Feb. 4, 1969 E. H. FISHER 3,425,499

HYDRAULIC VIBRATORY HAMMER FOR DRIVING AND OR EXTRACTING PILES AND THE LIKE

Filed Nov. 4. 1966

Sheet 1 of 3

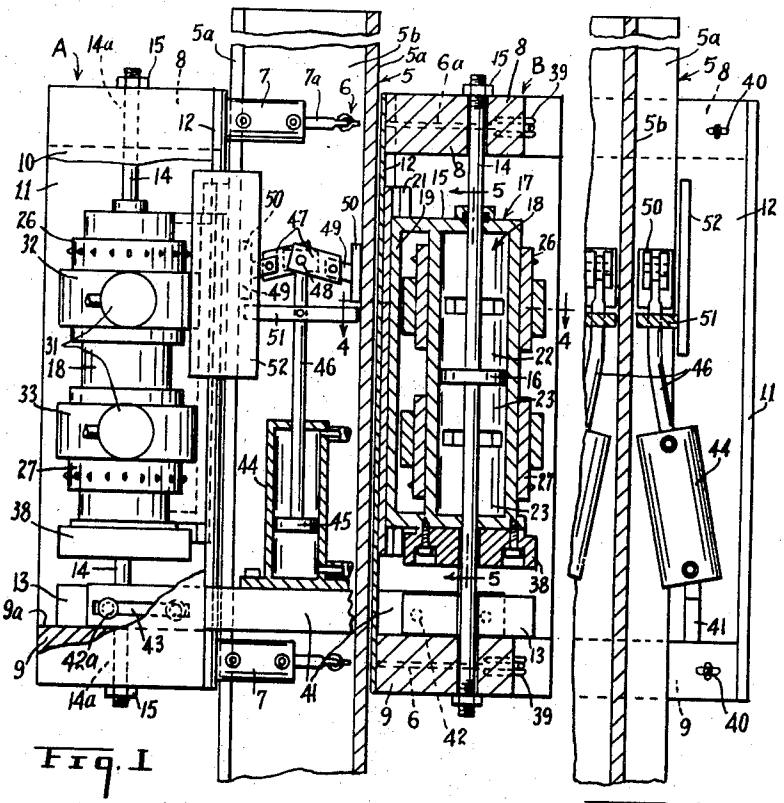


Fig. 1

Fig. 3

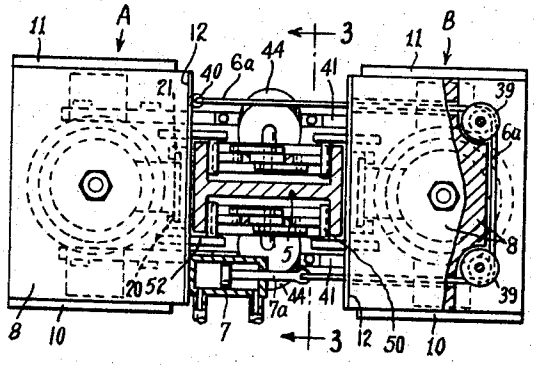


Fig. 2

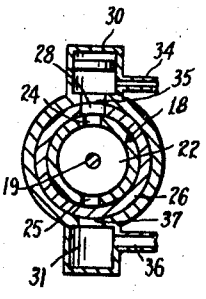


Fig. 4

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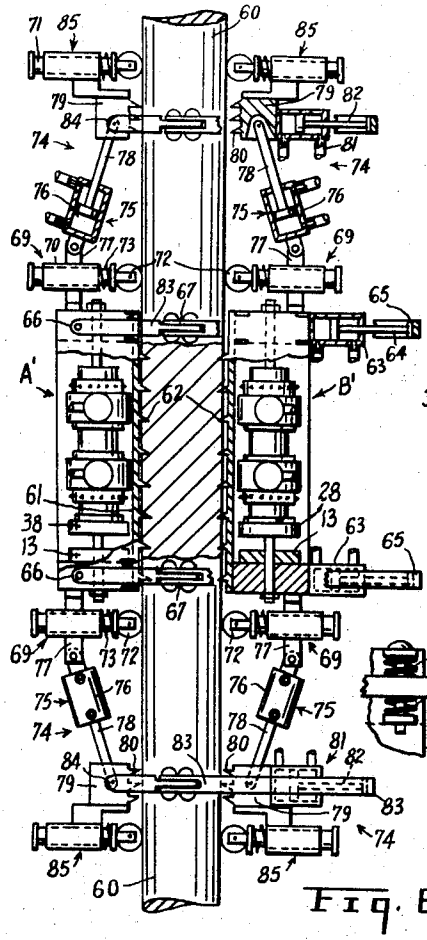


