

July 1, 1930.

J. H. THORNLEY

1,769,169

FILE DRIVING APPARATUS

Filed Aug. 13, 1926

2 Sheets-Sheet 1

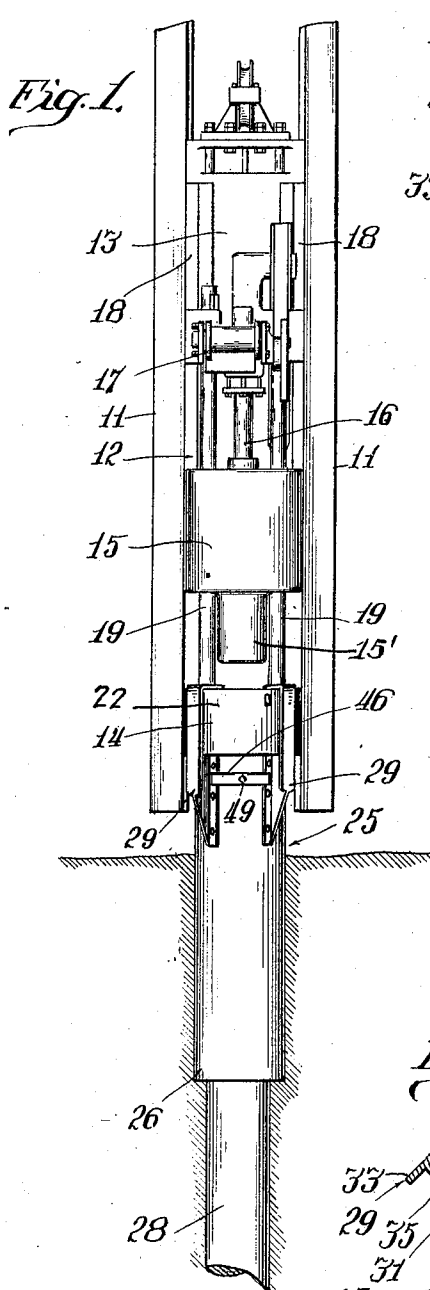


Fig. 5.

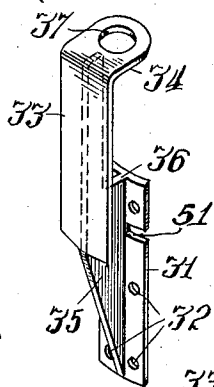


Fig. 2.

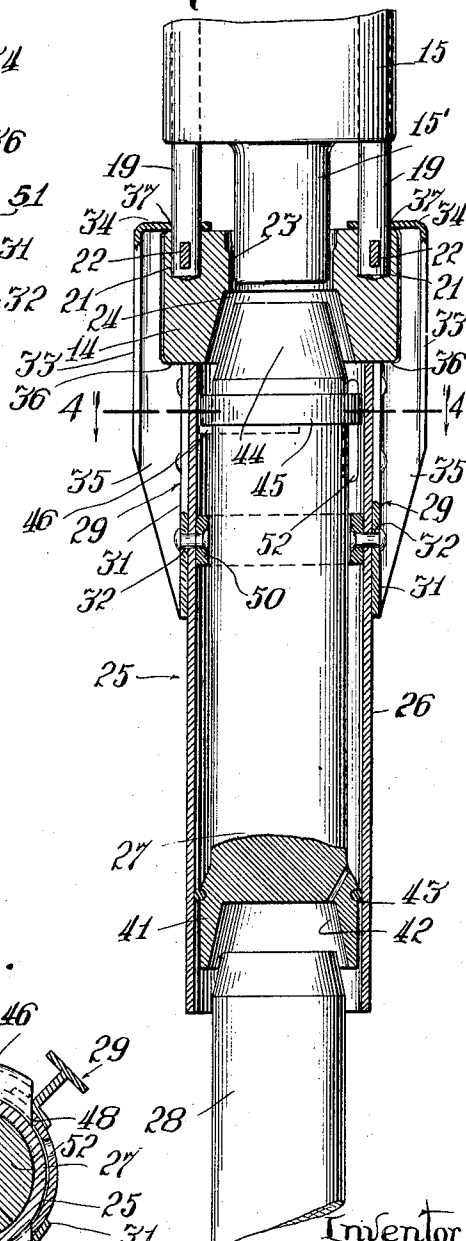
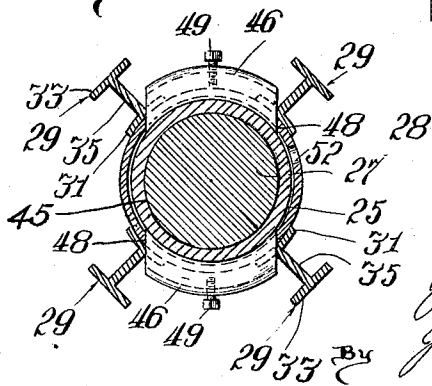


