

July 9, 1957

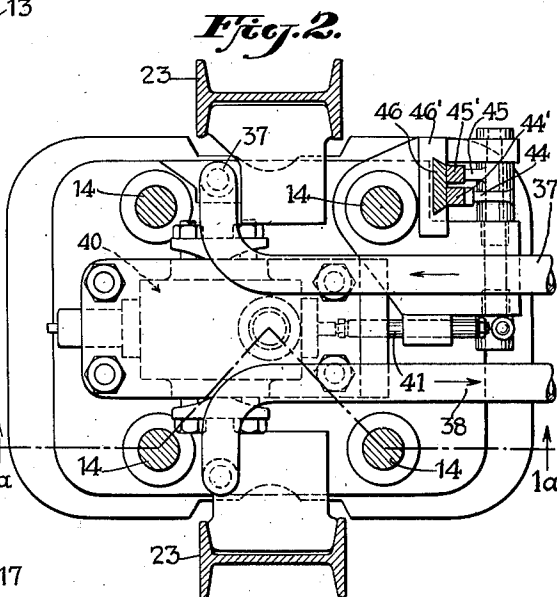
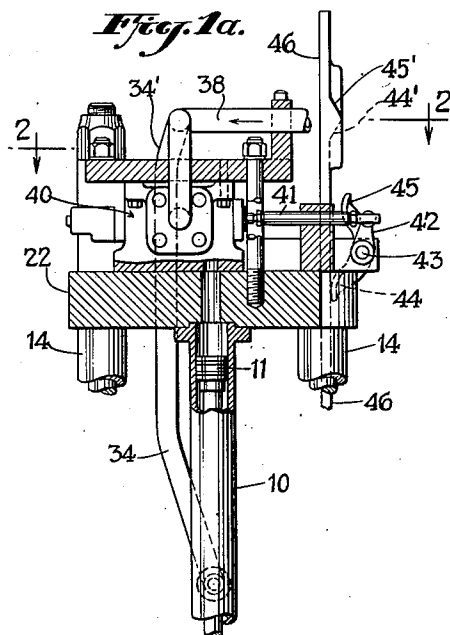
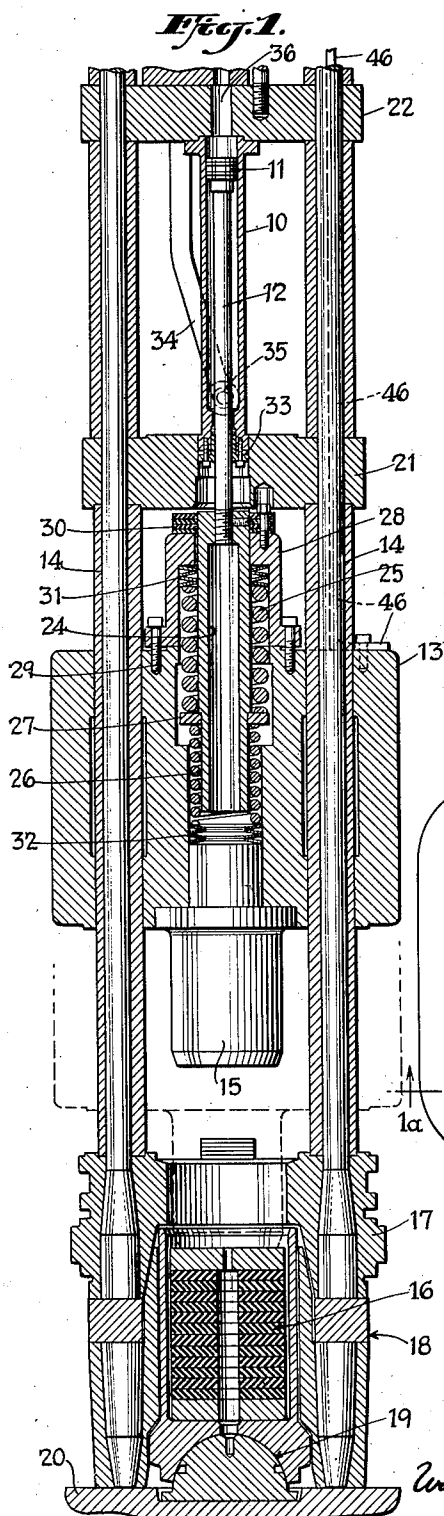
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2,798,363