Fig. 6

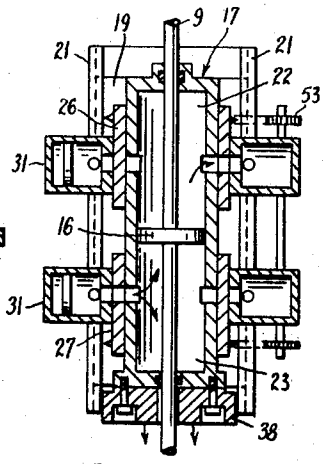


Fig. 5

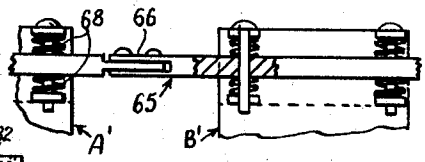


Fig. 8

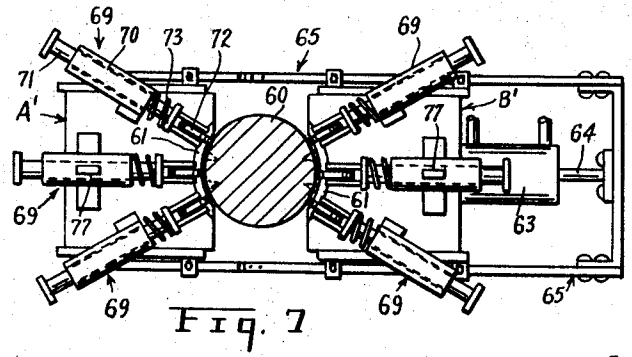


Fig. 7

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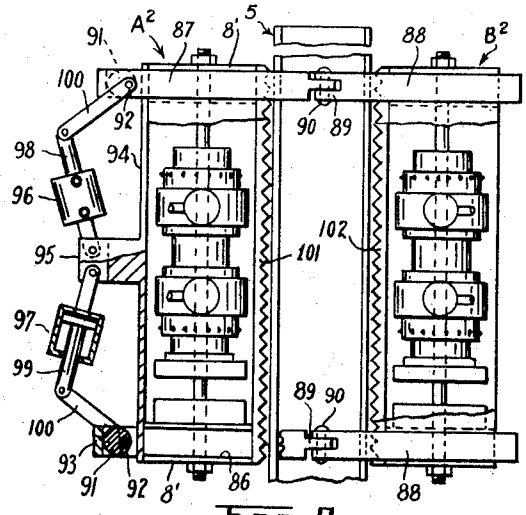


Fig. 9

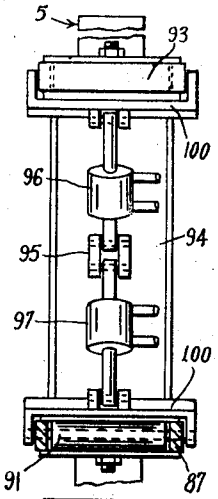


Fig. 10

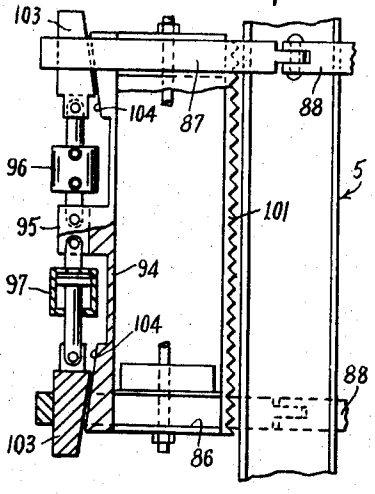


Fig. 11

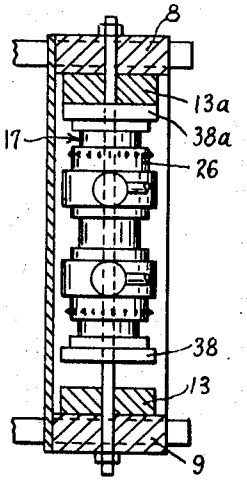


Fig. 12

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United States Patent Office

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HYDRAULIC VIBRATORY HAMMER FOR DRIVING AND OR EXTRACTING PILES AND THE LIKE

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Filed Nov. 4, 1966, Ser. No. 592,201

U.S. Cl. 173—125 14 Claims

Int. Cl. B25d 9/06

ABSTRACT OF THE DISCLOSURE

A frame positionable around a pile and carrying a hammer which is engageable with the pile for selectively driving and extracting the same relative to the ground. The frame also carries means for step-by-step advancing itself along the pile as the hammering operation progresses.

This invention relates to hammer arrangements for driving and/or extracting piles etc., in which the hammer can be secured to the pile at near ground level and has self-climbing characteristics.

