the reservoir 39 there is also a check valve 151 and return filter 18.

The leader mast 7 is situated at the front of the mini-rig. Its function is to guide the hammer in an up and down movement and it also helps to prevent the hammer from disengaging from the rig during operation.

The leader mast comprises two sections. The upper leader section 17 is telescopic whereas the lower leader section 19 is fixed. The telescopic upper leader mast can be extended and retracted by means of a hydraulic cylinder 21 located at the front of the leader mast. This cylinder is used to move the hammer up and down. Another hydraulic cylinder 23, which is at the rear of the leader mast, is used to effect telescopic motion on the leader.

Two further cylinders (not shown in these Figs) located at the leader foot ram function as a levelling system for the hydraulic hammer. At the side of the fixed leader section, one cylinder is mounted at each side which links with the upper chassis base. Therefore, the leader can tilt forwards or backwards. The fixed leader section base has a cylinder to make it more stable during operation. The power to drive all these cylinders is also supplied by the second pump 29.

The main hydraulics of the mini-rig comprises a pair of cylinders 25, 27 either side of the hammer 11 connected to the first pump 16 via a logic valve compact block 31. The equivalent of electronic logic switching is effected in hydraulic terms by a solenoid directional control valve 147 via an electrical control box 38. The hydraulic pump 16 provides the power to deliver hydraulic fluid from the reservoir 39. The fluid is

transferred around the system by means of hose and piping 41.

The pile hammer 11 comprises a driven helmet 43 which locates over a pile 47. The hydraulics lift a ram weight 45 as shown in Figure 2C and lets it fall onto a driven helmet 43 (Fig. 2C) as will be explained in more detail herebelow..

Referring specifically to Figure 2A, the logic valve block 31 is a combination of four logic valves/trigger valves 139, 141, 143, 145, a solenoid operated pilot valve 147, a pilot check valve 149, the aforementioned return line check valve 151 (with associated filter 185), and a pressure relief valve 153, all in single steel or aluminium block. This provides a high-efficiency and high fluid flow. The design helps to reduce piping cost, eliminates the chances of oil-spillage and easy of maintenance. The solenoid valves are operated by a first solenoid 140 and a second solenoid 142.

When the engine starts hydraulic fluid from the reservoir will be drawn by the first pump 16 and flows to the logic valve compact block 31. The low pressure hydraulic fluid opens all four logic valves 139-145. The hydraulic fluid flows in smoothly through a return filter and returns to the reservoir. At this stage, the hammer switch is yet to turn 'ON'.

When the hammer switches 'ON', the following will occur: First, the operating switch is switched to the "move" position. The solenoid 140 of valve 147 will be de-energised, while the solenoid 142 of valve 147 is energised in the logic valve block. Flow from port B of solenoid valve 147 causes the logic valves 141 and 143 to close. At the same time, fluid will flow from the

first pump 16 to the piston end of the ram weight cylinders 25,27, and the fluid power causes the respective rams of the cylinders 26,28 to extend.

When the cylinder has lifted the weight to a predetermined height, a time delay switch energises the solenoid 140 of valve 147 which activates logic valves 139 and 145 to close and allow logic valves 141 and 143 to open. When this happens, fluid flow from pump 16 is directed through logic valve 141 to the ram ends of the cylinders 25, 27 and causes the rams to retract.

The other two logic valves 139, 145 close whilst valves 141, 143 open. This causes fluid at the cylinder end of the piston to flow through logic valve 143 and the pilot check valve 149 to return to the reservoir. The cylinder thus retracts very quickly allowing the ram to fall onto the pile head. The hammer is ready for the next action.

In order to retract the cylinder at high speed, the return route for the fluid must have a high throughput and to allow discharge through two different return routes: -

1. Through the 'Over Size' logic valve return to the reservoir.
2. Through the pilot check direct return to the reservoir, without back pressure.

Next, referring to Figure 3A, the various components of the logic valve system are mounted on the square aluminium block 31, ie. the solenoid valves, a pressure relief valve and pilot valve check valve etc. Holes are also drilled in the block to enable the fluid to flow through to the hydraulic components. An auxilliary pump

unit 148 can be installed when the mini-rig is intended for outdoor use. In this case, the second pump 29 will be connected to the rig.

As shown in Figure 3B, the second pump 29 operates the leader mast and retractable leg hydraulics via a hand operated directional valve 181. The traction unit 3 is also operated through the same valve from the second pump, the traction motors being indicated by reference numerals 183, 185. All hydraulic components operated by second pump 29 are collectively indicated by reference numeral 187. The return line from these components to the reservoir is provided with a filter 189 and cooler 191.

As shown in Figures 3C and 3D, a pair of cartridge valves 139, 141 is placed each at the side corner and recessed in a cavity with a pair of respective control covers 150, 152 (pilot heads) arranged at the end of each cartridge. A pressure inlet port 154 is open at the centre of this face.