HYDRAULIC PILE DRIVING HAMMER

Filed May 17, 1956

2 Sheets-Sheet 1



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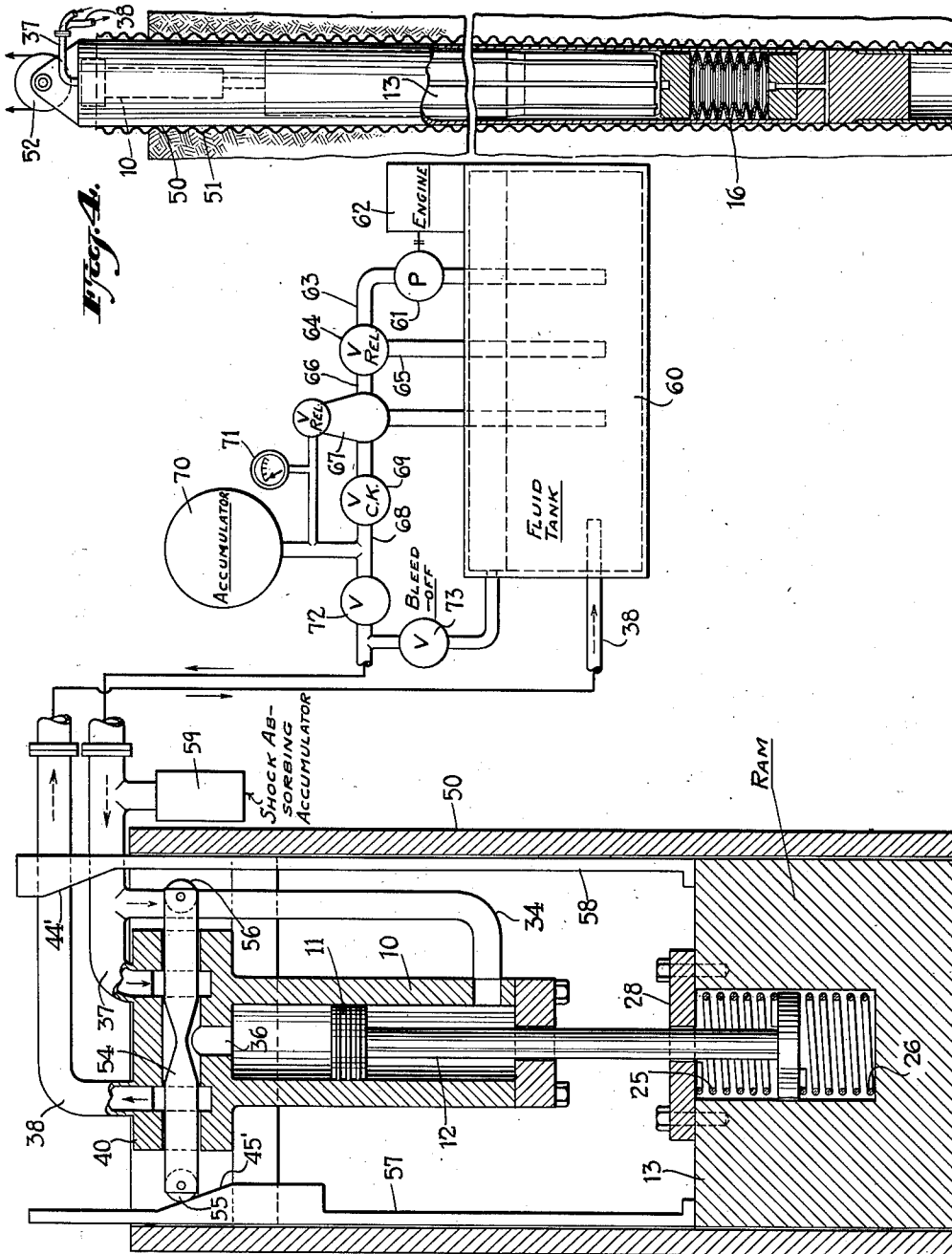


Fig. 3.

