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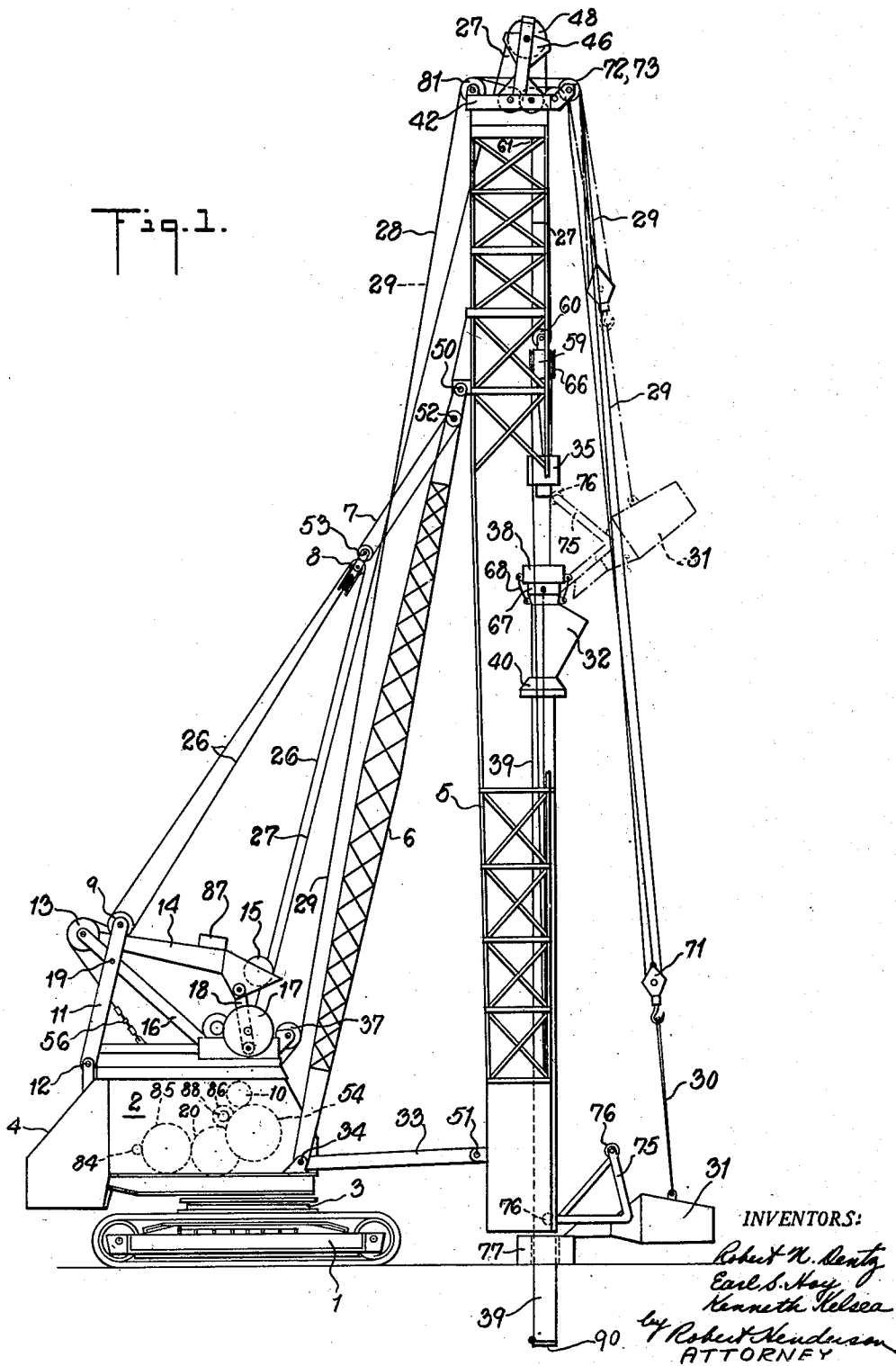
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PILE DRIVER

Filed March 31, 1955

5 Sheets-Sheet 1

Fig. 1.