The arrangement shown in Figure 3E is similar to that shown in Figure 3D but an open return port 156 is situated at the centre of the side face as shown. The cartridge valves 143, 145 shown on this side are also provided with respective pilot heads 158, 162.

Figure 3F shows two closed covers 164, 166 arranged on the two cartridge valves 143, 150 plane and another working port 168 is located at the centre of this face. The other side (view D in Fig. 3C) generally corresponds, i.e. with respective covers 170, 172 over valves 141, 145 and a central working port 174.

Figures 3G and 3H show the flow path layout within the block 31. Reference numerals which are shown in

brackets do not indicate the integers denoted by those numerals as such (in other drawings) but indicate that the flow path so shown leads to those integers.

In the solenoid valve 147, an inlet port 176 is provided for providing the hydraulic fluid under pressure from the first pump 16 to the solenoid valve 147. A return line 178 to the reservoir 39 is also provided.

Figure 3I shows a cross section below the upper surface of the block 31 as seen in Figure 3C. A pilot oil line is arranged inside the logic valve block, 'open' or 'close' the valves. Fluid flow pressure amounts from the small pressure line to a sub-plate and to solenoid valve, then through solenoid valve and supply to the various control covers (pilot heads). Fluid is flow from the sub-plate to the port through a small port and supply directly to the control covers on both sides.

A working line, pressure line and return line are arranged at the bottom of pilot line. Fluid flows through pressure port 154 and depending on functional activities, can be directed to either the working ports 168, 174 or to the return port 156. Each port cross-links at the cartridge cavity and forms a junction at the working ports 168, 174.

Details of the leader are shown in Figures 4A-4F. The leader comprises a first leader section 51, arranged to be moved between an (extended) up position and a down (retracted) position under the control of a first hydraulic cylinder 53. A second hydraulic cylinder 55 is provided for tilting the leader rake forwards or backwards. A second leader section 61 is provided with a foot boom 57. A third hydraulic cylinder 59 functions to move the second leader section 61 up or down. A lifting hammer or auger head is provided with a fork

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plate 63 and is lifted by means of a fourth hydraulic cylinder 67 driven by a sprocket wheel 67 operated by means of a roller chain 69. A fifth hydraulic cylinder 73 is provided for moving leader to R/L side.

Details of the hammer in accordance with the present invention are shown in Figures 5A-5H.

The hammer 11 comprises a cylindrical housing 75 into which is slidably located the generally cylindrical ram weight 45. The ram weight 45 is surmounted by a welded-on steel top plate 77 which limits the extent to which the ram weight can enter the housing from the top end 79 thereof. The rams 26, 28 of the weight lifting cylinders 25, 27 lift the weight by pushing on the underside of the plate 77. The lower end 81 of the ram weight 45 is provided with a cylindrical recess 83.

The hammer housing 11 is fabricated from C-channel members and a bottom steel plate 87 as described in more detail hereinbelow. The housing is structurally reinforced to withstand the heavy hammer operation. The lower end 85 of the housing is closed by means of a bottom plate 87 provided with a central circular orifice 89. The driven helmet 43 extends through this orifice. The extent of penetration of the driven helmet into the orifice of the housing is limited by a bottom flange 91 of the helmet.

The remainder of the helmet extending up from the bottom flange 91 is generally cylindrical but is provided with a waisted portion 93 where it extends through the bottom plate 87 of the housing. This feature enables the helmet to be retained by virtue of an annular retention ring 95 attached to the bottom plate 87 and encircling the orifice 89 by means of screws 97 or similar. The inner diameter of the retention ring is less than the

diameter of the bottom plate orifice 89 but greater than the diameter of the waisted portion 93.

The lower end 99 of the driven helmet 43 is provided with a central axial cylindrical recess 101 for receiving a pile. The upper end 103 of the helmet contains a shorter central axial cylindrical recess 105 into which is located a cylindrical cushion 107 which protrudes slightly above the upper end 103 of the helmet.

The upper end of the helmet fits loosely inside the recess 83 in the bottom of the ram weight 45 which can lift clear thereof.

The upper surface 109 of the bottom flange is provided with an annular recess 111 into which is located an annular cushion 113 which faces the bottom plate 87 of the housing and/or the retention ring 111.

The housing 75 has an elongate slot 115 extending end to end along the majority of its length. A pointer 117 attached to the ram weight 45 extends through this slot to indicate the degree displacement of the ram weight relative to the driven helmet by pointing at a scale 119.

The ram weight 43 comprises a pair of concentric steel tubes, namely an inner tube 121 and an outer tube 123, separated by spacers 125 etc., and defining hollow spaces 127 etc., filled with lead weighting 129 (poured in as molten lead and allowed to set).