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HYDRAULIC PILE DRIVING HAMMER

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Application May 17, 1956, Serial No. 585,439

11 Claims. (Cl. 61—76)

This invention relates to pile driving hammers and the like and more particularly to hydraulically operated hammers.

For many years, it has been the general practice to drive piles by the use of steam hammers. Yet such steam hammers have a number of serious disadvantages. For example, the steam pressure which may in practice be used is generally limited to about 150 pounds per square inch, and with such relatively low pressures, in order to provide a differential piston arrangement of such size as to operate a 5000 pound ram, for example, the upper piston must be of a diameter of nearly 14 inches, which is generally too large to permit the hammer to be fitted into the upper end of a pile driving core and thus substantial portions at least of the hammer must extend above such a core and this in turn minimizes the available headroom in the pile driving assembly, which is an important factor in pile driving, particularly in the case of the driving of long piles. The necessary piston size if steam is used, is also a limiting factor in the case of hammers of types not to be contained in a pile core and if, as is often desirable, very heavy rams are to be used. For example, to operate a ram of 15,000 pounds or heavier, the upper piston diameter, if steam is used, must be about 24" or more. With a cylinder and piston of such sizes, difficulty may be encountered in finding sufficient space to support the hammer between the pile driver leads, unless the latter and the supporting structure therefor are made excessively bulky and heavier than is the present practice.

Another disadvantage of steam hammers resides in the fact that the overall efficiency in the use of fuel, of the steam boiler and steam hammer, is very low. Also the burning of fuel for the boiler creates a smoke nuisance and fire hazard, and as the steam which escapes from the hammer generally contains some oil, this creates a further nuisance as well as objectionable noise.

Upon superficial consideration, it would appear that the above difficulties with steam hammers for the purpose could be overcome by the use of hydraulic hammers, since by the use of hydraulics, operating pressures of thousands of pounds are possible to be maintained by pumps driven with high efficiency from internal combustion engines, thereby avoiding the nuisances and losses of inefficient boilers and of discharging steam. Hydraulic pistons may be made quite small, even for operating the heaviest rams, and small enough to mount the hammer down in the pile driving core or conveniently to suspend the hammer between the leads of standard pile drivers, even though the ram used is much heavier than heretofore generally attempted.

However, so far as is known, successful hydraulic pile driving hammers have not been heretofore developed or used and the use of hydraulics for the purpose has involved difficulties which have not heretofore been surmounted. Authoritative treatises on the use of hydraulic pistons for moving any large masses connected thereto have many times expressed a caution against any attempt to move the piston at a rate faster than two feet per

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second, due to the destructive hydraulic shocks occurring when the valves and the direction of stroke are reversed. Such a speed is much too low for efficient pile driving. Experts in the art of hydraulic pistons also have long expressed caution against moving any large masses operated by hydraulic pistons unless the assembly is decelerated at controlled rates such as to avoid hydraulic shock on the system and consequent breakage of pipes, pumps and other components of the system. Like precautions have also long been taught against attempting instantaneously or practically instantaneously to stop the hydraulic piston assemblies at the end of each stroke. It has also been the general belief that it is impractical to directly couple a hydraulic piston to a control valve to control its stroke because of the difficulties of having the valve stop on dead center.

With the present invention, these long-recognized difficulties of hydraulically-operated piston and heavy mass assemblies are overcome by the expedient of yieldably associating the hydraulic system with a heavy ram, at least substantially at the time when the hydraulic piston is approaching the end of its stroke, thereby permitting further travel of the ram and completion of its stroke in such a way that the stopping of movement of its heavy mass does not cause a destructive shock on the hydraulic system. This may be accomplished by yieldably connecting the piston rod and ram as for example by a spring arrangement or other resilient means compressible in the direction of the stroke. However, there are other possible expedients for attaining such yieldable association of the ram with the system, or for aiding in doing so conjointly with such a flexible connection. For example, the hydraulic cylinder may be yieldably mounted so that at the termination of the stroke of the piston in the cylinder, the piston will stop with respect to the cylinder and with respect to the body of liquid therein without undue shock to the system, even though the cylinder and piston assembly, being yieldably mounted, moves with the ram to completion of its stroke. Also means may be provided in effect to yieldably discharge liquid from beneath the piston at the end of its stroke as by the use of accumulators of appropriate size, applied to the liquid intake connection to the cylinder, or by spring-release valves or other valves operable to be actuated at the end of the stroke to release liquid from beneath the piston back to the source of liquid supply.