Pile driving hammers at present in use are generally suspended from a crane or like structure, at an elevation above the top end of the pile and are operated to strike blows on the top of the pile. Such known pile drivers are heavy for the force of impact and frequency of impact that they produce; they lack the sustained rapid impact for quick driving of piles; diesel hammers are difficult to start, particularly in cold weather and are also difficult to keep running, particularly when the pile is falling away from the hammer; when diesel, air or steam pile hammers are driving at the top of the pile, much of the energy produced is lost in the pile and is not effective for the driving of the pile; when diesel, air or steam pile driving hammers are located at the top of the pile when driving, a larger crane than should be necessary is required to lift and hold the pile hammer and pile, also the heavy hammer at the top of the pile creates a high unstable load and the pendulum effect of a swinging load such as pile hammer and pile at this height could cause the crane to capsize under certain conditions; steam and air hammers require a separate boiler or air compressor for their operation and are expensive to operate because of their prime mover source and the inherent capital and operating expenditures involved, also much energy is lost in the steam or air lines to the hammer because of their distance from the initial source of energy such as boiler or compressor; the size of the pile hammer used is limited to the impact that the cross section and/or unsupported length of the pile will sustain; diesel hammers also lack the impact produced for the relative weight of the hammer involved compared with the hydraulic hammer.

The pile hammer of the present invention has been designed to overcome the above limitations in that the hydraulic hammer pressure can be high, say 4000 lbs. per sq. inch or more as compared to the common present day practice of using 100 lbs. per sq. inch for steam and air driven hammers; the hydraulic hammer can provide a greater impact because of its higher operating pressures; the pile hammer of the present invention is self-climbing on the pile and, with its inherent short coupled lines and the particular hydraulic valving arrangement, provides a rapid frequency of impact; the hydraulic hammer starts instantly because it is hydraulically reciprocated with oil forced from a prime mover pump; the hydraulic pile driving hammer will keep driving when the pile is falling away from the hammer because its operation is not dependent upon the resistance of the pile; the hydraulic self-climbing hammer transmits more energy to the driving of the pile than steam, air or diesel pile hammers operating at

the top of the pile because not so much energy is lost in the pile; the self-climbing hydraulic pile hammer, located part way up the pile, requires a lighter crane to perform the work also, the location of the self-climbing hydraulic hammer part-way up the pile provides a more stable and safer operation than with other hammers; the hydraulic hammer is operated by a pump arrangement drive by the engine of a crane or other prime mover source used for placing the pile in position; the hydraulic hammer will drive a pile faster than steam, air or diesel units because of the magnitude and frequency of the impact which is brought about by the higher operating pressures of the hydraulic hammer as well as by the greater frequency of impact produced by the special type of hydraulic valving arrangement, and because more energy is transmitted to the hammer owing to its location closer to the point of driving of the pile into the ground.

The hammer can also be used in reverse for the purpose of extracting piles out of the ground. When so used, the self-climbing feature is also used in reverse in order to lower the hammer on the pile as the pile is raised up out of the ground.

An object of the invention is to provide a pile driving and/or extracting arrangement which includes means to reverse its operation in order to change from driving to extracting.

An object of the present invention is to provide a pile driving arrangement whereby piles will be driven faster, at less cost, and at the same time the pile will have minimal distortion and/or damage.

A further object of the invention is to provide a hydraulically operated pile hammer that will climb the pile as the driving progresses.

A further object of the invention is to provide a hydraulic pile hammer that provides a rapid reciprocating action of a forceful impact and sustained pressure which can be varied in frequency of the reciprocating action as well as the thrust and/or impact.

A further object of the invention is to provide a hydraulic pile driving hammer arrangement which will require a smaller capacity of crane or other device to handle the pile driving hammer and the pile than in the past because of the lighter weight of the pile hammer.

A further object of the invention is to increase the safety of pile driving operations because the pile hammer is situated substantially downward from the top of the pile during the pile driving operation which provides a safer arrangement than when the pile hammer is situated at the top of the pile as at present.

A further object of the invention is to provide a greater portion of the driving energy to the actual driving of the pile because the hammer is located substantially downwards from the top of the pile and therefore, not as much energy is lost in the pile as at present when the pile driving hammer is situated at the top of the pile.

A further object of the invention is to decrease the time required to drive the pile thereby decreasing the cost of pile driving, the cost of equipment used for pile driving and the realization of a job completed sooner with its inherent economic benefits.

A further object of the invention is to provide a pile driving arrangement wherein the damage or distortion to the pile will be reduced, at the same time that the force of impact to the pile is increased.

These and other objects of the invention will be apparent from the following detailed specification and the accompanying drawings, in which:

FIG. 1 is a vertical elevation, partly in section showing two double-acting hydraulic pile driving hammers assembled on a steel pile and including self-climbing apparatus.

FIG. 2 is a plan view, partly in section, of the arrangement illustrated in FIG. 1.

FIG. 3 is a partial side sectional elevation taken on the line 3—3 of FIG. 1.

FIG. 4 is a transverse section taken on the line 4—4 of FIG. 1 showing the valving arrangement.

FIG. 5 is a vertical section taken on the line 5—5 of FIG. 1 showing the valving arrangement.

FIG. 6 is a vertical elevation, partly in section, showing two double-acting hydraulic pile driving hammers assembled on a wood pile and including self-climbing apparatus.

FIG. 7 is a plan view of the arrangement illustrated in FIG. 6.

FIG. 8 is an enlarged elevation detail of the tie mechanism connecting the two pile driving hammers.

FIG. 9 is a vertical elevation similar to FIG. 1 but showing a modified form of means for clamping the hammer to the pile.