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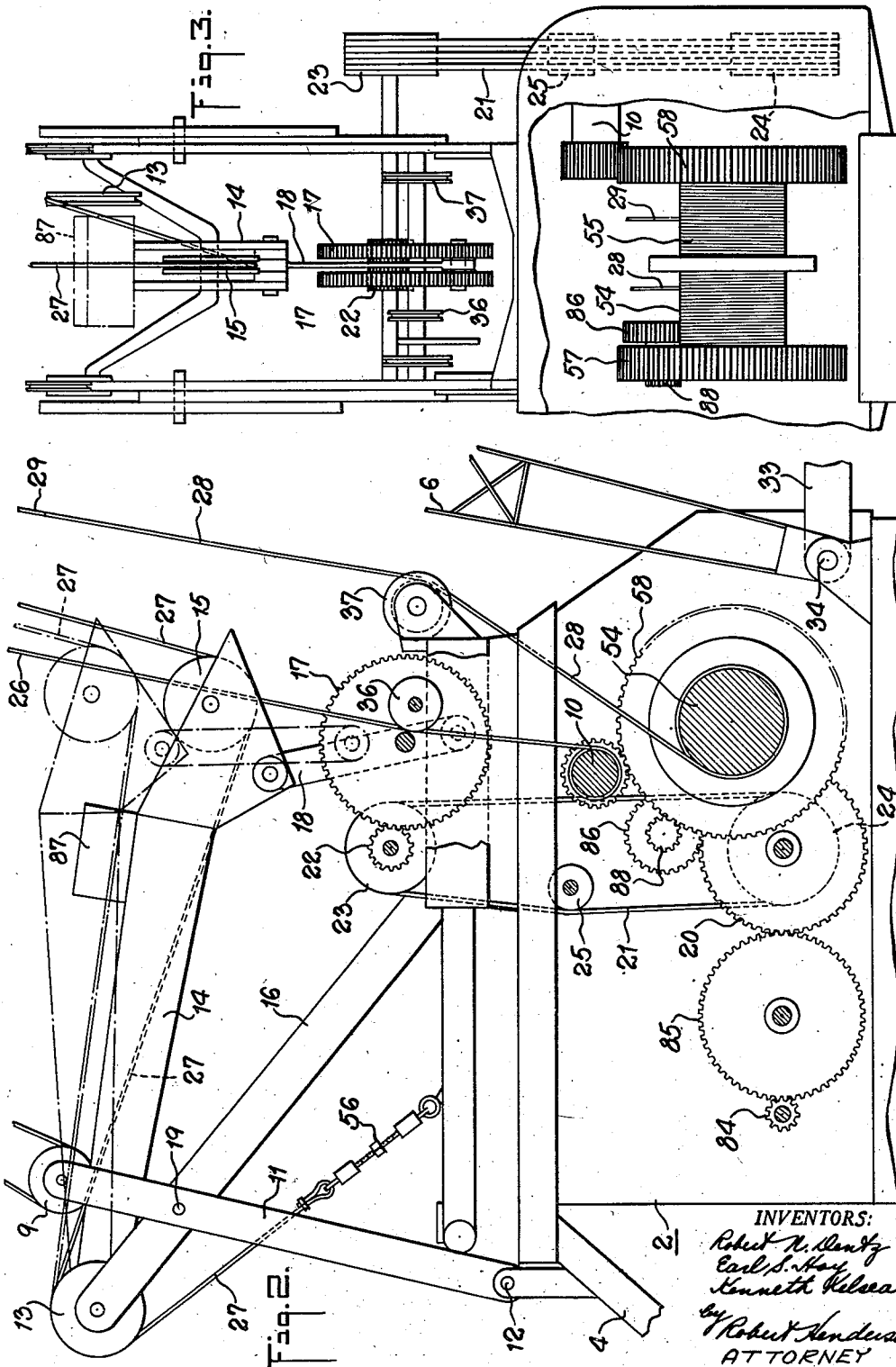
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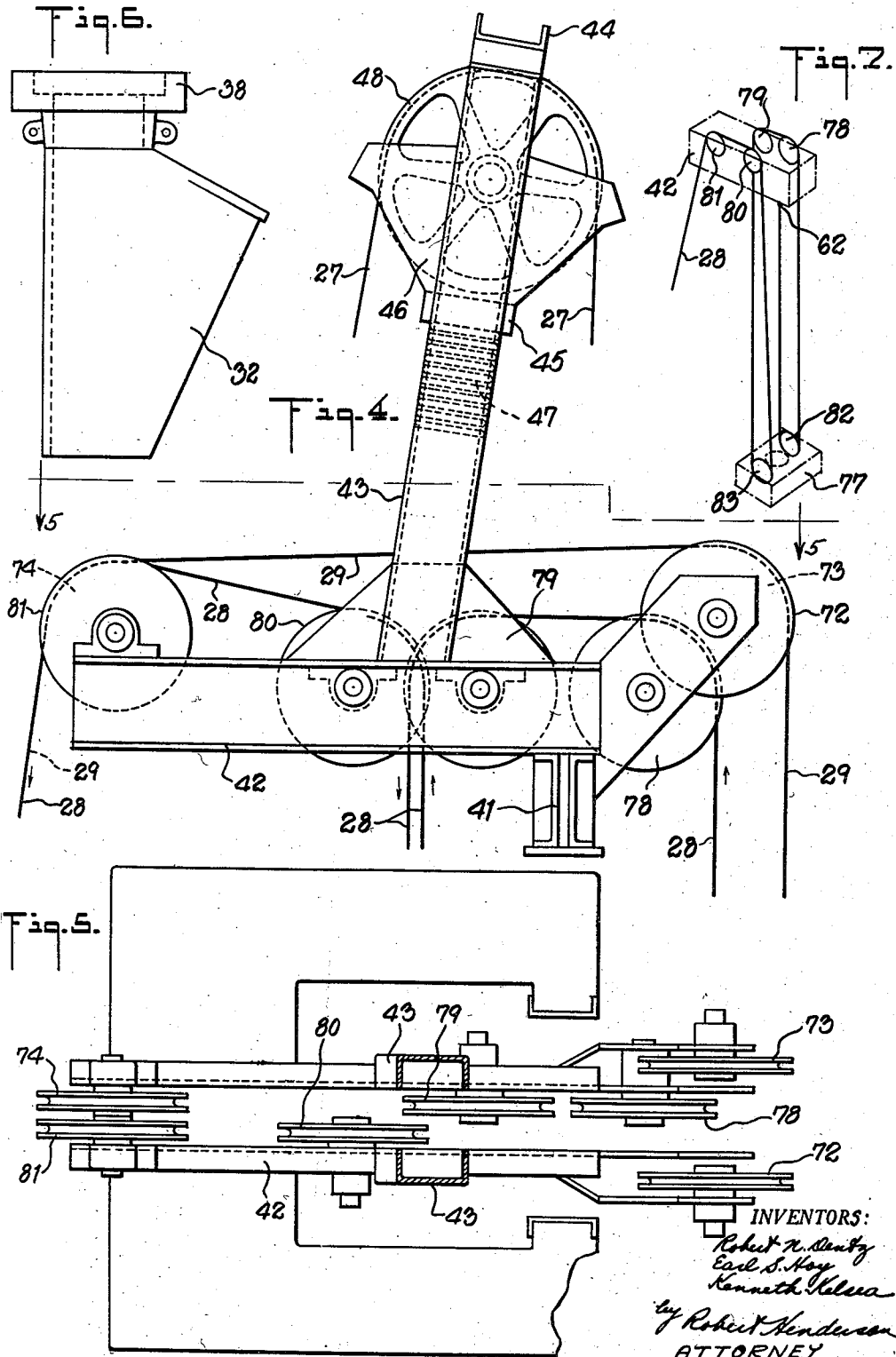