However, the expedient of using a yieldable connection between the piston and ram, supplemented by the use of an accumulator, if desired, constitutes the presently preferred arrangement for the purpose. Such a yieldable connection in the form, for example, of a spring arrangement, may be so devised that when the piston for example approaches the end of its down-stroke, the control valve acts abruptly to release the hydraulic pressure above the piston and since the hydraulic piston may be relatively small and light, the piston itself can abruptly stop, whereas the ram, being resiliently attached thereto, is free to advance further to fully complete its stroke and apply the desired impact. The control valve for the piston is so actuated by means connected to the ram, that such continued movement of the ram will insure complete reversal of the control valve without danger of its stopping on dead center and thus insuring that the return stroke of the piston will promptly start. Assuming that a differential type piston is used, the return or upward stroke of the piston itself can be abruptly stopped at the desired moment by admitting hydraulic pressure again into the upper part of the cylinder, whereas the ram being yieldably connected to the piston, will be more gradually brought to a stop and its final upward travel will insure complete reversal again of the control valve to cause forceful and prompt starting of the next down-stroke.

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Thus while the quite small lightweight hydraulic piston itself may be quite abruptly stopped at the end of each stroke, its weight is insufficient to cause destructive hydraulic shocks in the system and at the same time the ram, while very heavy, is only yieldably involved with the hydraulic system and thus does not tend to cause any destructive hydraulic shocks therein.

In addition to the use of the above-explained spring connection between the hydraulic piston and ram, the hydraulic intake connection to the cylinder may include a shock absorbing accumulator which will tend further to minimize the effects of any hydraulic shocks occurring at the ends of the strokes of the piston ram assembly. In some cases in fact such an accumulator may be used in lieu of the spring connection means between the ram and piston, but ordinarily such spring connection is necessary safely to achieve high speed operation of the hammer, and with such spring connection, satisfactory high speed operation may often be readily achieved without such an accumulator.

Further and more specific objects, features and advantages of the invention hereof will appear from the detailed description given below taken in connection with the accompanying drawings which form a part of this specification and illustrate, by way of example, preferred embodiments of the invention.

In the drawings:

Fig. 1 is a vertical sectional view showing one embodiment of a hydraulic hammer made in accordance with the invention and the upper portions of which are shown in Fig. 1a; portions of Fig. 1a being shown in section taken along line 1a—1a of Fig. 2;

Fig. 2 is a horizontal sectional view taken substantially along line 2—2 of Fig. 1a;

Fig. 3 is a vertical sectional view showing somewhat schematically another hydraulic hammer in accordance with the invention and as contained within the upper end of a pile driving core; and further showing a preferred arrangement of hydraulic pressure supplying and control apparatus which may be used therewith and also with the type of hammer shown in Figs. 1-2; and

Fig. 4 is an elevational view partly in broken section of a hammer as of Fig. 3 and contained in a core being used for driving a pile shell into the earth.

Referring now to the drawings in further detail, the hammer as shown in Fig. 1 comprises a hydraulic cylinder as at 10 containing a differential type piston 11 connected to a piston rod 12 and adapted to be operated for example by oil supplied at a pressure for example in the neighborhood of 2000 to 2500 pounds per square inch. The hammer ram is shown at 13 slidably mounted upon column assemblies 14 which may be of the type disclosed in the co-pending application of Edward A. Smith, Serial No. 544,225, filed November 1, 1955. The ram has a point portion 15 adapted to apply impacts to a cap block assembly indicated generally at 16 and which, if desired, may be of a construction and arrangement such as shown in the patent to E. A. Smith, No. 2,723,532, granted November 15, 1955. The hammer base is indicated at 17, with supplemental base parts 18 for receiving the cap block assembly, beneath which may be located ball and socket means as at 19 such as disclosed in said Patent 2,723,532, for applying the impacts to a so-called hammer follower indicated at 20.

A center plate may be provided as at 21 for retaining the lower end of the cylinder 10 in proper position with respect to the column means 14. A top plate forming a cylinder and valve support is indicated at 22.