FIG. 10 is a side elevation of the arrangement shown in FIG. 9.

FIG. 11 is a partial vertical elevation of still another means for clamping the hammer to the pile.

FIG. 12 is a partial sectional elevation of one hammer assembly in which an anvil is fitted at both top and bottom of the reciprocating cylinder.

Referring to the drawings and particularly to FIGS. 1 to 3, inclusive in which the invention is applied to the driving of a steel H section pile **5**. Two hydraulic pile driving hammer assemblies A and B are shown, one on opposite sides of the H pile **5**. The hammer assemblies A and B are similar to each other and are held clamped to the H pile by cable means **6** operated by a cylinder and piston devices **7** as will be described in detail later.

One hammer assembly will be described in detail. Each hammer assembly, A or B, consists of an upper block **8** and a lower block **9** held in vertically spaced apart relation by the structural side plate members **10** and **11** and in inwardly facing plate member **12**.

An anvil block **13** is secured to the upper face **9***a* of the lower block **9**.

A piston rod **14** extends between the upper and lower blocks **8** and **9** and has its threaded ends passing through the apertures **14***a* and is held rigid by the nuts **15**. A piston **16**, integral with the piston rod **14** is located midway between the upper and lower blocks **8** and **9**.

The movable portion of the hammers A and B consists essentially of a valving arrangement of the type disclosed in my copending U.S. patent application Ser. No. 423,073, filed Jan. 4, 1965, now Patent No. 3,369,459, issued Feb. 20, 1968. In this particular arrangement a cylinder block **17** includes a cylinder **18** enclosing the piston **16** and a guide plate **19** whose vertical edges **20** are enclosed by vertically disposed guides **21** mounted on the plate member **12** to permit vertical reciprocation of the cylinder block axially with respect to the stationary piston rod **14** and piston **16**. The cylinder **18** is divided into two compartments **22** and **23** by the piston **16**. Each compartment **22** and **23** is provided with oppositely disposed inlet ports **24** and exhaust ports **25** in the wall of the cylinder **18**. A pair of valve sleeves **26** and **27**, adapted to be rotated about the cylinder **18**, each are provided with a common inlet and exhaust port **28** aligned circumferentially with the inlet and exhaust ports **24** and **25**. These valve sleeves are synchronously driven by means of a suitable drive, not shown, so that they are 180° out of phase with each other. A pair of accumulators **30** and **31** are mounted diametrically opposite to each other on the stationary ring members **32** and **33** surrounding the valve sleeves **26** and **27**. The accumulator **30** has a feed inlet **34** and a port **35** communicating in one position of the sleeve **26** with the common inlet and exhaust port **28** and inlet port **24**, while the exhaust chamber **31** has an exhaust outlet **36** and a port **37** communicating with the common inlet and exhaust port **28** of the sleeve **26**.

When the valve sleeve **26** is in the position shown in FIG. 4 hydraulic fluid from the inlet **34** is permitted to flow into the chamber **22** or **23** through the ports **35**, **28** and **24**. As the sleeve **26** blocks the exhaust ports **25** and **37**, the cylinder block **17** is forced to move upwards and as the sleeves **26** and **27** are synchronized 180° out of phase with each other, the exhaust ports from the chamber **23** are open. Rapid reversal of the sleeves **26** and **27** causes a rapid reversal of inlet and exhaust of hydraulic fluid in the chambers **22** and **23** and a consequent rapid reciprocation of the cylinder block **17**.

Mounted on the lower end of the cylinder block **17** is a hammer block **38** which, as the cylinder block **17** is reciprocated, will make rapid contact with the anvil block **13** and so produce the rapid hammer effect which will be transmitted to the H pile **5** to effect downward driving of the pile.

In order to clamp the two hammers A and B to the pile **5** use is made of the cable clamp means **6** which consists of a hydraulically operated cylinder and piston devices **7** one each of which is shown secured to each of the top and bottom blocks **8** and **9** of the hammer A, at one side of the H pile **5** as seen in FIGS. 1 and 2. The cables **6***a* have one end attached to the piston rod **7***a* and are laid about the pulleys **39** mounted for rotation in the upper and lower blocks **8** and **9** of the hammer B. The opposite end of the cables **6***a* are secured to eyebolts **40** on the upper and lower blocks **8** and **9** of the hammer A at the side of the H pile opposite from the cylinder and piston devices **7**.

When the cylinder and piston devices **7** are activiated to move the piston rods **7***a* to the left, as seen in FIGS. 1 and 2 the hammers A and B are pulled into clamping position against the adjacent flanges **5***a* of the H pile **5**.

A pair of tie-rods **41** are secured at one end to the anvil block **13** on either side of the web **5***b* of the H pile **5** by means of the stud bolts **42** and are slotted at **43** at their opposite ends to engage with the headed bolts **42***a*. The slots **43** permit adjustment of the hammers A and B relative to each other in their clamped and unclamped position on the H pile **5**.