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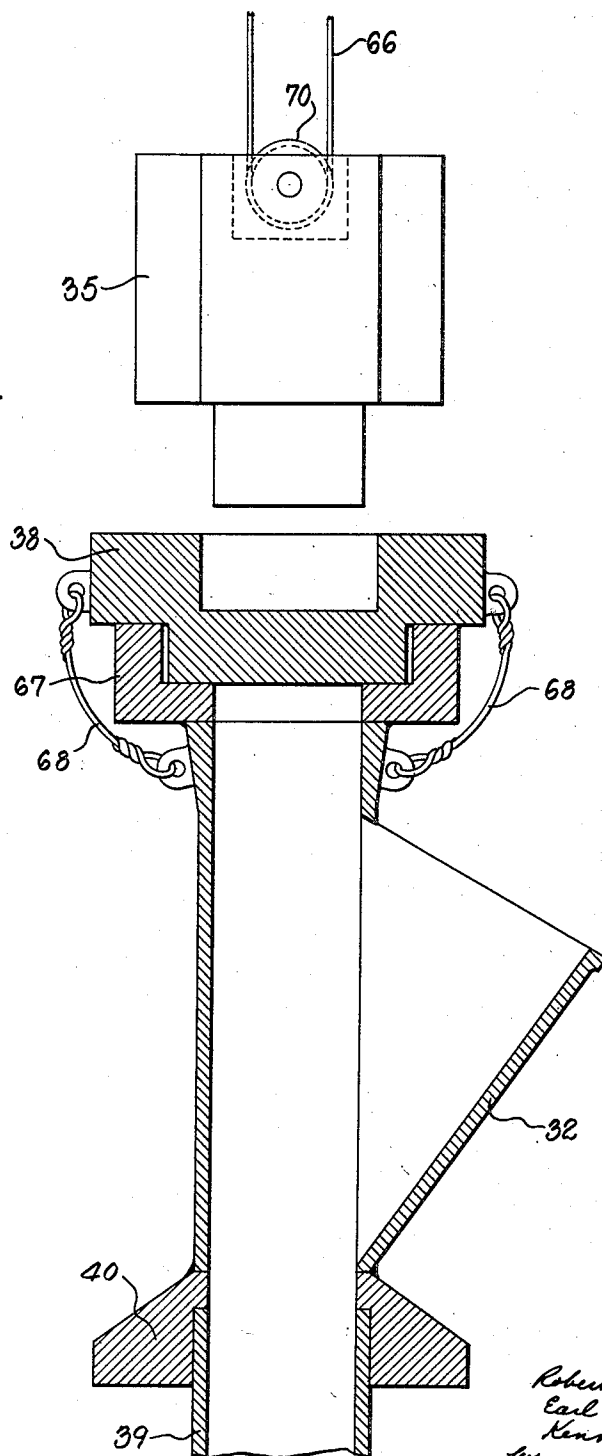
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Fig. 10.