This embodiment of the invention, as will be apparent from Fig. 2, is adapted to be slidably suspended between the followers or guide rails as at 23 of a pile driving hammer crane structure.

The lower end of the piston rod 12, as shown in Fig. 1, is connected by threaded engagement with a hollow piston rod extension 24 which is surrounded by an upper

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helical spring 25 and a lower and somewhat smaller helical spring 26. The extension 24 has a flange portion 27 secured thereto on its exterior and located between the adjacent ends of these two springs. The extension 24 is slidably retained in position by member 28 which embraces same and is secured as by screws 29 to the ram 13. The upper end of the extension 24 may be surrounded by a rubber buffer member 30, which, at the end of each upstroke of the hammer, may strike against the underside of the center plate 21. Spring washers such as assemblies of Belleville washers or the like or other resilient means are positioned as at 31, 32 above the upper end of spring 25 and below the lower end of spring 26.

Suitable packing means as at 33 surrounds the piston rod at the lower end of the cylinder and is contained within a central aperture in the center plate 21.

Hydraulic pressure is constantly maintained on the lower side of piston 11 and surrounding the piston rod 12 by a connection 34 terminating at a port 36 opening into the lower end of the cylinder. Hydraulic pressure is applied to the upper face of the piston 11 during each down-stroke, through a connection 36 passing through the top plate 22.

The piston 11, being arranged to operate as a differential piston, it will be understood that the downstroke is caused by the hydraulic pressure against the upper face of the piston supplemented by the weight of the ram. While the hydraulic pressure will at the same time be applied to the undersurface of the piston, yet the effective area of such undersurface, due to the presence of the piston rod, is quite small as compared with the effective area of the upper surface, and accordingly the pressure under the piston does not act to prevent the down-stroke. A valve is provided as hereinafter described which, at about the time of the starting of the upstroke, will relieve the hydraulic pressure against the upper face of the piston 11 so that the pressure beneath the piston will then be sufficient to raise the piston and the attached ram. The piston on its upstroke acts to force the liquid above the piston back to the source of supply as will be hereinafter explained more fully. Thus even if the hammer is located at a point far below the level of the hydraulic supply tank, it will operate properly without any additional liquid return pump.

Referring now more particularly to Figs. 1a and 2, the incoming pressure supply connection is shown at 37 and the liquid return connection is shown at 38. A reciprocating valve of suitable known type is contained within a valve chamber 40. Such valve may be constructed to operate in the manner hereinafter further explained, for example, in connection with the embodiment of Fig. 3. Such a valve may be operated by a reciprocable rod 41, which in turn is pivotally connected to a small crank 42 as shown in Fig. 1a, this crank being mounted on a rockable shaft 43. Such shaft is adapted to be rocked by rockable trip members 44 and 45 secured thereon. These trip members respectively are adapted to be engaged by cam surfaces as at 44' and 45' formed on a valve operating rod 46, which in turn is mounted on the ram 13 so that such cam surfaces are reciprocated during each stroke of the hammer in accordance with the movements of the ram. The rod 46 may be slidably received in a guideway member 46' (Fig. 2).

A branch 34' from the pressure intake connection 37 runs down to the pressure connection 34 for maintaining the pressure beneath the piston in the cylinder 10 at all times during operation of the hammer.

The operation of the hammer of Figs. 1-2 may be described as follows. First, we will assume that the piston is in its uppermost position as shown and that the ram, acting through the cam means and one of the trip members, has just caused the valve in chamber 40 to move to a position to admit hydraulic pressure to the upper surface of the piston. Thereupon the down-stroke will