This design enables the hammer to work in an enclosed space unrestricted by the height of the building or other on-site impediments. The hammer with the ram weight is able to perform on-site pile driving with 2m length pile and can work on a 3m height leader.

There are advantages in using both lead and steel in the ram construction. Using both materials reduces the noise level and impact energy caused when the ram impacts the pile. The two materials greatly affect the noise level and impact energy by reducing them to a more comfortable level and help protect the environment cause lesser damage to the pile.

Referring to Figure 5C, the four C-channel members are welded on to the steel bottom plate 87. Each member is positioned diagonally relative to the others. Bronze plates are mounted on the channels to guide the up and down ram movement and serves as a ram guide. The contact point between the ram weight and the guide is very slight and the bronze plates are polished to a smooth surface for reducing friction. Thus, the ram weight free-drop energy is influenced to a minimum.

The size of the bottom steel plate 87 is just slightly larger than the housing diameter. Since the driven helmet 43 is located in this way in the recess 83 base of the ram weight 45, to serve as a pile cap without using an anvil, the transfer of impact energy is made more efficient.

The driven helmet 43 is cast from steel and the cylindrical cushion 107 on top of it is made of nylon. The recess 101 in the helmet, used for guiding the pile during operation, reduces the height of the hammer, making it convenient to use where there is limited head-room. The annular cushion 113 is for example a rubber O-ring and it reduces the rebound energy to protect the hammer. The driven helmet 43 is first cast and trimmed by manual tooling. A pair of half diameter lock plates is used to lock the movement in between the driven helmet and housing.

During operation, the ram weight 45 impacts the driven helmet 43 and transfers energy direct to the pile. However, due to the design, the impact energy will not be imparted to the hammer base or any other part of the hammer, so preventing damage.

The hydraulic cylinders 25, 27 mounted at either side of the hammer housing function as an actuator for the ram weight. The cylinders are specially designed for heavy duty operation. At the rear of the housing, a hammer guide is mounted. This is fixed onto the leader.

Figures 6A-6C show how the hammer is fitted over a pile 131 in an environment having restricted height capability defined by the ground 133 and an overhead obstruction such as a ceiling 135.

As shown in Figure 6A, a pile of 2m length is to be driven into the ground. The top of the hammer is some 1.4m above the ground and the top of the leader mast is 2.1m above the ground. The ceiling is 3m above the ground.

Next as shown in Figure 6B, the leader mast is telescopically extended ready to fit over the pile. Then, as shown in Figure 6C, the leader tilts at 45° to enable the helmet to fit over the pile within the height confines of the ceiling.

As shown in Figure 7A, the pile fits into the recess of the driven helmet. The hammer does not touch the ceiling. Therefore, during operation, as the ram weight 45 impacts upon the driven helmet 43 and thus upon the pile, there is no interference with the ceiling 135.

Figure 7B shows how the apparatus can drive a pile into a trench 137 in the ground with a headroom of 2.8m. As shown in Figure 7C, the leader and hammer extend

downwards into the trench, thus reducing the height of extensions above the pile. This is especially advantageous when there are very low overhead obstructions.

A conventional hydraulic oil cooling system for a pile driving machine will normally be mounted at the front of the engine and connected with the radiator. When the engine starts running, it drives the cooling fan with either to expel or to take-in air in order to achieve the desired cooling effect. An alternative arrangement would be to mount the hydraulic oil cooler at the rear of the engine and provide an extra cooling fan, driven by a hydraulic or electrical motor.

As shown in Figure 8A-8D, the system used in this preferred embodiment of the invention is very much different from the aforementioned conventional arrangements. Here, the hydraulic oil cooler 155 is mounted at the rear of the engine 157. When the engine starts running it drives the cooling fan 159 which is mounted in between the engine and a front radiator 161. It will blow-out the hot air and at the same time it takes in fresh air from the rear and passes it through the hydraulic oil cooler. The fresh air cools down the hydraulic oil temperature as well as the engine and hot air is expelled by the cooling fan. The cycle is continuous in order to keep the air fresh. This is particularly suited to use in tropical and other hot climates. The design also helps cut down the number accessory items and maximizes the space in the power pack, thereby increasing the efficiency of the cooling system and reducing maintenance cost.

The electrical control system shown in Figure 9 uses a 24 DC power supply which is fed through diodes and fuse

(5A) to the main switch which is either in the HAND or the AUTO POSITION.

AUTOMATIC OPERATION: When switch in AUTO position, an indicating lamp is illuminated. Timer T1 is switched on through instant contact T2, at solenoid 'B' and a hydraulic valve which operates in the down (DW) direction upon T1 run-out. Therefore delay contact T1 on Timer T2 switches on and self-holds to T2 through delay contact T2. Instant contact T1 drops and solenoid coil 'A' becomes operational (up direction). Upon T2 run-out, delay contact T2 cuts out and T2 and T1 are turned on again, and so the cycle repeat itself.