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PILE DRIVER

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3 Claims. (Cl. 61—74)

This invention relates to pile drivers and, more particularly, to a special-purpose pile driver. The equipment herein disclosed as embodying our invention is peculiarly adapted for use in land reclamation work. Consider, for example, an area of marshy or soggy land on which it is desired to build a roadway, or to provide a solid foundation for a building. The ground may be so soft as to provide relatively little support for whatever is to be built thereon. It is found, however, that, if sand can be sunk into the mud to suitable depths, and in the form of piles, or cores which function with a sand blanket to drain moisture from the marshy earth, the spacing-apart of these cores being determined according to the requirement for drainage and weight support, and according to the softness and the depth of the marshy condition of the ground, then the pile driver of our invention becomes a very useful means for sinking such piles or cores for the stated purposes.

Our pile driver, briefly described, comprises essentially a tower in the form of a so-called "lead" or guide structure. The lead has guideways for the guidance of a hammer as it is lifted and dropped on an anvil. The anvil is at the top of a hopper, and the latter is attached to or made integral with a cap of a pipe or tube to be driven into the ground. A so-called "skip," or bucket, is raised and lowered by means of a skip hoist line, and is used to pour sand into the hopper while the pipe is driven into the ground. A dolly surrounds the pipe and rests at the ground level until the pipe has been driven into the ground. Then the dolly is raised by means of a dolly hoist line to extract the pipe, leaving the sand from the pipe in the ground to form a core or pile. Then the tower or lead is moved to a different position so that the operation can be repeated.

The tower and all of the apparatus operatively associated therewith are supported on a windlass frame. The necessary hoist lines are trained on sheaves and on winding drums of the windlass. An oscillating arm controls the lifting and dropping of the hammer.

An important feature of our invention is concerned with the improved means which we employ for causing the hammer automatically to follow the anvil as it descends from hammer impact and inertia. Heretofore, it has been necessary for the operator, using a foot-control, to pay out the hammer hoist line from the windlass drum, bit by bit, as the pile would sink with each hammer stroke. This extremely exhausting, nerve-racking and inefficient operation is entirely avoided by our improved automatic control.

Other novel features of our invention will be brought out in the hereinafter-stated objects and in the more detailed parts of this specification.