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start by reason of such pressure supplemented by the weight of the ram and opposed somewhat by the hydraulic pressure constantly maintained on the smaller and undersurface of the piston 11. The down-stroke will proceed until the ram has carried the valve-operating cams down far enough so that the trip member 44 will be engaged and operated by the cam surface 44'. Then the valve in chamber 40 will be actuated to release abruptly the hydraulic pressure above the piston and as soon as the upstroke starts, the liquid will be forced from the cylinder space above the piston out through return connection 38. While the release of the hydraulic pressure above the piston substantially at the moment of termination of the down-stroke of the piston, will cause the piston rather abruptly to stop its downward movement due to the pressure in under the piston, yet the ram, because of the presence of the spring 25, will not thus be abruptly stopped in its downward movement, but will be able to complete the impact of the ram point 15 against the cap block 16. The final downward movement of the ram will insure movement of the control valve fully to its position for releasing the pressure above the piston to the outlet connection 38. Also during the final downward movement of the ram, the spring 25 will have become compressed somewhat and this will tend to cause the ram to rebound, inasmuch as the spring will be reacting against the piston rod and at this moment, pressure under the piston will be tending to force the same upwardly and the upward movement of the ram will thus be promptly and forcefully started and will continue until the piston reaches a point near the upper end of its stroke. Meanwhile, the pressure under the piston will cause the piston forcibly to eject the liquid from above the piston out through the return connection 38 back to the hydraulic supply source.

As the piston approaches the upper end of its stroke, the cam and trip members will act to move the valve in the direction to close off the return connection 38 and to readmit the hydraulic pressure through connection 37 onto the upper surface of the piston. This will cause abrupt stopping of the upstroke of the piston, but the ram on the other hand, due to the presence of spring 26, will be less rapidly decelerated in its upward movement. And the ram will continue upwardly somewhat further and far enough to insure that the valve is completely opened to permit free admission of hydraulic pressure to the upper face of the piston. Meanwhile, spring 26 will have become compressed somewhat and thus this spring reacting against the now downwardly moving piston assembly, will tend rapidly to start the down-stroke of the ram, aided by gravity, and such down-stroke will be powerfully continued by the hydraulic pressure above the piston.

Spring 25 when under compression tends to act against the force of gravity on the ram and hence this spring should be relatively large. Spring 26, however, when under compression, tends to act with the aid of gravity, and therefore this spring may be somewhat smaller. Spring 25 should, of course, be large enough to support the weight of the ram during the upstroke and also, in the event the impacts of the hammer should be against a pile in soft ground, then the spring 25 should be heavy enough to resist and stop excessive downward movement of the ram at the proper time. And if the impacts are applied against a pile such that the ram tends to rebound considerably, such rebound will be enhanced by the heavier spring 25 and thus cause more rapid starting of the upward stroke of the ram.

A hydraulic hammer of the example of the invention above described and with a 5000 pound ram, has been found capable of delivering in the neighborhood of 110 blows per minute with a stroke of from 16 to 18 inches. At this speed, the maximum velocity of the ram was about 13 feet per second, corresponding to over 13,000

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foot pounds of delivered energy on each stroke. The cost of fuel for operating the pump driving engine for such a hydraulic hammer amounts only to some twenty-five percent or less of the fuel required for operating such a steam hammer of equivalent size. The above-described type of hydraulic hammer is also particularly well adapted for use in cases where much heavier rams are desirable as when a short stroke hammer is preferred and in cases where only low headroom is available, necessitating a short stroke. And since oil may be used as the hydraulic liquid, the construction is well adapted for use where boiler water is not easily obtainable or where low temperatures would be liable to cause freezing, of the water supply and water connections.

The form of the invention as shown in Figs. 3 and 4 somewhat schematically in the interests of simplicity, is embodied within the upper end of a pile driving core 50 such as may be used for driving for example a tapered corrugated steel pile shell as at 51 (Fig. 4). As indicated in Fig. 4, substantially all parts of this form of hammer, except for a sheave-supporting assembly 52 and the connection hoses, may be located down below the upper end of the core. This is of great advantage as above noted, in that it makes possible greatly increased headroom, whereas in the prior steam hammer constructions, at least a part of the hammer, and more often all of it, because of the size of the piston assembly, had to be located above the core. Thus the fact that the hydraulic hammer of this invention requires a piston assembly of only very small diameter, makes it possible to provide not only a much more compact and lighter arrangement, but also it should be noted that the hammer impacts will occur down substantially within the core, thus muffling to a large extent the sound of the impacts. The fact that this hydraulic hammer does not involve the noise of any escaping steam or other fluid, coupled with the fact that the region of the impacts is entirely enclosed, makes it possible to drive piles at locations, such as near hospitals or residential areas, where heretofore the accompanying noise has been highly objectionable.