MANUAL OPERATION: When switch to put in the HAND position, current supply to coil A and B is effected through push buttons a and b to operate the hydraulic valve manually.

STROKE HEIGHT adjustment: Adjustment of the cylinder stroke is effected by adjusting of the Up and Down timer, depending on the height required.

In the light of this disclosure, modifications of the described embodiments, as well as other embodiments, all within the scope of the invention as defined by the appended claims, will now become apparent to persons skilled in this art.



Claims:

1. A self-transportable pile driving apparatus adapted to be capable of use on a site in a place having limited lateral space and headroom;

said pile driving apparatus comprising a hammer;

said hammer comprising:- a housing; a driven helmet; a weight; hydraulic ram means; and cushion means;

an orifice being provided in a bottom end of said housing;

the driven helmet slidably projecting downwardly through said orifice and being retained, relative to the housing, by helmet retention means; a lower part of the driven helmet being provided with a first recess for receiving an upper end of a pile which is to be driven by the hammer,

the weight being slidably located within said housing above the helmet, for falling upon, and hitting, a top part of said driven helmet; the weight being provided with a locating means for locating with said top part of the driven helmet, said locating means comprising a second recess for accommodating said top part of the driven helmet;

said cushion means being provided for cushioning the impact of the weight on the driven helmet and/or said cushion means being provided between the driven helmet and the housing;

said hydraulic ram means being adapted and arranged for lifting the weight so it can thereafter be let to fall on the helmet to drive the pile;

said pile driving apparatus further comprising controlled, powered, support means for supporting the hammer selectively either tilted for transport, or upright for use, and for varying the working height of the hammer during use;



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said pile driving apparatus further comprising chassis means mounted on a self-powered traction means; the hammer and its support means being mounted on the chassis means; the self-powered traction means being motor-driven for said pile driving apparatus to transport itself around the site;

said pile driving apparatus further comprising retractable anchoring means for anchoring said pile driving apparatus during pile-driving operations.

2. A self-transportable pile driving apparatus according to claim 1, wherein said cushion means is provided in or on the top part of the driven helmet for cushioning the impact of the weight on the driven helmet.

3. A self-transportable pile driving apparatus according to claim 1 or 2, wherein said cushion means is provided between the driven helmet and the housing in or on an upwardly facing flange surface of the driven helmet and exterior to said housing.

4. A self-transportable pile driving apparatus according to claim 1, 2 or 3, wherein said powered support means is adapted and arranged to be selectively raised or lowered by being telescopic.

5. A self-transportable pile driving apparatus according to any preceding claim, wherein said hydraulic ram means of the hammer comprises a pair of hydraulic cylinder rams on or adjacent the housing.



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6. A self-transportable pile driving apparatus according to any preceding claim, wherein the hammer further comprises indicator means for indicating the position of the weight relative to the housing.

7. A self-transportable pile driving apparatus according to claim 6, wherein the indicator means comprises a pointer attached to said weight and visible through or projecting through an elongate slot arranged in the housing.

8. A self-transportable pile driving apparatus according to claim 6 or 7, wherein a scale is provided for enabling a quantitative indication of the position of the weight to be obtained.

9. A self-transportable pile driving apparatus according to any preceding claim, wherein the weight comprises an at least partly hollow body, at least partly filled with a weighting substance.

10. A self-transportable pile driving apparatus according to claim 9, wherein the weight comprises a pair of concentric steel tubes, separated by spacers and defining hollow spaces filled with lead weighting.

11. A self-transportable pile driving apparatus according to any preceding claim, wherein the housing of the hammer is fabricated from C-channel members and a bottom steel plate, the housing being structurally reinforced, the lower end of the housing being closed by means of said



bottom plate, which is provided with said orifice, the extent of penetration of the driven helmet into the orifice of the housing being limited by a bottom flange of the helmet.

12. A self-transportable pile driving apparatus according to claim 11, wherein the remainder of the helmet extending up from the bottom flange thereof is generally cylindrical but is provided with a waisted portion where it extends through the bottom plate of the housing, enabling the helmet to be retained by virtue of an annular retention ring attached to the bottom plate and encircling the orifice.

13. A self-transportable pile driving apparatus according to any preceding claim, wherein hydraulic logic valve means for selectively operating at least said hydraulic ram means.

14. A self-transportable pile driving apparatus according to claim 13 wherein the hydraulic logic valve means is incorporated in a single block.

15. A self-transportable pile driving apparatus according to claim 13 or 14, wherein said hydraulic logic valve means comprises at least one solenoid valve.