A hydraulic cylinder **44** is supported in each of the tierods **41** on either side of the web **5***b* of the H pile **5**. A piston **45** within the cylinder **44** has a piston rod **46** projecting upwardly therefrom. A pair of arms **47** are mounted on the pivot pin **48** at the top end of the piston rod **46**. A dog **49** is pivotally mounted on each of the arms **47**. Each dog **49** includes a vertically disposed clamping face member **50** adapted to lie against the adjacent inner face of the H pile flanges **5***a*. A cross arm **51**, mounted on each of the piston rods **46** below the dogs **49** acts as a stop to maintain the dogs in close relationship to the flanges **5***a*, of the pile.

When the cylinders **44** are activated to move their piston **45** upwards, the dogs **49** are released from contact with the flanges **5***a* of the H pile **5**. Upward movement of the piston rods **46** is continued to the limit of their stroke to bring the dogs **49** to a position higher up on the pile. The flow of fluid to the cylinders is now reversed thereby pushing the dogs **49** outwards against the flanges **5***a* at a higher position than previous. Continued downward pressure of fluid on the piston **45** will force the cylinder **44**, tie-rods **41** and hammers A and B to move upwards. During this part of the operation the clamping effect of the cylinders **7** is released to permit the hammers A and B to move up freely. When the hammers A and B have reached a new position relative to the H pile **5**, they are again clamped tightly to the H pile by means of the cylinders **7**.

When the hammers A and B are activated and are either synchronously or non-synchronously driven with respect to each other, a hammer effect takes place between the hammer blocks **38** and the anvil blocks **13** which will drive the pile downwards.

Referring particularly to FIG. 5 as the valve sleeves **26** and **27** are rotated through 180° with a oscillatory movement by means of the drive **53** oil under pressure is permitted to flow alternately into the chambers **22** and **23** of the cylinder **18**. The accumulators **31** ensure that the pressure of the oil feed is maintained and that there is a quick response in the chambers **22** and **23** on reversal of the valve sleeves **26** and **27**. As the piston rods **19** are fixed in relation to the pile **5** when the hammers A and B are clamped to it, quick reversal of fluid pressure in the chambers **22** and **23** will cause the cylinder block **17** to be rapidly reciprocated to effect a rapid hammering of the blocks **38** on the anvil blocks **13**, thus driving the pile downwards.

In FIG. 5 inlet fluid is permitted to flow into the lower chamber **23** while fluid in the upper chamber is exhausted, this results in a downward movement of the cylinder block **17**.

It will be seen that reciprocation of the valving arrangements of the hammers A and B would also drive the pile downwards even if actual contact of the hammer blocks **38** and the anvil blocks **13** did not take place because of the reversal vibratory effect of the hammers on the H pile.

By means of the above described apparatus the hammers *a* and *b* can be located on the pile near ground level and can be raised upwards by degrees as the pile is hammered downwards.

While the hammer assembly has been described for use with a steel H section pile, it will be realized that the hammer assembly can be used with piles having a section other than H section, for instance the hammer assembly could be used with a channel section, in which case only one of the two self-climbing assemblies shown in FIGS. 2 and 3 would be used.

Similar hammer assemblies with self-climbing characteristics can be used with wood piles or piles made of material soften than steel. Such use is illustrated in FIGS. 5, 6 and 7.

The pile **60** can have either round, square or rectangular cross section. In the drawings a round pile is shown for illustrative purposes.

The hammers A′ and B′ are similar in every respect to the hammers A and B described above except that the inwardly facing plate members **61** are arcuate in shape and are provided with a series of spikes **62** which dig into the adjacent surface of the wood pile **60**. If the pile were of square or rectangular section, the plate members **61** would, of course be flat. It will also be readily seen that the plate members **61** could have a serrated or knurled face, or an insert made of resiliant material for gripping the pile **60** rather than spikes **62** for use with certain pile material and/or driving conditions. For example this alternative arrangement could be used for driving steel piles.

The hammers A′ and B′ are clamped to the pile **60** by the hydraulic cylinder and piston devices **63** mounted on the hammer B′ with their piston rods **64** being connected to the U shaped members **65**. The free ends of the U shaped members **65** are secured to the sides of the hammer A′ at **66**. For convenience of assembly. The U shaped members **65** are in sections coupled together at **67**. Due to the fact that the pile is not always cylindrical in shape and that there is considerable vibration in the operation of this device the U shaped members are provided with combination self-aligning and cushioning springs **68**.

In order to permit the hammers A′ and B′ to disengage from the pile **60** when the self-climbing feature is to take effect, a series of spring-wheel assemblies **69** are mounted above and below the hammers A′ and B′. These assemblies **69** each consist of a sleeve member **70**, a shouldered spindle **71** slidable in the sleeve **70**, a wheel **72** mounted for rotation on the inner end of the spindle **71** and a spring **73** between the sleeve member **70** and the shoulder of the spindle **71**, forcing the wheel **72** into engagement with the surface of the pile **60**, see FIGS. 5 and 6.