An important general object of our invention is to provide an improved special-purpose pile driver having a mechanically actuated hammer, in combination with means for driving a long pipe into the ground, means for simultaneously filling the pipe with sand, and means

for extracting the pipe, leaving the sand in the ground upon extraction of the pipe.

Another important object is to provide improved, substantially automatic means for causing the hammer to follow the pile in the latter's descent.

Another important object is to provide a suitable construction of the tower or lead and of the hammer and anvil which will facilitate removal of the latter members from the lead whenever necessary for repairs or replacement.

A further object is to provide suitable means for pouring sand into the pipe concurrently with the pile driving operation.

Again, it is an object to provide improved, windlass-operated tackle means connected to a dolly for extracting a driven pipe or pile from the ground.

The achievement of these and other object will now be explained in detail by describing a preferred embodiment of our invention. We use this particular embodiment illustratively, but we believe that our contribution to the art is of sufficiently broad scope to comprehend various modifications of structure within the invention.

In the detailed description of our invention, reference is made to the accompanying drawings in which:

Figure 1 is a more or less diagrammatic, side elevational view of a pile driver according to the present invention, showing the entire assembly of parts, certain of which are illustrated in more detail in other figures;

Fig. 2 is an enlarged, side elevational view, of part of the side illustrated in Fig. 1, showing certain details of control equipment, particularly a device for oscillating the hammer; also, other devices including a windlass for operating various hoist lines;

Fig. 3 is an end elevational view of the same details as presented in Fig. 2, as seen from the right side of the latter figure;

Fig. 4 is a side elevational view of a preferred construction for mounting sheaves at the top of the tower or lead;

Fig. 5 is a horizontal sectional view of the construction otherwise shown in Fig. 4, substantially on the irregular line 5—5 of the latter figure;

Fig. 6 is a side elevational view of a hopper which serves to funnel sand or other loose material into a pipe or hollow pile;

Fig. 7 is a perspective, diagrammatic representation of sheave and cable arrangements and a dolly for extracting the pipe from the ground;

Fig. 8 is a side elevational, diagrammatic view of interrelated components, including the pile-head, surmounted by the hopper and the anvil, and, above all that, the hammer and the hammer hoist line; also, at the bottom, a dolly for extraction of the pipe or pile after the same has been sunk into the ground;

Fig. 9 is an elevational, diagrammatic view of the components otherwise appearing in Fig. 8, as seen from the right side of the latter figure; and

Fig. 10 is an enlarged side view, principally in central, vertical, cross-section, of the hammer, the anvil, the pipe-head, the hopper and related equipment.

Referring first to Fig. 1, we show a preferred mounting of our pile driver on a turn-table 3 which is carried by a caterpillar 1. A windlass 2 is of somewhat conventional type and embodies winding drums 10, 54 and 55 (Figs. 2 and 3), gears and other parts of a conventional windlass assembly, including clutch and brake mechanisms. A showing of these details has not been presented, since they are well known in the art and they are not of the essence of our invention. Furthermore, we have omitted to show a power source for operating the windlass and the caterpillar, although the need for power drive is obvious. It will be understood, also, that the equipment includes essen-

tial control levers or equivalent means for hand and foot operation, but these, being conventional, likewise are not shown, since they would add nothing to the clarity of this description of our invention.

The tower or lead 5 comprises vertical guide members or ways within which a hollow pile 39 and a hammer 35 are guided. The tower is supported in a vertical position by means of a boom 6 and a radius frame 33, both of which are pivotally secured to the windlass frame 2, as by means of an anchor bolt 34. This means of support is also complemented by a boom hoist line 26 and by a block and tackle arrangement and related parts. Near the bolt 50 which fastens the upper end of the boom 6 to the tower 5 is a block 52 for holding a cable loop 7. This loop extends downward to another block 53 which is pulled downward and backward by the boom hitch hoist line 26. Block 53 and a pulley 8 are linked together and one end of the line 26 is fastened to the under side of the connecting link. This line extends downward to block 9, which is held by a brace member 11, the latter being anchored by an anchor-bolt 12 to the windlass frame 2 and also being bolted to another brace member 16, as by a bolt 19.