Fig. 4.



Witnesses
Hulton Lenoir

Inventor
Joseph H. Thornley
John R. Jackson
Attorneys

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PILE DRIVING APPARATUS

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2 Sheets-Sheet 2

Fig. 6.

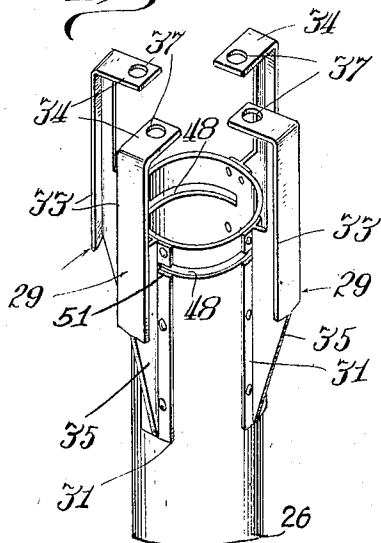


Fig. 8.

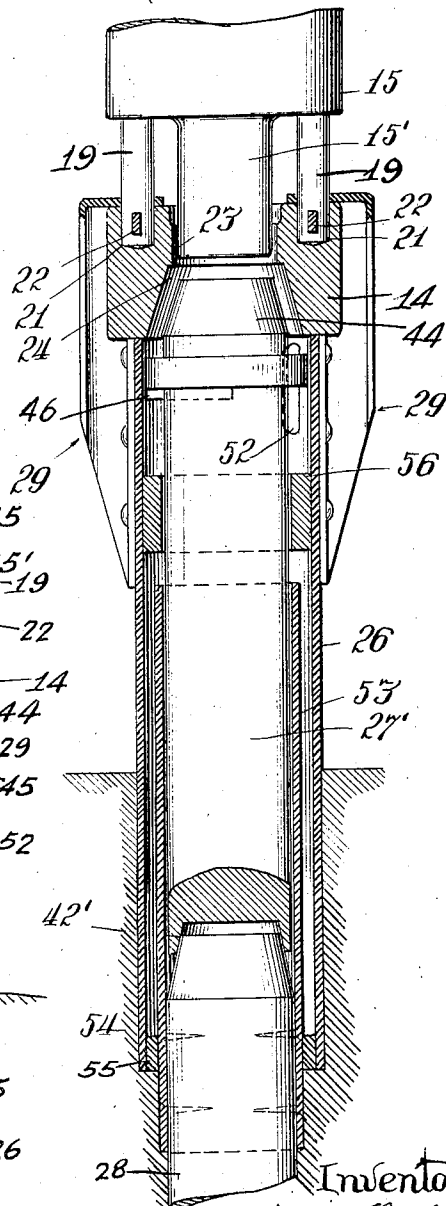


Fig. 7.

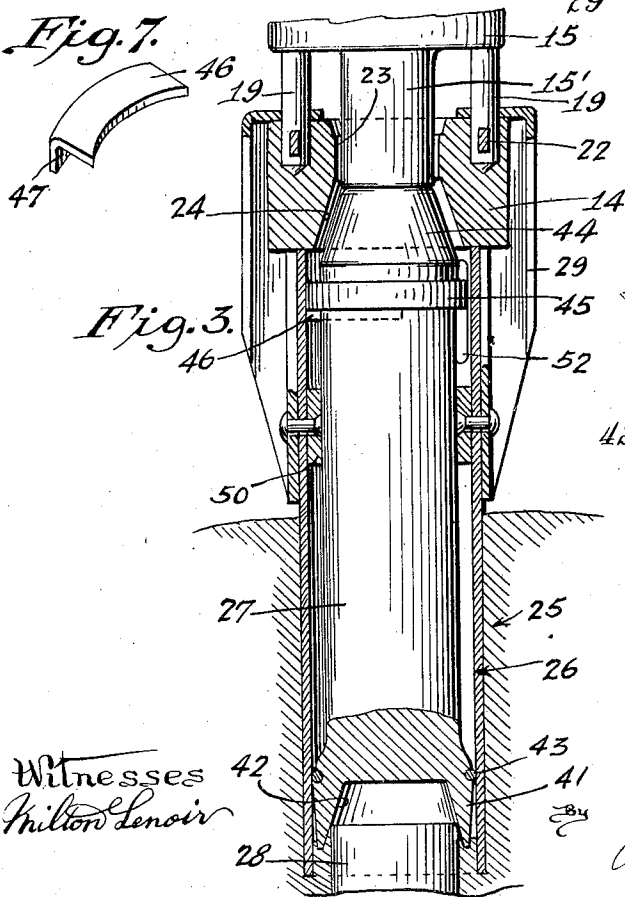


Fig. 3.

Witnesses
Hilton Lenoir

Inventor
Joseph H. Thornley
John R. Jackson
Attorney.

UNITED STATES PATENT OFFICE

JOSEPH H. THORNLEY, OF CHICAGO, ILLINOIS

PILE-DRIVING APPARATUS

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The present invention relates to pile driving apparatus, and has particular reference to improvements devised to enable the upper ends of piles to be driven below ground level. This is impossible with the ordinary pile driving hammer. The guides or leads of the derrick can only extend to the ground level, and obviously the hammer unit cannot continue with the movement of the pile down below the ends of the leads and into the ground.

The desirability of driving piles below ground level is frequently encountered in construction work, and heretofore this practice has involved considerable expense or has been otherwise objectionable. A typical situation wherein it is desired to drive piles below ground level is illustrated in the case of a base, column or pedestal which is to be set down in a pit in the surface of the ground and which is to be supported on the upper ends of piles driven into the ground. Heretofore, in erecting this type of foundation, the piles are first driven down as far as possible with the ordinary pile driving hammer, which in practically all cases leaves some portion of the pile end projecting above the ground level. Thereafter, a pit is dug down to the desired depth by digging the earth from around and between the piles. Finally, the upper ends of the piles are cut off at the proper point to leave their remaining ends projecting to the desired distance above the bottom of the pit. The difficulty of excavating around and between the closely grouped piles, and the difficulty of sawing off the upper portions of the piles at the bottom of the excavation makes the labor cost on this method very high. Furthermore, the load bearing value of that portion of the pile which is cut off is lost, and there is considerable loss of timber in the cut off ends.

In attempting to circumvent these difficulties, it has been proposed to use ordinary loose followers interposed between the ram of the hammer and the head of the pile for continuing the driving of the pile below ground level, but this practice has been objectionable for numerous reasons. One of the principal objections has been the inability

to guide the follower properly. The guiding of the upper end of the follower is not such a problem, but the difficulty arises in guiding the lower end of the follower—and therefore the upper end of the pile—in driving the pile below ground level. If the pile is the least bit out of line with the guides of the derrick, the upper end of the pile will tend to kick sidewise under the blows transmitted through the follower. The freedom of the lower end of the follower to kick sidewise at such times also aggravates this objectionable tendency of the pile head to kick or spring sidewise. The net result of such lateral springing or kicking of the pile is that the earth bond around the upper portion of the pile is loosened and greatly diminished in strength so that the load bearing value of the entire pile is lessened.

Another objection to the use of such follower lies in the inability to judge accurately the load bearing value of the pile after it has been driven to approximately its desired depth. It is customary, particularly in certain soils, to test the load bearing value of the pile as it approaches the bottom of its penetration by measuring the depth of penetration resulting from each blow of the hammer. When the ordinary loose follower is employed this method of determining load bearing value is deprived of all certainty. Such a follower is frequently of larger diameter than the pile, and the frictional resistance thereof with the soil is generally of such degree that it is impossible to tell what proportion of the resistance opposed to the driving action of the hammer represents the load bearing value of the pile and what proportion represents the load bearing value of the follower. Thus, after lifting the follower from the head of the pile, the pile remains with an indeterminate load bearing value.

Another objection to the use of such followers arises from the spring or resiliency therein. Such followers are generally constructed of a section of timber six or eight feet long, and the spring in this length of timber is often sufficient to lessen the intensity of the blow delivered to the pile. The net result of all of these objections has been

that in many localities throughout the country the building codes now expressly prohibit the driving of piles with a follower, particularly where the piles are required to have a definite load bearing value. As before
 5 stated, the need of driving piles below ground level is frequently encountered in construction work to facilitate the building of foundations etc., and where these piles must have
 10 their definite load bearing value, or when they are driven in a locality where the use of a follower is prohibited, it is still necessary to pursue the expensive practice of driving the piles down approximately to ground level
 15 and thereafter excavating around the piles and then cutting off the upper portions of the piles.

It is the fundamental object of the present invention to provide improved means for
 20 driving piles below ground level which will avoid these prior objections and which will enable piles to be driven in a manner complying with the requirements of the building codes. More specifically, it is an object of the
 25 invention to provide an improved construction of pile driving hammer characterized by an extended base and contained core for driving the piles.

A further object of the invention is to provide a construction wherein the penetration
 30 of the pile for each blow of the hammer during the latter part of the driving of the pile can be measured accurately and without being subject to the opposing pressures of the base
 35 extension. It is a further object to provide apparatus of this type which will serve to drive composite piles having metallic sleeve extensions on their upper ends. These piles
 40 are generally constructed of a section of wood piling, to the upper end of which a metallic sleeve is either bolted or spiked with the upper end of the sleeve projecting considerably
 45 above the top of the wood pile. Such piles are usually driven to bring the top of the sleeve extension to a desired level, either above or below ground level, and thereafter the hollow interior of the extended sleeve
 50 portion is filled with concrete to support a cap, pedestal, base or other foundation member. In driving such piles it is practically imperative that the driving blows be imparted
 55 directly to the upper end of the wood pile as distinguished from the sleeve. One embodiment of my improved apparatus has been designed to drive piles of this type, and in such
 60 embodiment the central core or impacting member is arranged to operate within the sleeve extension for applying the driving blows directly to the upper end of the wood pile.

A further object of the invention is to embody this apparatus in a detachable unit which may be readily mounted upon or dis-
 3 mounted from a standard assembly of pile driving hammer so that the unit can be quick-

ly applied and removed in adapting the hammer to different classes of work.

Other objects and advantages will be apparent from the following description of a preferred embodiment of my invention.

In the drawings illustrating this embodiment:

Figure 1 is a front elevational view illustrating a standard hammer unit with my improved base extension mounted thereon, the
 75 apparatus being shown supported between the guides of the derrick and in the act of driving a pile.

Fig. 2 is a vertical sectional view through the base extension and core illustrating the
 80 mounting of this base extension on the base of the hammer unit.

Fig. 3 is a similar sectional view illustrating the relation of the base extension and core in the act of driving a pile below ground
 85 level.

Fig. 4 is a transverse sectional view taken on the plane of the line 4—4 of Fig. 2.

Fig. 5 is a perspective view of one of the brackets for connecting the base extension to
 90 the standard base member.

Fig. 6 is a perspective view illustrating the upper end of the base extension with the several supporting brackets riveted thereto.

Fig. 7 is a perspective view of one of the releasable coupling keys which serve to couple
 95 the casing and core of the base extension, and

Fig. 8 is a vertical sectional view of another embodiment of the invention designed to drive the composite piles before men-
 100 tioned.

Referring to Figure 1, the two vertical guides or leads of the pile driving derrick are indicated at 11—11. Sliding between these
 105 guides is a hammer unit 12, which, for the greater part, is of any standard construction of either single or double acting type. Generally, these units comprise an upper steam
 110 cylinder 13, a lower base member 14 and an intermediate reciprocating ram 15. The ram connects to a piston rod 16 entering the bottom of the cylinder 13 and being attached to a piston reciprocating in this cylinder. Any
 115 suitable valve mechanism 17 serves to admit and discharge the steam from the cylinder.

The unit is guided by two guide channels 18—18 extending substantially from end to end thereof and engaging over the rails or
 120 flanges of the leads 11. The base member 14 is connected to the cylinder 13 by columns 19, generally four in number, which are keyed at their upper ends in a flange formed on the
 125 lower end of the cylinder 13 and which at their lower ends enter sockets 21 formed in the top of the base member 14, in which sockets they are similarly secured by removable
 130 keys 22 (Fig. 2). By thus connecting the base member 14 to the steam cylinder 13 the base member receives the guiding influ-

ence of the cylinder 13 in the movement of the cylinder between the leads 11.

The four columns 19 serve as guides along which the ram 15 reciprocates relatively to the cylinder 13 and base 14.

It will be observed from Fig. 2 that the ram 15 has an extension 15' which plays in an opening 23 formed in the base member 14. In the construction of hammer shown, this base member also has a flaring recess 24 for receiving the upper end of the pile directly, the ram extension 15' ordinarily delivering its blows directly to the head of the pile in such instances where the pile directly engages within the opening 24. The preceding construction of hammer has been chosen for illustrating the present invention merely because it represents a popular, conventional type, but it will be understood that the invention has application to other types of hammer units as well.

In embodying my improvements in this type of hammer unit I employ a base extension, indicated in its entirety at 25, which depends from the main base member 14. This base extension functions as a guide for a contained core or impacting member 27 and for the head end of the pile 28. To this end, it may be constructed in various forms, the principal requirement being that it have ample guiding and bracing rigidity for guiding the core 27 and pile 28. For simplicity of construction I preferably make the same from a section of heavy pipe or tubing 26, cut to the desired length. For most purposes this length will be approximately six or eight feet, but it may be extended to much greater lengths for deep driving, if desired. The upper end of the casing 26 is firmly anchored to the base member 14 by a plurality of heavy brackets 29 which are riveted to the sides of the casing and which embrace and are connected to the base member.

One of such brackets is shown in Figure 4, from which it will be seen that it consists of a section of H beam having its flanges and web cut away to form the necessary attaching surfaces. The inner flange 31 is provided with a plurality of rivet holes 32 by which this flange of the bracket is riveted to the upper end of the casing 26. This flange may be bowed or curved on a longitudinal axis to afford maximum area of contact with the side wall of the casing. The upper end of the outer flange 33 is folded inwardly to form a hook like supporting member 34 for engaging over the top of the base member. The web 35 is cut back intermediate the top of the inner flange 31 and the outer flange 33, this cut away portion receiving the side surfaces of the base member 14. There are preferably four of such brackets spaced equidistantly around the casing 26, as best shown in Figure 6, and these brackets embrace the sides or corners of the base member. When

the casing is being driven into the ground in the operation of driving the pile, the entire upper end thereof bears against the flat bottom of the base member 14 thereby affording an extensive area of bearing engagement between the base and base extension for retaining the two in alinement. The shoulders 36, formed by the upper ends of the bracket flanges 31 and by the cut away portions of the webs 35, also increase this area of bearing engagement. When the casing is being withdrawn from the ground after the pile has been completely driven, the effort of lifting the casing by the hammer unit is imposed on the hook like extensions 34. This withdrawing effort is much less than the driving effort of the casing. These hook like extensions have holes 37 therein through which pass the lower ends of the columns 19 in effecting their anchored engagement in the base 14, and this engagement of the members 34 with the columns prevents any possibility of the base extension becoming accidentally disengaged from the hammer unit. When it is desired to adapt the hammer unit to other classes of work the entire base assembly consisting of the main base member 14 and the base extension 25 may be removed for substitution by a standard base member (similar to the base member 14) by simply removing the keys 22; or, the entire base assembly can be first removed in this manner, and thereafter the main base member 14 can be disengaged from the base extension 25 and replaced on the supporting columns 19. The keys 22 can be removed by simply driving them from one end out of their sockets in the base member 14.

Contained within the casing 26 is a core or impacting member 27, preferably constructed of metal, such as steel. The lower end of this member is preferably formed with an enlarged head 41 in which is formed a tapered socket 42 for receiving the upper end of the pile 28. It will be understood that the pile 28 is representative either of a wood pile, a pre-cast concrete pile, a steel pile, or any other type of pile. The lower head of this core member is guided within the lower portion of the casing 26 either by contacting with the casing directly or through a bearing ring 43 recessed in the periphery of the head portion. The upper end of the core member is tapered as indicated at 44 to be received within the opening 24 in the base member. The driving blows of the ram extension 15' are imparted directly to this tapered end of the core, the lower end of the core normally resting on the head end of the pile, and the velocity impact occurring between the upper end of the core and the ram. Directly below this tapered upper end 44, a relatively wide collar 45 is keyed or otherwise rigidly fastened to the core member. This collar functions as an upper guide surface for guid-

ing the upper end of the core within the casing. It also functions as a stop shoulder against which releasable keys 46, carried by the casing, engage. During the initial driving of the pile while the casing 26 is above ground level, the casing will follow the descent of the pile along with the cylinder and base of the hammer unit under the action of gravity. After the casing encounters the ground, however, as shown in Fig. 3, driving effort has to be imparted thereto concurrently with the driving of the pile to make the casing follow the pile into the ground. This is the function of the keys 46. One of such keys is shown in Fig. 7, from which it will be seen that it is constructed in the form of an arcuate plate having a downwardly turned lip 47 along its outer edge. Two of these keys are disposed at diametrically opposite sides of the casing, sliding in arcuate slots 48 cut in the sides of the casing and serving as key sockets or key ways. The inner edges of these keys are adapted to engage under the lower edge of the collar 45 while the core and casing are being driven together, the keys being held in this position by cap screws or studs 49 which engage in holes in the lips 47 of the keys and in the sides of the casing. The inner flanges 31 of the brackets 29 may be cut away at 51 in forming the slots 48, if the use of relatively wide keys is desired. The fastening of the brackets to the columns 19 groups these brackets about the base 14 so that one pair of brackets will lie on the outer side of the plane of the derrick leads, and the other pair on the inner side thereof where they will not interfere with the leads. The two keys 46—46 are similarly disposed on the outer and inner sides of the casing where they can be readily removed without interference by the leads.

A relatively long vertical slot 52 is cut in the casing 26, extending above and below the plane of the collar 45, through which the movement of the collar can be observed for reckoning the descent of the pile, and thereby determining the final load bearing value of the pile, after the keys 46 have been removed.

In the operation of the apparatus, the base extension is centered over the upper end of the pile with the pile guided between the leads 11, and thereupon the pile is driven down into the ground approximately to the desired depth. When the pile is first started into the ground, and before the lower edge of the base extension 26 has engaged the ground, said base extension is free to drop downwardly, the connected parts of the hammer unit consisting of the cylinder 13 and base 14 of course moving downwardly with the base extension. This downward movement will be limited by the flaring recess 24 in the base member 14 engaging with the tapered end 44 of the core, or by the lower edge of the re-

cess 24 striking the collar 45 on the core. After the driving operation has been continued to the point where the base extension or casing 26 enters the ground, as shown in Fig. 3, a resistance is set up to further downward movement of the casing, and thereupon the engagement of the collar 45 against the keys 46 compels the casing to follow the pile down into the ground. Preparatory to delivering the last blow or blows to the pile, the keys 46 are withdrawn or released which disconnects the core 27 of the base extension from the casing thereof. Thereafter, the final blow or blows delivered to the core will be only effective on the pile 28, and by sighting through the slotted opening 52, and watching the movement of the collar 45, the descent of the pile for each of such blows can be measured. This will give an accurate indication of the load bearing value of the pile, as the downward movement of the pile at this time is not impeded by the resistance of the base extension. After these final blows, the base extension and core are pulled up out of the ground through the action of the hoisting cables raising the hammer unit, where the core and casing are again properly associated for the driving of another pile by the replacement of the keys 46 in position below the collar 45. In order that the core and casing will not become separated during this withdrawing operation, a ring 50 is fixedly secured within the casing just below the slot 52. This ring or collar will engage the bottom of the collar 45 on the core and hold the core within the casing during the operation of lifting the latter.

While the pile is being driven, the upper end of the core 27 is held accurately centered in the opening 24 of the base member, and any lateral stresses set up between the upper end of the core and the base member, incident in the pile being deflected out of alignment with the leads, will be transmitted directly to the base member and thence to the leads. Hence, there is no possibility of displacement of the upper end of the core or of the hammer unit from any such side thrust. Similarly, any lateral stresses set up between the pile head and the lower end of the core, arising from disalignment or deflection of the pile, will be resisted by the guiding influence of the heavy outer casing 26. The rigidity of the bearing engagement between this casing and the base member 14 will result in such lateral stresses being transmitted directly to the base member where they will be resisted by the leads of the derrick. Thus, here again, any side kick or thrust incident between the head end of the pile and the lower end of the core cannot force the core out of line, where the effect of its blows would be largely dissipated in flexing the upper portion of the pile and loosening the earth bond thereof.

The modification illustrated in Fig. 8 differs from the preceding embodiment principally in the provision of an annular space between the core and casing into which the sleeve like extension on the upper end of the composite pile can extend. This sleeve like extension is indicated at 53, and consists of a very light shell, since its only function is to serve as a temporary form for the concrete which is subsequently joined to the top of the wood pile. The lower end of such sleeve extension is spiked or bolted to the upper end of the pile at 54. The lower end of the core 27' is of sufficiently small diameter to pass down within this sleeve extension and engage the upper end of the wood pile section directly. If desired, the lower end of this core may be formed with a tapered socket 42' for engaging over the tapered upper end of the wood pile. The inner diameter of the casing 26 may have guiding contact at its lower end directly with the exterior of the sleeve 53, or a ring 55 may be secured in the lower end of the casing for guiding contact with the sleeve. A relatively wide ring 56 is preferably riveted or bolted to the interior of the casing 26 adjacent its upper end for guiding engagement with the upper portion of the core. This guide ring affords a longitudinally extended bearing engagement between the core and casing and avoids the necessity of bearing contact between the lower end of the casing and the pile sleeve 53, where this is desirable. Such guide ring also holds the core and casing against complete separation in withdrawing the casing from the ground. The remainder of the structure is substantially a duplication of the preceding embodiment and need not be again described.

In the operation of this embodiment, the composite pile is driven through impacting blows transmitted through the core 27' directly to the head end of the wood pile section, whereby there is no possibility of injuring the metallic sleeve extension 53 of the pile. The extended base 26 affords the same guiding influence against side thrust, as in the preceding embodiment. After the pile has been driven to the point where the upper end of the sleeve 53 is at approximately the desired distance either above or below ground level, the base extension and core are removed. The load bearing value of the pile may, of course, be determined by removing the keys 46 preparatory to delivering the last blow or blows. With the core and casing of the extended base removed, the interior of the sleeve extension 53 may be filled with concrete, and any suitable reinforcement embedded therein, for mounting an upper cap, pedestal or the like.

It will be observed that by driving the piles according to this method any pit or excavation which may be desirable for receiving

such cap, pedestal or the like, can be readily dug without interference from the piles.

While I have shown what I consider to be a preferred embodiment of my invention, it will of course be understood that such embodiment is merely exemplary of the essence of the invention and that proportions and the arrangement of the parts can be varied considerably without departing therefrom.

What I claim as my invention and desire to secure by Letters Patent, is—

1. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a base extension rigidly secured to and depending from said base, and an impacting member guided by said base extension, said impacting member being adapted to rest upon the upper end of the pile and to receive the driving blows of the ram.

2. In pile driving apparatus, the combination of a cylinder and ram embodied in a hammer unit, an impacting member disposed between said ram and the head of the pile, and guide means fixedly secured to said hammer unit for guiding the lower end of said impacting member and the upper end of the pile.

3. In a pile driving apparatus, the combination of a pair of leads of a derrick frame, a driving unit reciprocating between said leads, an impacting member adapted to have its lower end rest on the upper end of the pile and adapted to receive the blows of said driving unit at its upper end, and guide means cooperating with the lower portion of said impacting member and rigidly secured to said driving unit for laterally restraining the lower part of said impacting member and the upper end of the pile.

4. In pile driving apparatus, the combination of derrick leads, a hammer unit mounted therein and comprising a cylinder and ram for driving the pile, and a tubular guide fixedly secured as a depending extension of said hammer unit for laterally guiding the upper end of the pile after it has been driven below ground level.

5. In pile driving apparatus, the combination of a pair of derrick leads, a hammer unit, a follower member adapted to be interposed between said hammer unit and the upper end of the pile and to follow the end of the pile below ground level, and guide means receiving the guiding influence of said hammer unit for laterally guiding the lower end of said follower member and the upper end of said pile after the lower end of said follower member has passed beyond the guiding influence of said leads.

6. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a guide extension fixedly secured to and depending from said base, an intermediate member vertically guided by

said guide extension and transmitting the driving blows of the ram to the upper end of the pile, and releasable means for compelling said guide extension to follow the downward movement of the pile below ground level.

7. In a pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a base extension depending therefrom, a core guided for vertical movement in said base extension, the lower end of said core being adapted to rest on the upper end of the pile and the upper end of said core receiving the driving blows of said ram directly, and a releasable key for coupling said base extension and said core together for concurrent downward movement.

8. In pile driving apparatus, the combination of a hammer unit comprising an extended base constituting a fixed part thereof, a core member guided for reciprocatory movement within said extended base and adapted to transmit driving blows from the hammer unit to the upper end of the pile, releasable means for compelling downward movement of said extended base with the pile below ground level, and means for indicating the penetration of the pile for each driving blow when said base extension is released from said core member.

9. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a tubular extension fixedly secured to and depending from said base, a core vertically guided within said tubular extension and delivering the driving blows of said ram to the upper end of the pile, and means for compelling downward movement of said tubular extension and said core below ground level, said latter means being releasable to permit said core to transmit a blow to the pile unimpeded by the resistance of said tubular extension for measuring the load bearing value of the pile.

10. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a tubular extension depending from said base, a core vertically guided within said tubular extension and transmitting the driving blows of said ram to the upper end of said pile, releasable means for compelling said tubular extension to follow the downward movement of the pile below ground level, and means for indicating the penetration of the pile per blow of the ram when said last named means has been released.

11. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a tubular extension depending from said base, a core vertically guided within said tubular extension and transmitting the driving blows of said ram to the upper end of said pile, releasable means for compelling said tubular extension to fol-

low the downward movement of the pile below ground level, and a sight opening in said tubular extension through which the movement of the core, and thereby the movement of the pile, can be determined after said tubular extension has been released from said core.

12. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a cylindrical casing depending from said base, a plurality of brackets secured to said casing and engaging with said base to fixedly suspend said casing therefrom, and a core vertically guided within said tubular extension.

13. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a cylindrical casing, a plurality of brackets extending between said base and said casing for fixedly securing said casing below said base, means permitting disconnection of said brackets to permit separation of said casing and base, and a core vertically guided within said casing.

14. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, vertically extending columns joining said cylinder and said base, a tubular casing depending from said base, brackets secured to said casing and embracing the sides of said base, supporting extensions on said brackets engaging said columns, and a core vertically guided within said casing.

15. In pile driving apparatus for driving composite piles having sleeve extensions on their upper ends, the combination of a cylinder, ram and base embodied in a hammer unit, a tubular extension fixedly secured to and depending from said base, and a ram within said tubular extension, the lower end of said ram being receivable within the sleeve extension on the upper end of a composite pile for transmitting the driving blows of the ram directly to the lower section of said pile, said tubular extension embracing and guiding said ram and said sleeve extension.

16. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a tubular extension depending from said base and connected thereto, a core extending longitudinally of said tubular extension, a collar on the upper portion of said core, and an arcuate key plate in a key slot in said tubular extension and engaging with said collar.

17. In pile driving apparatus, the combination of guide leads, a cylinder, ram and base embodied in a hammer unit and having guiding engagement with said leads, a sleeve portion fixedly secured to said base whereby said sleeve portion receives the benefit of the guiding engagement of said hammer unit with said leads, and a follower guided at its upper end within said sleeve portion and

adapted to transmit the driving blows of said ram to the pile.

18. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a sleeve fixedly secured to said base, a follower having relative reciprocatory movement within said sleeve, said follower transmitting the driving blows of said ram to the pile, shoulder means on said follower and cooperating shoulder means on said sleeve adapted to engage during the lifting of said hammer unit for lifting said follower from the upper end of the pile.

19. In pile driving apparatus, the combination of a cylinder, ram and base embodied in a hammer unit, a sleeve fixedly secured to said base and depending therefrom, and a follower guided at its upper end within said sleeve, said base having an opening therein, said ram imparting driving blows to said follower through said opening, said follower transmitting said blows to the upper end of the pile.

JOSEPH H. THORNLEY.