When the clamping exect of the cylinder and piston devices **63** is released, the springs **73** will exert a reaction pressure on the sleeve members **70**, forcing the hammers A′ and B′ away from the pile **60** thereby withdrawing the spikes **62** out the pile.

A pair of self climbing assemblies **74** located above and below the hammers A′ and B′ each consist of a double acting cylinder and piston device **75**, the cylinders **76** of which is pivotally mounted on the bracket **77** on the sleeve members **70** of pairs of oppositely disposed spring-wheel assemblies **69**. The piston rods **78** of the devices **75** have their free ends pivotally mounted in the climbing blocks **79** whose opposite faces are provided with spikes **80** for engagement with the adjacent surface of the pile **60**, also it will readily be seen that block member **79** could have a serrated or knurled face for griping the pile rather than spikes **80** for certain pile material and/or driveing conditions. For example, this arrangement could be used for the driving of steel piles.

A cylinder and piston device **81** is mounted on one of each pair of climbing blocks **79** and the piston rod **82** of the cylinder and piston device **81** is connected to a U shaped member **83**. The free ends of the U shaped member **83** are pivotally connected to the climbing block **79** at **84**, opposite from the climbing block to which the cylinder and piston device **81** is connected to a spring-wheel assembly **85**, similar to the spring-wheel assemblies **69** above described is mounted on each of the climbing blocks **79** and functions in the same manner to effect disengagement of the climbing blocks **79** from the pile **60** when the pressure inthe cylinder and piston devices **81** is released. When the climbing blocks **79** are disengaged from the pile **60** they can be moved upwards relative to the pile to take up a new position on the pile. As seen in FIG. 5 both the upper and lower pairs of climbing blocks **79** are moved upwards when pressure fluid is fed to the lower portion of the cylinders **76** to effect upwards movement of their associated pistons and piston rods **78** in an upward direction. When the climbing blocks **79** are moved upwards the desired distance, the cylinder and piston devices **81** are activated to effect movement of the blocks **79** inwards so that their spikes **80** dig into the surface of the pile **60**.

With the hammers A′ and B′ clamped to the pile **60** by means of the spikes **62**, the hammers are activated either synchronously or non-synchronously with respect to each other in the same maner as above described in connection with the hammers A and B and as illustrated in FIG. 5.

When it is desired to raise the hammers A and B after the pile has been driven down a distance into the ground, the hammers are released from the pile by activating the cylinder and piston devices **63** to force the hammers outwards from the pile. While the climbing blocks **79** are still engaged with the pile the cylinder and piston devices **75** are activated to exert an upwards pressure on the hammers through movement upwards of the cylinders **76**. After the hammers have been raised to the limit permitted by the movement of the cylinders **76** relative to their stationary pistons and rods the hammers are again clamped to the pile by activation of the cylinders **63**. It will readily be seen that one or more pairs of the climbing and clamping arrangement **74** and **75** could be eliminated if not required for any reason.

While the cable clamping means shown in FIGS. 1 and 2 is suitable for some forms of pile driving hammers, over a period of time the cable **6***a* may stretch and, unless adjustment is made, the clamping pressure of the hammer on the pile may not be sufficient to hold the hammer to a fixed position on the pile under vibration and hammering effect.

In FIGS. 9 and 10 there is shown a hydraulic-mechanical arrangement using roller cams to force the hammers into clamping engagement with the pile.

The hammers A^2 and B^2 are similar to the hammers A and B previously described except for the following modifications.

The upper blocks **8'** and **9'** are slotted on their sides to provide horizontal guides **86** to receive the top and bottom pairs of U shaped members **87** and **88** embracing the hammers A^2 and B^2. The U shaped members **87** and **88** are coupled together at **89** by the pins **90**. A cam member **91** is secured on the pins **92** spanning the space between the legs of the U shaped members **87** close to web **93** joining the legs of the U members together. A side plate **94** secured to the upper and lower blocks **8'** of the hammer A^2 has an outwardly projecting bracket **95** located midway of its height. A pair of cylinders **96** and **97** are pivotally mounted on the bracket **95** and their respective piston rods **98** and **99** are connnected to the levers **100** which, in turn, are secured to the ends of the pins **92**.

As the cylinders **96** and **97** are activated to move their piston rods outwards, the cam members **91** rotated to exert pressure against the plate **94** forcing the serrated plate **101** against the pile **5** and at the same time exerting a pull on the hammer B^2 so that its serrated plate **102** is forced against the pile. In this manner both hammers A^2 and B^2 are firmly anchored to the pile for the pile driving operation.

In FIG. 11 the roller cams **91** of FIGS. 9 and 10 are replaced by wedges **103** which contact the angled surfaces **104** and when the cylinders **97** are activated, act to force engagement of the hammers A^2 and B^2 with the pile **5** in the same manner as in FIGS. 9 and 10.

The serrated plates **101** may have knurled surfaces and there can also be used in place of the plates **12** in FIG. 1 or the spiked plates **61** in FIG. 6.

The pile climbing means shown in FIGS. 1, 2 and 3 apply to the arrangement shown in FIGS. 9, 10 and 11 but have not been shown.

It will be readily understood that the reciprocating cylinder can be utilized to provide a hammering effect at the top as well as at the bottom of the assembly. With an anvil arrangement at the top, the apparatus can be used to extract piles out of the ground. By such an arrangement a pile can be driven into the ground and, should it meet with too much resistance before reaching its proper depth, by reason of rock formation, the pile can immediately be extracted and moved to a slightly different location for driving, without removing the apparatus from the pile. Such an arrangement is shown in FIG. 12 where the lower anvil block **13** is secured to the lower block **9** and the hammer block **38** makes contact with the anvil block **13** to effect downwards driving of the pile as previously described. An upper anvil block **13*a*** is secured to the upper block **8** and a hammer block **38*a*** is secured to the upper end of the reciprocating cylinder **17**.

When the apparatus is to be used for extracting a pile the valving arrangement is operated to reciprocate the cylinder **17** in such a manner that the hammer block **38** does not make contact with the anvil block **13** but the hammer block **38*a*** makes contact with the anvil block **13*a***. Hammering contact between the hammer block **38*a*** and the anvil block **13*a*** will transmit an upward force on the pile with the result that the pile will be driven upwards out of the ground.

This arrangement can be applied to any of the assemblies shown in FIGS. 1, 6 or 9.

Where the apparatus is adapted for both driving and extracting piles, the climbing apparatus will be operated to either climb or descend the pile in order to keep the apparatus at a more or less uniform height above ground level.

As will be understood from the above description the hammers A and B or A' and B' can be clamped to piles at a position relatively close to ground level and require only very short hydraulic lines for their operation. As the pile is driven further into the ground, the hammers can be raised at intervals by hydraulic means without having to mechanically uncouple either the hammers from the pile or their hydraulic lines. The hammer operating pressure can be high in comparison with that used in air, steam or diesel operated hammers and the speed or frequency of the hammer stroke can be maintained at a high rate controlled by the drive to the sleeve valves combined with the use of the accumulators. The operation of the hammers can be varied from direct blows on the anvil blocks to a high frequency vibration and the operation can be adjusted in such manner to suit the working requirements such as the soil conditions.

The apparatus is readily portable from pile to pile and, as it can be attached to the piles at near ground level there is no necessity for use of high cranes.

As noted previously in the foregoing, the varying arrangement described in my copending U.S. patent application Ser. No. 423,073 filed Jan. 4, 1965 is essentially the same as for this patent application. In patent application No. 423,073 it was explained that either the cylinder or the piston and piston rod would reciprocate depending upon which member was restrained from movement. The piston and piston rod have been shown as restrained from movement for embodiments of the subject invention. However, it will be readily seen that either of these arrangements can be alternatively used for embodiments of the subject invention and can be made interchangeable by using an exchange piston, piston rod and hammers for attaching to the ends of said piston rod. Although for the subject invention the cylinder portion is shown as reciprocating because piston **16** is restrained from movement (see FIG. 1). However, it will be readily seen, referring to FIGS. 1 and 12, that if the movement of cylinder **18** is restrained from movement in the guiding arrangement **19**, **20**, and **21** and that instead of piston rod **14** being attached to blocks **8** and **9** by nuts **15**; both ends of piston rods **14** were shorter so that the anvils **38** and **38*a*** could be attached to both ends of the piston rod rather than the cylinder block **17** (see FIG. 12). It will be seen that when the valving arrangement is actuated under these conditions, piston **16** and piston rod **14** will reciprocate as will hammers **38** and **38*a*** which are now attached to it, and will strike anvils **13** or **13*a*** whichever is required for the driving or extracting of the pile. Driving will also take place if there is no actual contact between the hammers **38**, **38*a*** and anvils **13** and **13*a***.

A similar valving arrangement for the subject invention was used in my copending U.S. patent application No. 580,966 filed Sept. 21, 1966. Here inlet and exhaust header arrangements were used so that the cylinder would reciprocate without hydraulic lines attached to it. The same arrangement could be used for embodiments of the subject invention if and where required.

What I claim is:

1. Hammer apparatus for driving piles into the ground comprising a pair of hydraulically operated hammers, each of said hammers including a frame, an anvil block in the lower portion of the frame, a pair of stationary pistons and piston rods vertically disposed in the frame, a double-acting hydraulic cylinder positioned about each of the said pair of stationary pistons and piston rods, guide means on the said frame, the said cylinders adapted for reciprocating movement in said guide means, a pair of valves associated with each of the said cylinders, means to operate the said valves to alternately feed hydraulic pressure fluid to either ends of the cylinders to effect reciprocation of the cylinders in their associated guide means, a hammer block on the lower end of the said cylinders, the said hammer blocks adapted to make hammering contact with the anvil blocks on reciprocation of the cylinders, telescopic means to couple the said pairs of hammers together on opposite sides of the pile to be driven, clamp means connected to the said pair of hammers, the said clamp means on activation, moving the hammers towards or away from the said pile, and hy-

draulic climbing means adapted to raise the said hammers longitudinally of the pile when the said clamp means release the hammers from clamping engagement with the pile.

2. Hammer apparatus as set forth in claim 1 in which the said pairs of valves are sleeves mounted for oscillatory rotation out of phase with each other to alternately admit pressure hydraulic fluid to and exhaust fluid from each chamber of the double acting cylinders formed by the said stationary pistons.

3. Hammer apparatus as set forth in claim 1 in which hydraulic fluid accumulators are associated with the said cylinders and valves, the said accumulators providing a quick response to the action of the hydraulic fluid on alternate feed of fluid by the pair of valves.

4. Hammer apparatus as set forth in claim 1 in which the said clamp means include one or more double-acting hydraulic cylinder and piston devices.

5. Hammer apparatus as set forth in claim 1 in which the said telescopic means connect the lower portions of the said frames, and the said hydraulic climbing means includes one or more double-acting cylinder and piston devices each having their cylinders mounted on said telescopic means, and toggle clamps are pivotally mounted on the upper end of the piston rod of the cylinder and piston devices, the said cylinder and piston devices when activated in one direction forcing said toggle clamps into clamping engagement with the pile and the reaction force from such movement effects raising of its cylinder, attached telescopic means and the pair of hammers relative to the pile when the said hammers are disengaged from clamping contact with the pile.

6. Hammer apparatus as set forth in claim 1 in which the pile is of steel H section and the said hydraulic climbing means are two in number one on each side of the web of the H section of the pile, and the toggle clamps engage opposing faces of the flanges of the H section pile.

7. Hammer apparatus as set forth in claim 5 in which the piston rods of the hydraulic climbing means have a cross arm located adjacent the said toggle clamps, the said cross arm forming a stop for the toggle clamps when they are disengaged from contact with the pile.

8. Hammer apparatus as set forth in claim 1 in which the pile is of wood or like material and each of the said hammer frames have a roughened surface for engaging with the adjacent surface of the pile and spring mounted rollers located above and below each of the said hammers maintain roller contact between the hammers and the pile.

9. Hammer apparatus as set forth in claim 8 in which the said hydraulic climbing means are located one above and below each of the said hammers and each include a pair of climbing head each having a series of pile engaging spikes, telescopic means to couple the said pairs of climbing heads, a double-acting cylinder and piston device associated with each pair of climbing heads which, on activation, move the climbing heads towards or away from the said pile, and hydraulic means located between the upper and lower ends of the hammers and the adjacent climbing heads, the said latter cylinder and piston devices adapted to raise the said climbing heads relative to the pile when the climbing heads are disengaged from the pile.

10. Hammer apparatus as set forth in claim 9 in which the said climbing heads have a spring mounted roller supported thereon, the said rollers maintaining rolling contact with the said pile.

11. Hammer apparatus for driving and for extracting plies comprising a pair of hydraulically operated hammers, each of said hammers including a frame, a pair of anvil blocks, one located in the lower portion of the frame and the other located in the upper portion of the frame, a pair of stationary pistons and piston rods vertically disposed in the frame, a double-acting hydraulic cylinder positioned about each of the said pair of stationary pistons and piston rods vertically disposed in the frame, a double-acting hydraulic cylinder positioned about each of the said pair of stationary pistons and piston rods, guide means on said frame, the said cylinders adapted for reciprocating movement in said guide means, a pair of valves associated with each of said cylinders, means to operate the said valves to alternately feed hydraulic pressure fluid to either ends of the cylinders to effect reciprocation of the cylinders in their associated guide means, a pair of hammer blocks for each cylinder, one lower hammer block being secured on the lower end of each cylinder and one upper hammer block being secured to the upper end of each cylinder, the said valves being operated in one case to effect hammering contact between the said lower hammer blocks with an adjacent lower anvil block for downward driving of the pile, and in the other case to effect hmamering contact between the said upper hammer blocks with an adjacent upper anvil block for upward extraction of the pile, telescopic means to couple the said pairs of hammers together on opposite sides of the pile, clamp means connected to said pair of hammers, the said clamp means on activation, moving the hammers towards or away from the said pile, and hydraulic climbing means adapted to reposition the said hammers longitudinally of the pile when the said clamp means release the hammers from clamping engagement with the pile.

12. In an apparatus for selectively driving and extracting a pile relative to the ground, the combination of frame means positionable around a pile, impact producing means carried by said frame means, releasable means reacting between said frame means and said impact producing means for operatively engaging the latter with a pile to impact the pile when the impact producing means are energized, and means for step-by-step advancing said frame means with said impact producing means longitudinally along the pile as the impacting operation progresses, said last mentioned means comprising releasable pile gripping means also carried by said frame means, and means reacting between said gripping means and the frame means to move the latter relative to the former to a new position longitudinally of the pile when said impact producing means are disengaged from the pile.

13. The apparatus as defined in claim 12 wherein said impact producing means are hydraulically actuated.

14. The apparatus as defined in claim 12 wherein said step-by-step advancing means are hydraulically actuated.

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