The parts corresponding in function to those of Figs. 1-2, although shown in somewhat simplified form in Fig. 3, are identified by the same reference characters. Here the valve chamber 40 is shown as containing a reciprocable piston type valve piece 54, operated if desired as by cam followers in the form of rollers 55, 56, which are adapted to be engaged respectively by the down-stroke cam 45' and the upstroke cam 44', these cams being supported for example respectively by rods 57 and 58 mounted on the ram 13.

The valve piece 54 is shown in Fig. 3 in its central or dead center position and is about to be thrust to the right to admit liquid from connection 37 to the upper part of the cylinder for starting the down-stroke. When the piston is about to start its upstroke, it will be understood that the cam follower 56 will engage cam 44' for thrusting the valve to the left, allowing liquid from above the piston to be forced out through connection 38.

As shown in Fig. 3, the inlet connection 37 may have connected thereto a shock absorbing accumulator 59. This may be of any suitable known type and preferably one which is capable, in so far as possible, of withstanding for prolonged periods, such hydraulic shocks as same may receive, and to cushion the effect of such shocks in the hydraulic system, as above explained.

The hydraulic fluid, such as oil, may be contained in a tank 60 upon which may be mounted a high pressure hydraulic pump 61 driven by an internal combustion engine 62 for pumping the oil through a connection 63, through a spring-loaded relief valve 64, which has a connection 65 back to the tank for returning liquid thereto in case excess pressures are supplied to the outgoing connection 66.

A pilot pressure-operated unloading relief valve is indicated at 67 for permitting return to the tank of excess

pressurized liquid in the line 68 at a point beyond a check valve 69. Another hydraulic accumulator 70 is connected to the line 68 as may also be a pressure gauge as at 71.

Finally the pressurized liquid may pass through a quick-opening hammer-operated valve as at 72 and thence to the supply connection 37 running to the hydraulic hammer. A manually operable bleed-off valve 73 may be located between the connection 37 and the tank 60.

The return connection 38 from the hydraulic hammer may communicate directly into the tank 60.

It will be understood that various features of the invention may be used in hydraulic hammers of forms which are not necessarily of the differential type. Also the hammers according to the invention are adapted to be telescoped within and enclosed by pile shells of certain types adapted to be driven directly without using a pile core, and the terms "core" and "core assembly" as used herein are intended to apply to such shells and the like as well as to members more strictly referred to as "pile cores."

As shown in Fig. 5, it will be noted that the hammer is substantially fully contained within the confines of the pile core and shell without the necessity of increasing the sizes of the upper portions thereof beyond the usual normal sizes. By the "normal" size of the upper end of the core is meant that same is either straight sided or has no more than the usual slight taper, such as the taper which tapered pile shells customarily have, but not a bulging upper end such as disclosed in the above-mentioned patent to E. A. Smith No. 2,723,532.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A hydraulically operated hammer for driving piles and the like comprising in combination: a cylinder and differential piston and piston rod assembly; a ram; means compressible in the direction of the stroke of the piston for yieldably connecting the piston rod and ram; means for constantly maintaining hydraulic pressure surrounding the piston rod and in under the piston during the operation of the hammer; a valve for controlling the admission and exhaust of hydraulic pressure above the piston; valve operating means; and means connected to and operative in response to movements of the ram to actuate said operating means and thereby operating said valve to admit hydraulic pressure above the piston substantially at the start of each downstroke thereof, and to release such hydraulic pressure from above said piston at substantially the termination of each such downstroke.

2. A hydraulically operated hammer comprising in combination: a cylinder, piston and piston rod assembly; a ram; spring means compressible in the direction of the stroke of the piston for yieldably connecting the piston rod and ram; a valve for controlling the admission and exhaust of hydraulic pressure to the piston; valve operating means; and means operatively connected to and acting in response to movements of the ram to actuate said operating means and thereby operating said valve to admit hydraulic pressure to the piston substantially at the start of each work stroke thereof and to release such hydraulic pressure from said piston at substantially the termination of each such work stroke.