The hitch hoist line 26, after running through the block 9, extends upwardly and through the pulley 8, thence downward past a deflecting idler pulley 36 (Fig. 2) to a drum 10 on which it is wound. Drum 10 is driven by a coaxial gear which engages with the main windlass gear 58 and is suitably adapted to be disengaged therefrom after the tower 5 has been brought into its desired upright position. Conventional pawl or equivalent means, not shown, are used to prevent unwinding of the drum 10 except when further adjustment of the boom hoist line is needed.

On the rear end of the windlass frame is mounted a counterweight 4 to balance the weight of the tower as well as the hammer and other forwardly-situated components.

The mentioned brace member 16 serves as a spar for holding at its rear end a sheave 13 over which is trained a hammer hoist line 27. This line is preferably hitched to a turn-buckle 56 (Fig. 2) and is trained under a sheave 15 and upward to and over a sheave 48 (Figs. 8 and 9) at the top of the tower 5. Thence the hammer hoist line 27 is directed downwardly to and under a sheave 60, carried by a hammer dolly 59. The line 27 extends upwardly again to a fixed termination upon an anchorage eye 61 which is fastened to the framework of the tower 5.

Sheave 15, as may be understood from Fig. 2, is rotatably mounted at the free end of a rocker spar 14, the pivotal support for which is provided upon the fixed spar 16 which has been hereinbefore referred to as a brace member for carrying the sheave 13. The free end of rocker spar 14 is arranged to be swung up and down by means of a pitman 18 which interconnects the spar 14 and an eccentric pin on the side of a gear 17. Gear 17 is driven by a smaller gear 22, the shaft of which is common to a pulley 23. Pulleys 23 and 24 are intercoupled by means of a belt 21, the latter being held taut by means of an adjustably positioned idler pulley 25. Pulley 24 is coaxial with respect to and driven by a gear 20, one of a train of power transmission gears the others of which are referenced 84, 85 and 86.

The application of power for driving the pulley 24, also the drums 54, 55 and 10, all selectively, involves the utilization of conventional selective clutches, gears, pay-out brakes and operating control levers such as are well known in the art and need not be illustrated or described in this specification. Suffice it to say that they are conventionally provided to meet all of the operational requirements of our pile driver, enabling each control to be used independently of the others, sometimes singly, as well as concurrently when desired. The shaft of gear 84 is that to which connection is made to the power source.

From the foregoing description, it will be seen that the

rocker spar 14 may be oscillated up and down at will, and, by doing so, the raising and lowering of the hammer dolly 59 above the hammer or ram 35 is accomplished. This ram is suspended from the dolly in a novel manner which will now be explained, particularly with reference to Figs. 8 and 9. These figures are skeletonized in order to show more clearly the cable suspension and the sheaves for controlling hammer operation to cause the hammer to drive the pile completely with a substantially unvarying stroke, despite the fact that the dolly 59 is rapidly moved up and down by the rocker spar 14 within fixed upper and lower limits while said dolly remains at a high location near the top of the tower 5.

Unlike pile driving operations where numbers of piles are driven into the ground and left in place, the pile 39 is repeatedly sunk into the ground and filled with sand while the hammer or ram 35 forces it downward. Then the pile is extracted, leaving a sand core in the hole. Thus, the pile itself remains a part of the operating equipment and normally does not need to be detached from the pile driver components with which it is operatively associated, unless for repairs or replacement.

The pile 39, as used in our pile driver, is sometimes called a mandrel because it determines the cylindrical diameter of the hole in the ground, wherein a sand core is to be formed and left in the ground after the pile is extracted. Assembled with the pile 39 are these components, a pipe cap 40, a hopper 32 for pouring sand into the pipe or pile 39, an anvil seat 67 and an anvil 38. As shown in Fig. 10, the parts 40, 32 and 67 may be separately formed and welded together, or they may originally be fabricated as a single casting. The anvil seat 67 is recessed at the top to receive (with suitable clearance) the lower portion of the anvil 38. This anvil is also recessed to receive the butt end of the hammer 35, the recess being of larger diameter than that of the hammer butt so as to allow for a certain amount of mushrooming of the latter without sticking.

Since the anvil 38 and the anvil seat 67 fit together loosely, they are preferably joined together by means of short pieces of cable 68. The hammer and the anvil are also channeled on opposite sides so as to be guided by the lead members of the tower 5.

Referring again to Figs. 8 and 9, we show therein our novel method of suspension of the hammer 35 from the oscillating dolly 59. We employ a cable 63 the mid-portion of which is looped over two sheaves 66 on dolly 59 and extends downward and under a pulley 70, the latter being rotatively mounted on top of the hammer, or within a recess of the same. Opposite ends of the suspension cable 63, after being led over the sheaves 66, extend downwardly to sheaves 69 which are rotatively mounted on the framework of the tower 5 toward the lower end of the latter; thence the cable 63 extends upwardly to fixed anchorage at anchoring lugs 64 on the anvil seat 67 above the pipe cap and hopper. This disposition of the cable 63 enables the hammer to follow down and repeatedly strike the pile to drive it without, however, requiring the cable 27 to be payed out under manual control as has been necessary in the past.

In practice we have used a hammer the weight of which is of the order of 7,500 pounds and the starting point of the hammer head before dropping it on the anvil is about high enough to allow a 36" to 40" drop while the rocker spar 14 moves from its lowest to its highest position. The cable 27 is adjustably lengthened or shortened by the turn-buckle 56 so that, when the rocker spar 14 is at the high point of its stroke and the hammer strikes the anvil, there will be a suitable slackness in said cable to avoid any damping action on the hammer blow.

It will be noted that while the dolly 59 moves up and down within a fixed range, due to the oscillation of the rocker spar, and due also to the fixed anchorage of the hammer hoist line 27 at both ends, the hammer stroke is also held within a fixed range approximately twice as great

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as that of the dolly 59. But at the same time, each driving blow applied to the anvil 38 lowers the lower and upper limits of hammer movement, due to the fact that the cable loop between the sheaves 66 and the pulley 70 is lengthened by the same amount that the distance is reduced between the lugs 64 and the sheaves 69. Furthermore, this arrangement constitutes a means causing the hammer to follow the pile down to an extent approximately corresponding to the distance of sinking of the pile in response to each hammer blow and inertia in the pile immediately following such blows. A heavy counterweight 87 is mounted on the rocker spar 14 for at least partially balancing the weight of the hammer 35 and for equalizing the power load as applied to the rocker spar through the pitman 18.

The operation of filling the hollow pile with sand is carried on concurrently with that of pile driving, in order to conserve time. We accomplish this advantageous result by the use of a so-called "skip" or bucket 31 and a skip hoist line 29 which operates through suitable pulley blocks and has one end wound on a drum 55 (Fig. 3), the other end being attached to a pulley block 71. The skip hoist line is drawn over sheaves 72 and 73 (Fig. 5) which are mounted at the upper end of the tower 5. The loop of cable suspended from these sheaves is threaded through the block 71. Cable 29 runs horizontally across from sheave 73 to sheave 74 and thence downward past an idler pulley 37 to the drum 55 on which it is wound.

The skip 31 is attached to a hook on the block 71 by means of a bridle 30 so as to be hoisted to a proper level for spilling its load of sand into the hopper 32. It is provided with suitable gating means at the funnel-shaped outlet and a control rope therefor, the details of which are not shown because they are conventional. When the skip lies on the ground it can be quickly loaded with sand in any suitable manner.

The skip 31 is provided with strut frames 75 rigidly attached thereto. The upper and lower extensions of these frames have rollers 76 so as to be guided in vertical channel bars of the tower lead. The rollers on the lower extensions ride within the grooves of the channel bars. The rollers on the upper extensions ride on the outer surfaces of these channel bars so as to enable the skip to be dropped on its side when reaching the ground. According to our present design of the skip, its capacity is substantially half as great as that of the hollow pile 39. It is our practice to tip the sand-filled skip and hoist it to a level above the hopper 32 just as the pile driving operation is about to be started. The skip and the hopper are lowered together as the pile driving is continued; that is until the skip has been emptied. Then a second load of sand in the skip is raised to the proper height above the lowered position of the hopper, to fill the pile.

The details of construction at the top of the tower 5 are best described with reference to Figs. 4 and 5. The upright members of the tower are held together at the top by means of cross-bar beams 41 and 42. These members also support brackets for journaling certain of the sheaves, and also a superstructure which provides resiliently supported journal bearings for a sheave 48, this sheave being one which carries cable 27 on which the oscillating hammer-suspension dolly 59 is hung. Said superstructure comprises an assembly of U-bars 43 and 44, so constituted as to provide ways within the flanges of U-bars 43 for guidance of a pulley block 45, the latter being resiliently supported. It has side plates 46 in which a sheave 48 is journaled. Block 45 is shown as resting on a heavy helical spring 47 which is of the type commonly used in railway trucks, although, if desired, we may use other cushioning means as, for example, an assembly of discs of interleaved metal and sheet rubber in place of the spring 47. This resilient mounting for the sheave 48 contributes toward relieving the shocks and strains on the superstructure which would otherwise

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result from the continual raising and dropping of the hammer 35.

The cross-beams 41 and 42, together with brackets attached thereto, give journal-bearing support to seven sheaves, of which sheaves 72, 73 and 74 carry the skip line 29, while sheaves 78, 79, 80 and 81 carry the dolly hoist line 28 which is used for extraction of the pipe or pile 39. Dolly 77 is suspended by the hoist line 28 and is equipped with two sheaves 82 and 83. This dolly has a hole extending vertically through it of sufficient diameter to allow the pile to slip freely through it. Initially of a pile-driving operation, the dolly rests on the ground and the bottom end of the pile is dropped through the hole in the dolly. When the pile has been driven all the way down as far as it will go, the operator controls a wind-up of the line 28 on the drum 54 (Fig. 3), thus lifting the dolly 77 up under the pipe cap 40, whereby a continuation of the winding operation causes the pile 39 to be extracted. The course of the cable 28, as shown by Fig. 7, is from an anchorage eye 62 on the tower beam 42 through sheaves 82, 78, 79, 83, 80 and 81, in that order, and thence to the drum 54 (Figs. 2 and 3).

Referring again to Figs. 2 and 3, it will be seen that drum 54, on which the dolly hoist line 28 is wound, is coaxial with respect to drum 55 on which the skip line 29 is wound. Winding and pay-out operations by these drums are independent one with respect to the other, since the power transmission or braking action on release is through gear 57 for drum 54 and through gear 58 for drum 55. These gears mesh with one and the other of two pinions 88 which are independently driven. As stated hereinabove, we employ conventional clutching and braking devices for controlling all of the hoist lines independently, so that it does not appear necessary to go into these structures in this specification.

The pile 39 has suitable means at its lower end as, for example, a pivoted flap or cover 90 (Fig. 1), normally in its illustrated horizontal or closed position while the pile is being driven, to exclude from the interior of the pile any of the earthy material into which the pile is being sunk. As the pile 39 is lifted by dolly 77, the flap 90 may be forced open by the weight of the column of sand within the pile, thereby permitting the sand to remain in the earth while the pile 39 is removed. If the weight of the sand column is insufficient to accomplish this, the hopper 32 and the upper end of pile 39 may be suitably closed and compressed air introduced into the upper end of the pile to eject the sand downwardly therefrom.

With regard to the operation of our novel pile driver, this seems to require no further explanation than that heretofore supplied in this specification. It will be understood that our invention is capable of modification in various ways, both as to structure and as to the method of operation, but without departing from its spirit and scope as set forth in the following claims.

We claim:

1. In a pile-driver operating system for guiding and driving a pile vertically into the ground, an upright tower lead, a hammer dolly, dolly-actuating cable means above said dolly and coacting with said lead to suspend the dolly from the lead, near the upper end of the latter, means for approximately equally paying out and retracting said cable means to vertically oscillate said dolly between fixed limits, a vertically reciprocable hammer between said dolly and said pile, first sheave means on said dolly, second sheave means on said lead toward the latter's lower end, and a compensating cable, on which said hammer is suspended, connected between said hammer and said pile, toward the latter's upper end and extending about both said sheave means to cause said hammer, apart from the reciprocation derived by the latter from the reciprocation of said dolly, to descend to approximately the same extent as the pile during the driving of the latter.

2. The combination according to claim 1, said compensating cable having two opposite, similar portions which are inter-continuous, said cable being looped about a sheave on said hammer at the juncture of said two portions.

3. The combination according to claim 1, further including an oscillating rocker spar with an oscillating end of which said dolly-actuating cable means coact to be payed out and retracted to cause vertical reciprocation of said dolly and said hammer.

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