3. A hydraulically operated hammer comprising in combination: a cylinder, piston and piston rod assembly; a ram; two springs compressible in the direction of the stroke of the piston for yieldably connecting the piston rod and ram; one of said springs being positioned to become compressed when the ram, at a time near the end

of its working stroke, continues its movement after the piston stops, the other of said springs being positioned to become compressed when the ram, at a time near the end of its return stroke, continues its movement after the return movement of the piston stops; a valve for controlling the admission and exhaust of hydraulic pressure to the piston; valve operating means; and means operatively connected to and acting in response to movements of the ram to actuate said operating means and thereby operating said valve to admit hydraulic pressure to the piston substantially at the start of each work stroke thereof and to release such hydraulic pressure from said piston at substantially the termination of each such work stroke.

4. A hydraulically operated hammer comprising in combination: a cylinder, piston and piston rod assembly; a ram; two means compressible in the direction of the stroke of the piston for yieldably connecting the piston rod and ram; one of said means being positioned to be compressed to allow the rod and ram to move toward each other, and the other of said means being positioned to be compressed to allow the rod and ram to move in a direction further away from each other; a valve for controlling the admission and exhaust of hydraulic pressure to the piston; valve operating means; and means operatively connected to and acting in response to movements of the ram to actuate said operating means and thereby operating said valve to admit hydraulic pressure to the piston substantially at the start of each work stroke thereof and to release such hydraulic pressure from said piston at substantially the termination of each such work stroke.

5. A hydraulically operated hammer comprising in combination: a cylinder, piston and piston rod assembly; a ram; means for yieldably connecting the piston rod and ram; a valve for controlling the admission and exhaust of hydraulic pressure to the piston; valve operating means; and means operatively connected to and acting in timed relation to the movements of the ram to actuate said operating means and thereby operating said valve to admit hydraulic pressure to the piston substantially at the start of each work stroke thereof and to release such hydraulic pressure from said piston at substantially the termination of each such work stroke of the piston, said yieldable means allowing overtravel of the ram as compared with the travel of the piston.

6. A hammer construction in accordance with claim 5, and in which said yieldable means comprises two springs, one relatively stronger than the other, the stronger spring being positioned to limit downward movements of the ram with respect to the piston, and the other spring being positioned to resist upward movements of the ram with respect to the piston.

7. A hydraulically operated hammer for driving piles and the like comprising in combination: a cylinder, piston and piston rod assembly; a ram; means compressible in the direction of the strokes of the piston for yieldably connecting the piston rod and ram; a valve for controlling the admission and exhaust respectively of hydraulic pressure to the piston on the downstrokes and upstrokes thereof; and means operative in timed relation to the movements of the ram to actuate said valve to admit hydraulic pressure to the piston substantially at the start of each downstroke thereof and to release such hydraulic pressure from said piston substantially at the termination of each such downstroke of the piston, said compressible means allowing overtravel of the ram on its downstrokes and upstrokes as compared with the travel of the piston.

8. A hydraulically operated hammer and pile driving assembly, comprising a hollow core having an upper portion of normal size, a differential piston and piston rod assembly and a ram, all contained within and surrounded by said core, the core being adapted to be surrounded in turn by a pile shell to be driven by the impacts of the ram in the core.

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9. The combination comprising a hydraulically operated pile driving hammer including a cylinder, a hydraulically operated piston and piston rod assembly, a ram connected to the piston rod, and a shell-like member adapted to be driven by the hammer and containing and surrounding all said parts.

10. A hydraulically operated hammer for driving piles and the like, comprising in combination: a hydraulic system including a cylinder, piston and piston rod; a cam; and means yieldably associating the hydraulic system with said ram to actuate the latter, such yieldability at least substantially at the time when the piston is approaching the end of its stroke in and with respect to the cylinder, permitting further travel of the ram and completion of

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its stroke without destructive shock on the hydraulic system.

11. A hydraulically operated hammer for driving piles and the like, comprising in combination: a hydraulic system including a cylinder, piston and piston rod and valve means for admitting and discharging liquid with respect to the cylinder for operating the piston; a ram; and compressible means for yieldably associating the ram with said system, said compressible means allowing over-travel of the ram as compared with the movement of the piston with respect to the cylinder.

No references cited.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,798,363

July 9, 1957

John T. Hazak et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 22, for "Fig. 5" read -- Fig. 4 --; column 9, line 9, for "a cam" read -- a ram --.

Signed and sealed this 27th day of August 1957.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents