July 9, 1968 J. L. LEBELLE 3,391,435

HYDRAULIC CLAMPING SYSTEM FOR VIBRODRIVERS

Filed June 15, 1967

3 Sheets-Sheet 1

FIG. 1

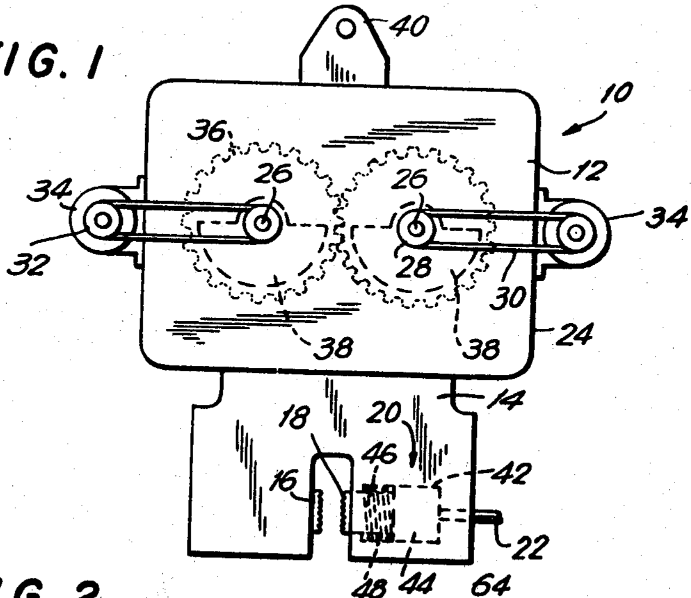
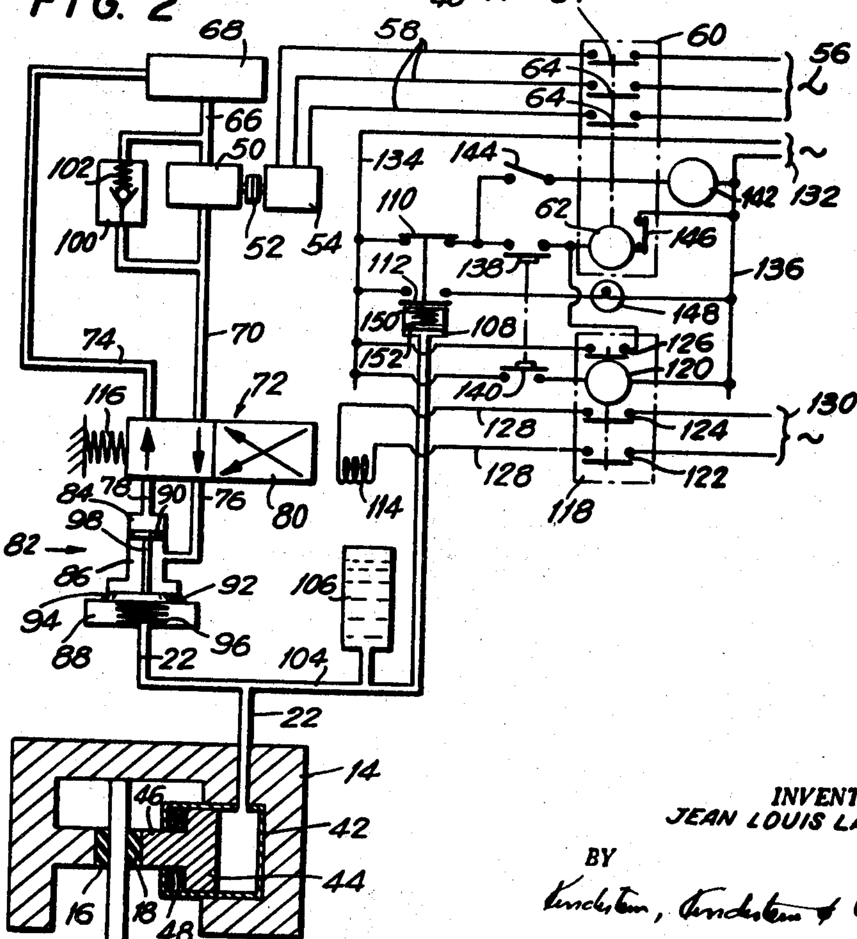


FIG. 2



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HYDRAULIC CLAMPING SYSTEM FOR VIBRODRIVERS

Filed June 15, 1967 3 Sheets-Sheet 2

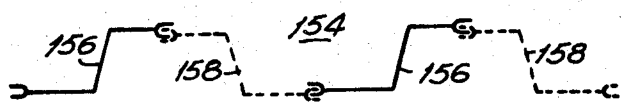

FIG. 3

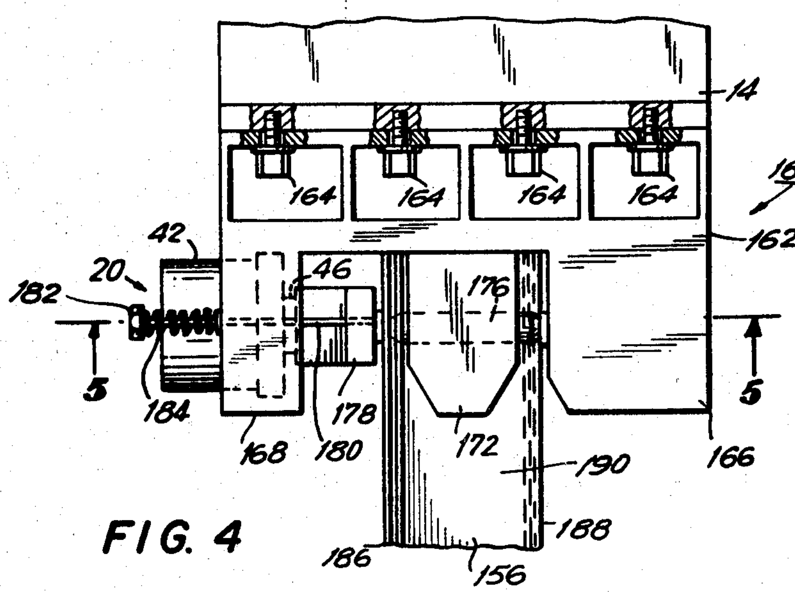

FIG. 4

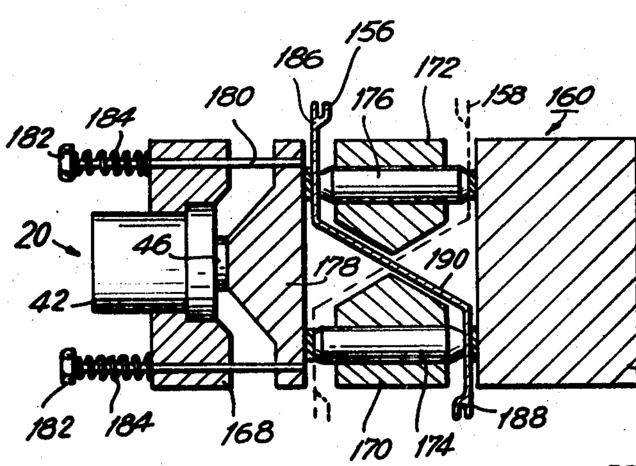

FIG. 5

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HYDRAULIC CLAMPING SYSTEM FOR VIBRODRIVERS

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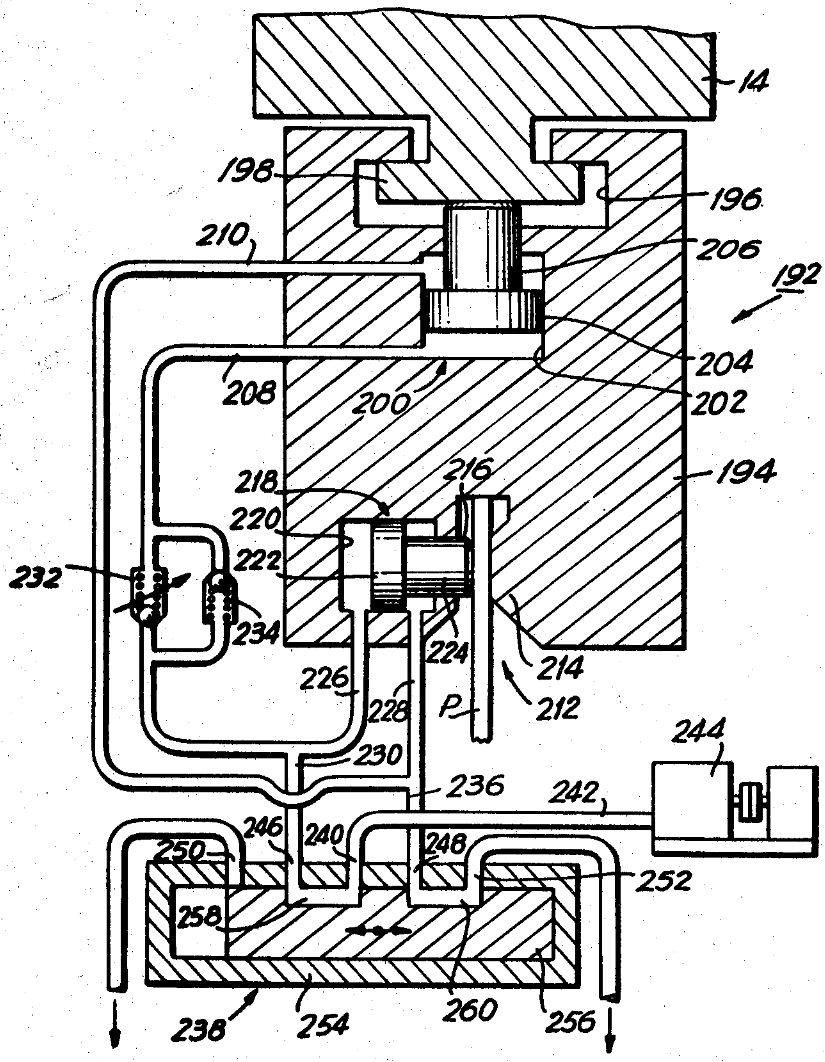
FIG. 6



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1

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HYDRAULIC CLAMPING SYSTEM FOR VIBRODRIVERS

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ABSTRACT OF THE DISCLOSURE

A vibrodriver clamping system in which a clamp actuating hydraulic jack is supplied with pressurized liquid by an electric motor-driven pump that is controlled by the pressure of said liquid. The pressure of the liquid trapped by a check valve in the high pressure section of the system when the motor is deenergized maintains the jack in clamped condition. The hydraulic jack actuated clamp has an anvil and a movable jaw between which two parallel rods are slidable to grip a Z-piling in either of two mirror-reversed positions. The hydraulic jack actuated clamp is fixed to an intermediate block shiftable on the vibrodriver and an auxiliary hydraulic jack fixes the block to the vibrodriver shortly after the clamp-actuating hydraulic jack is rendered effective.

BACKGROUND OF THE INVENTION

Field of the invention

A vibrodriver clamp actuated by a hydraulic jack to which liquid under pressure is supplied through a check valve by a motor driven pump, the motor being shut off when the liquid reaches a predetermined value. The liquid trapped when the motor stops keeps the clamp closed. When leakage of liquid drops the pressure to a lower predetermined value the motor is restarted. Two parallel rods in substantial transverse registration are supported for axial slidable movement between the anvil and movable jaw of a clamp so that they can grip a Z-piling in either of the two mirror-reversed positions in which it may be oriented for driving or extraction in a string of Z-pilings. The clamp and its hydraulically actuated jack are fixed to an intermediate block that, in turn, is shiftably supported from the vibrodriver so as to permit the clamp as it is closed to adjust its position to an elongated element to be driven into or extracted from the ground. A second hydraulic jack is arranged to be actuated by the same pressurized liquid as the first jack but with a slight time delay. The second jack locks the intermediate block to the vibrodriver.

Description of the prior art

A vibrodriver is used to drive into or extract from the ground an elongated member such as a pile, stake, post or piling. A vibrodriver includes a set of counterrotating balanced eccentric weights the components of the centrifugal forces of which along an axis of vibration are additive. The components of said centrifugal forces perpendicular to said axis cancel each other out. To be effective the vibrodriver must be fixed to the ground engaging member so as to be, effectively, functionally unitary therewith. Previously two systems were used to achieve detachable fixing. In the first system bolts or wedges firmly fastened the vibrodriver to an end of the ground engaging member. In the second system an end of the ground engaging element was gripped by a clamp the jaws of which were squeezed together by a hydraulic jack. Either both jaws were movable toward and away from one another, like a pair of pliers, or one jaw was fixed, i.e. was an anvil, while the other jaw was movable, like a vise.

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The first system is so tedious and delicate to manipulate that its use has been essentially discontinued.

The second system is speedy and simple to operate, but it has certain drawbacks. As pointed out above the clamp must secure the vibrodriver to an end of the ground engaging member so firmly that no relative movement can be experienced, i.e. there must be no play. The pressure exerted on the clamp by the hydraulic jack is intended to fulfill this purpose. To perform properly the force provided by the hydraulic jack should be predetermined and should vary only slightly from that value. If the force is too low the clamp may shake loose or may slide on the elongated member so that the vibrations no longer will be transmitted thereto. If the force is excessive the hydraulic jack or the clamp may be broken or the elongated member may be crushed by the clamp. This problem has been overcome by having the pump that supplies pressurized liquid operate continuously and by including in the high pressure section of the system fed by the pump an automatic discharge valve, that is to say a valve that opens to relieve pressure in excess of the predetermined pressure by discharging liquid to low pressure, e.g. a sump or reservoir. But this solution raises fresh drawbacks. Principally its disadvantages are that it uses too much power running the pump continuously and that it involves a high cost of maintenance because the valve wears out quickly since it opens and closes in quick succession practically without letup.

Another drawback of the second system arises when the hydraulic clamps are used to drive or extract Z-piling. Heretofore the clamps likewise were of Z-shape to match the configuration of this Z-piling. However in a string of interconnected Z-pilings consecutive pilings are disposed in mirror symmetry in relation to a plane perpendicular to the general line of the string and passing through the lock joining said pilings. Hence consecutive pilings present mirrored identical cross-sectional configurations. Therefore two different clamps of mirror matching configurations had to be employed, one for even pilings and the other for odd pilings, but neither for both pilings.

A third drawback of the second clamping system occurs when the hydraulically operated clamp is bodily shiftable with respect to the vibrodriver with the aid of an intermediate block that can be fixed to the vibrodriver by an auxiliary hydraulic jack other than the jack which actuates the clamp. This arrangement is usually found in vibrodrivers having two or more hydraulically actuated clamps separated from one another. The arrangement is employed, for example, to grip separately the two offset flanges of a Z-piling, or to grip separately the ends of two previously interconnected piles, or to grip separately diametrically opposed segments of a tubular pile. At one time the two clamps were mechanically fixed at the desired distance apart. Subsequently, but prior to this invention, it was proposed to shiftably mount each clamp on the vibrodriver and to fix the clamp with respect to this vibrodriver by an auxiliary hydraulic jack, the auxiliary jacks and the principal (clamping) jacks being fed from the same high pressure oil line that actuated all of the jacks simultaneously. The drawback of such arrangement is caused by the fact that the pile, or piles, although superficially similar, vary somewhat in shapes and dimensions. The use of at least one clamp shiftable on the vibrodriver ameliorates the problem by permitting a regulation of the spacing between two clamps, but because all the jacks are concurrently energized the clamps have insufficient time to adjust themselves to their correct relative positions before being immobilized on the vibrodriver by actuation of the locking auxiliary hydraulic jacks. This then causes excessive mechanical deforming forces to be exerted on the clamps.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved vibrodriver hydraulic clamping system which overcomes the foregoing drawbacks.

It is another object of this invention to provide a system of the character described in which the clamp actuating hydraulic jack is supplied with pressurized liquid by an electrically driven pump having in its electrical feed circuit a pressure-sensitive relay that controls energization and de-energization of the pump when the pressure of the hydraulic fluid supplied to the jack reaches, respectively minimum and maximum predetermined values.

It is another object of the present invention to provide a system of the character described employing an off-and-on pump energization wherein a check value is interposed between the pump and the clamp actuating hydraulic jack to trap liquid under high pressure in the jack when the pump is de-energized.

It is another object of the present invention to provide a system of the character described employing an off-and-on pump energization wherein a pressure storage element, such as an accumulator, is branched off the hydraulic feed circuit for the jack and includes a body of gas to smooth out pressure variations in the hydraulic feed circuit and to protract energization and de-energization periods of the pump.

It is another object of the present invention to provide a vibrodriver hydraulically actuated clamp for Z-piling which clamp can grip Z-piling in either mirror-reversed position thereof.

It is another object of the present invention to provide a vibrodriver hydraulicaly actuated clamp for Z-piling which clamp includes an anvil and a hydraulically movable jaw spaced therefrom, there being two axially slidable parallel rods extending in a direction between the anvil and jaw whereby, depending on the position of the Z-piling in the clamp, the flanges of the Z-piling either will be gripped between the movable jaw and one end of a first rod and between the anvil and one end of the second rod, or will be gripped between the movable jaw and the other end of the second rod and between the anvil and the other end of the first rod.

It is another object of the present invention to provide a principal hydraulic jack actuated clamp shiftably mounted by an intermediate block on a vibrodriver to which it is locked by an auxiliary hydraulic jack, both jacks being fed by a common high pressure hydraulic line, the auxiliary jack through a delay mechanism, so that the clamp will grip an elongated member, accommodating itself to a proper position thereon, and only thereafter will the auxiliary jack fix the position of the clamp relative to the vibrodriver.

It is another object of the present invention to provide a principal hydraulic jack actuated clamp shiftably mounted by an intermediate block on a vibrodriver to which it is locked by an auxiliary hydraulic jack, both jacks being fed by a common high pressure hydraulic line, wherein the principal jack is actuated before the auxiliary jack so that the clamp will grip an elongated member, accommodating itself to a proper position thereon, and only thereafter will the auxiliary jack fix the position of the clamp relative to the vibrodriver.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings in which are shown various possible embodiments of the invention,

FIG. 1 is a front elevational view of a conventional vibrodriver with a conventional clamp and a conventional clamp actuating hydraulic jack, the same being shown only for the purpose of illustrating a complete vibrodriver hydraulic clamping system embodying the present invention;

FIG. 2 is a hydraulic and electric circuit diagram, shown in conjunction with a schematically illustrated clamp and jack, of a jack pressure regulating circuit according to the present invention;

FIG. 3 is a schematic top plan view of an interconnected string of Z-pilings;

FIG. 4 is a side view of a modified form of clamp, according to the present invention, for gripping a Z-piling in either one of its two mirror-reversed positions;

FIG. 5 is a sectional view taken substantially along the line **5—5** of FIG. 4; and

FIG. 6 is a vertical sectional view through another modified form of clamp, according to the present invention, including a hydraulic circuit diagram for automatically actuating the principal jack that closes the clamp before actuating the auxiliary jack that fixedly secures the clamp carrying intermediate block to the vibrodriver.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in detail to the drawings, and, more particularly to FIG. 1, the reference numeral **10** denotes an apparatus for driving into or extracting from the ground an elongated member such as a pile, post, stake or piling of any of the multitude of configurations and constructions that are well known to the art. The apparatus **10** includes a vibrodriver **12**, a head **14** functionally unitary with the vibrodriver, a fixed jaw **16**, i.e. anvil, which may be rigidly secured to the head, a movable jaw **18** mounted on the head for movement toward and away from the anvil, and a principal hydraulic jack **20** for actuating the movable jaw. A feed line **22** supplies hydraulic fluid to the principal jack.

Briefly the vibrodriver includes a casing **24** which houses a pair of parallel horizontal shafts **26** journalled in the front and back walls of the casing. The shafts carry sheaves **28** that engage belts **30** trained about sheaves **32** on the shafts of electric motors **34**. These latter may, as illustrated, be mounted on the exterior of the casing **24**. Fast on the shafts **26** are identical gears **36** which mutually mesh at a vertical plane located centrally of the casing **24**, ensuring synchronous rotation of the shafts **26** in opposite directions. Each of the shafts has fixed thereon an eccentric weight **38**. The weights are so disposed that they pass through the tops and bottoms of their orbits at the same instants but in opposite directions so that the weights will develop centrifugal forces the components of which along the vertical axis of the vibrodriver are additive while their horizontal components perpendicular to said axis cancel out one another. Thus a vibratory force will be developed along the central vertical axis of the vibrodriver.

At the top of the casing there is provied a perforated ear **40** to facilitate suspension of the apparatus **10**.

The jaws **16**, **18** form a clamp for detachably engaging an elongated member to be driven into or retracted from the ground.

The hydraulic jack **20** for operating the clamp constitutes a cylinder **42** in which a piston **44** may be reciprocated by hydraulic forces in both directions. Or as is shown here the piston is shifted by hydraulic force in only one direction which is for closing movement of the clamp and biasing means is provided to move the piston in the return (opening) direction;

The piston is connected to a shaft **46** which carries the movable jaw **18** of the clamp. The feed line **22** communicates with the side of the cylinder **42** opposite to that in which the shaft **46** is located. Thereby introduction of liquid under high pressure into the feed line **22** will force the movable jaw **18** toward the anvil **16**. A helical return spring **48** encircles the shaft **46** and is under compression between an end of the cylinder **42** and the facing surface of the piston **44**.

Pursuant to a feature of the present invention a hydraulic and electric circuit (shown schematically in FIG. 2) is provided to supply liquid under pressure to the feed line **22** in such a fashion that high pressure is maintained in the feed line while the clamp is to be held closed yet the pressure is maintained without constant operation of the hydraulic pump.

The aforesaid circuit includes a hydraulic pump **50** driven through a coupling **52** by a three-phase electric motor **54**. The motor is supplied from an alternating source of three phase 440 volt power **56** by leads **58**. The leads are interrupted by a contactor **60** having an actuating coil **62** and three pairs of contacts **64** interposed in the different leads **58**. The contacts **64** are normally open, that is to say they are open when the coil **62** is idle.

The intake (low pressure) side of the pump **50** is connected by a conduit **66** to an oil reservoir **68**. The outlet (high pressure) side of the pump **50** is connected by conduit **70** to a distributor **72**. A return conduit **74** runs from the distributor **72** to the reservoir **68**. The two conduits **70**, **74** are on the inlet (pump-reservoir) side of the distributor. A pair of conduits **76**, **78** are disposed on the outlet (jack) side of the distributor.

The distributor is, in essence, a valve which includes a valve body **80**. The body has two sets of passageways indicated by the arrows in FIG. 2. The body may occupy either one of two positions. In the position shown in FIG. 2 one set of passageways connects the conduit **70** to the conduit **76** and connects the conduit **74** to the conduit **78**. As soon will be appreciated, the directions of liquid flow through the distributor in this position are as indicated by the arrows. In the second position of the body the other set of passageways connects the conduit **70** to the conduit **78** and connects the conduit **74** to the conduit **76**. As also will soon be seen, in this second position of the body the directions of the flow are as indicated by the arrows.

The jack feed line **22** is connected to the conduits **76**, **78** by a controlled check valve **82** the primary purpose of which is to allow fluid under pressure to flow from the pump **50** to the cylinder **42** and, when the pump stops, to trap the high pressure liquid in the portion of the system between the check valve and the high pressure side of the piston **44**.

The controlled check valve **82** has a top chamber **84**, an intermediate chamber **86** and a bottom chamber **88** in axial alignment. A piston **90** is slidable in and separates the top chamber and the intermediate chamber. The check valve body **92** is adapted to be abutted against a valve seat **94** located between the intermediate chamber and the bottom chamber. A spring **96** biases the check body **92** against the seat **94**. A spindle **98** connects the piston **90** to the check valve body **92**. The conduit **78** communicates with the top chamber **84**. The conduit **76** communicates with the intermediate chamber **86**. The feed line **22** communicates with the bottom chamber **88**.

In the illustrated position of the distributor body **80** with the left hand set of passageways effective, when the pump **50** is running liquid under pressure will flow from the conduit **76** into the intermediate chamber **86** and will open the check valve body **92** against the spring **96** to permit high pressure liquid to flow to the jack cylinder **42**. In the alternate position of the distributor body with the right hand set of passageways effective, when the pump is running high pressure liquid therefrom will flow through the conduit **70** to the conduit **78** causing the check valve body **92** to be unseated and allowing oil under pressure from the cylinder **42** to flow into the conduit **76** and from there to the conduit **74** which is connected to the reservoir **68**.

When the pump **50** is turned off the spring **96** will urge the check valve body **92** against its seat **94** and if at this time the oil present in the system from the feed line **22** to the cylinder **42** is under high pressure it will be trapped at such high pressure. Thus, the distributor **72** insures flow of the oil in a direction from the reservoir to the pump to the jack when the clamp is closed or being closed, i.e., is in service, and the motor is running, and insures relief return of the oil in a direction from the jack to the reservoir when the clamp is open or being opened.

A relief valve **100** is connected across the pump **50** between the conduits **66**, **70**. The relief valve is a one-directional valve. It prevents flow of oil in a direction from the conduit **66** to the conduit **70** and permits flow of oil in a direction from the conduit **70** to the conduit **66**. The flow of oil in the latter direction is against a strong spring **102** that tends to hold the valve **100** closed. The spring is overcome and flow permitted to take place through the valve only when the pressure in the conduit **70** exceeds the maximum pressure which the pump can withstand. Hence, the relief valve is essentially a safety valve which only is brought into operation when there is a failure of the control system.

A conduit **104** is tapped into the feed line **22** between the controlled check valve **82** and the cylinder **42** so that said conduit **104** is in shunt with the supply line to the jack. The conduit **104** runs to an accumulator **106** and to a pressure-sensitive switch **108**. The accumulator **106** and the pressure-sensitive switch **108** are thus connected in shunt with one another and with the feed line **22**.

The pressure-sensitive switch **108** has a pair of contacts **110**, **112**. The contacts **110** are normally closed and the contacts **112** are normally open. When the oil pressure in the switch **108** reaches a predetermined maximum, the contacts **112** are closed and the contacts **110** are opened.

The distributor **72** is actuated by a coil **114** against a return spring **116**. When the coil **114** is de-energized the spring causes the body of the distributor to assume the position shown in FIG. 2 in which the left-hand set of passageways is effective. When the coil **114** is energized the right-hand set of passageways becomes effective. The coil **114** is controlled by a contactor **118** having an actuating coil **120** and three pairs of normally open contacts **122**, **124**, **126**. The pairs of contacts **122**, **124**, are interposed in leads **128** running from a 110-volt single phase source of power **130** to the actuating coil **114** for the distributor **72**.

A twenty-four volt source of control power **132** runs to a pair of control bus lines **134**, **136**.

Two manually actuable push buttons **138**, **140** control pairs of contacts. The push button **138** is the clamp closing push button. The push button **140** is the clamp opening push button. The push buttons **138**, **140** are interlocked in such a fashion that when the push button **138** is actuated to close its associated contacts it does not act on the push button **140** or its associated normally open contacts, but when the push button **140** is actuated to close its associated normally open contacts, the push button **138** is reversely operated to open its associated contacts. The push button **138** is affiliated with the motor control coil **62** and the push button **140** is affiliated with the distributor control coil **120**.

Also provided are: a horn **142**, a manually controlled switch **144** for the horn, a normally closed motor thermal switch **146**, and a lamp **148**.

A first circuit runs between the control bus lines **134**, **136** in series through the contacts **110**, the contacts controlled by the push button **138**, the motor control coil **62** and the thermal switch **146**. A second circuit runs between the control bus lines **134**, **136** in series through the contacts **110**, the manually controlled switch **144** and the horn **142**. A third circuit runs between the control bus lines **134**, **136** in series through the contacts **112** and the lamp **148**. A fourth circuit runs between the control bus lines **134**, **136** in series through the contacts **126**, the motor control coil **62** and the thermal switch **146**.

A fifth circuit runs between the control bus lines **134**, **136** in series through the normally open contacts **140** and the distributor control coil **120**.

The operation of the circuit is as follows:

Assume the apparatus to be idle. The clamp closing button **138** is in motor off position with its contacts open. The clamp opening button **140** is in clamp closed position with its contacts open. The body **80** has its left-hand set of passageways effective. The motor **54** and pump **50** are at rest. The hydraulic jack is without pressure. The pressure-sensitive switch is in its down (low pressure) position, so that the contacts **110** are closed and the contacts **112** are open. Switch **144** is closed. The horn **142** is sounding and the lamp **148** is out. The thermal switch **146** remains closed as long as the motor **54** is not overheated.

To start operation, the clamp closing button **138** is moved to motor on position to close its contacts. The button **140** remains in clamp closed (idle) position with its contacts open. Current flows through the first circuit, energizing the coil **62** and closing motor contacts **64** to start the motor. Oil pressure builds up in the hydraulic jack to close the clamp. Oil pressure also builds up in the accumulator **106** and in the pressure-sensitive switch **108**, compressing the air in the accumulator above the body of oil therein and lifting the membrane **152** against the opposing force of the spring **150**. When the oil pressure has reached a predetermined high value the pressure-sensitive switch **108** operates to open the contacts **110** and close the contacts **112**. Thereby, the coil **62** is de-energized to open the contacts **64** and stop the motor **54**. Also, the horn **142** is de-energized. Furthermore, the lamp **148** is lit.

When the pump stops, the check valve body **92** closes against its seat **94** under the action of the spring **96**, since the valve is no longer held open by high pressure in the conduit **76**. Hence, oil at high pressure is trapped in the system between the valve **82** and the piston **44** and will hold the clamp closed.

The accumulator **106** due to the presence of the body of air therein, smoothes out pressure variations in the hydraulic feed line **22** for the jack. It also maintains pressure in the feed line **22** as leakage occurs from the high pressure section of the system, e.g., at the hydraulic jack, or as air in the hydraulic circuit dissolves in the oil. Eventually, as leakage continues, the oil pressure in the high pressure section of the system falls below a predetermined minimum value, causing the pressure-sensitive switch to operate to close the contacts **110** and open the contacts **112**, thus restarting the motor and horn and quenching the lamp **148**. The cycle of starting and stopping the motor continues so long as the clamp is to be held closed (the push button stays in contact closing position), the running and idle times of the motor and pump being protracted by the action of the accumulator **106**.

To de-actuate the hydraulic jack, and thus open the clamp and release the pile gripped thereby, the button **140** is pushed to clamp open position so as to close its contacts. The button **140** is momentary, i.e., biased to a contact open position, so that it must be manually held closed for the desired time. The interlock between the two buttons causes the button **138** to shift to a position in which its contacts open as the contacts for the button **140** are closed, thereby preparing the motor to be stopped when the button **140** is released and allowed to resume its clamp closed position.

Closure of the contacts for the clamp opening button **140** completes the fifth circuit to send current through the distributor control coil **120**. This closes contacts **122**, **124** to actuate the coil **114**, and, thereby, shift the distributor body **80** so as to render its right-hand set of passageways effective which open the check valve **82** and connect the feed line **22** to the conduits **78**, **74** and, through them, to the reservoir **68**. Energization of the coil **120** also closes contacts **126** completing the fourth circuit to keep the coil **62** energized and the motor **54** running. Oil pressure from the pump **66** holds the check valve **82** open while the feed line **22** is connected to the reservoir **68**.

When the push button **140** is released it resumes its contact open position de-energizing the coil **120**. This causes the motor and pump to stop by opening contacts **126** and de-energizing coil **62**. It also de-energizes coil **114** to allow the spring **116** to shift the distributor body **80** back to its normal position in which the left-hand set of passageways is effective. Thereupon, the apparatus is ready to have the clamp reclosed upon pressing the button **138** to its contact closed condition, since the distributor is ready to direct flow of high pressure oil from the pump to the jack. However, because the motor **54** is de-energized the jack and clamp remain in open position.

FIG. 3 illustrates a string **154** of interconnected Z-pilings **156**, **158** in which, for convenience, the odd numbered pilings **156** (counting from the left) have been drawn in solid lines while the even numbered pilings **158** have been drawn in dotted lines. Said view shows the mirror-reversed positions of adjacent pilings **156**, **158** which heretofore has made it necessary to employ two hydraulically actuated clamps having jaws of mirror-reversed configurations or clamps which are mutually bodily shiftable in order to alternatively grip odd and even numbered pilings.

FIGS. 4 and 5 illustrate a new hydraulically actuated vibrodriver clamps **160** according to the present invention which is so constructed that the single clamp can grip either odd or even Z-pilings.

The clamp includes a frame **162** secured by bolts **164** to the head **14** depending from the vibrodriver **12**. The frame has an integral pendant anvil **166** at one side and an integral pendant pillar **168** at the opposite side. The frame also has integral pendant front and back posts **170**, **172** located between and spaced from the anvil and the pillar. The posts are formed with horizontal coplanar through straight bores which slidably receive a front rod **174** and a rear rod **176**. The rods are longer than the widths of the posts and project from both sides thereof.

The cylinder **42** of a hydraulic jack **20** is fixed to the pillar **168** in such position that the shaft **46** carried by its piston extends toward the anvil **166**. The shaft **46** at its free end carries a movable jaw **178** which is horizontally elongated in a front-to-back direction to such an extent that it has surface portions aligned with and facing the adjacent (left-hand) ends of the rods **174**, **176**. The remote (right-hand) ends of the rods **174**, **176** are aligned with and face surface portions of the anvil **166**.

The facing portions of the movable jaw and the anvil are parallel to one another. The rods are of the same length. The movable jaw is situated between the pillar and the posts and, specifically, between the pillar and the adjacent ends of the rods. The inner surfaces of the posts are tapered toward their centers (see FIG. 5) to accommodate the sloped webs of Z-pilings in either of the two mirrored-reversed positions thereof.

Spindles **180** slidable in the pillar **168** are connected at one set of ends to opposite ends of the movable jaw **178**. The other set of ends are spaced from the outer side of the pillar **168** and are in the form of heads **182**. Coil springs **184** encircling the spindles are under compression between the heads **182** and the pillar **168** and bias the movable jaw **178** to a retracted position spaced from the adjacent ends of the rod **174**, **176**.

FIG. 5 shows how the clamp **160** is used to grip a Z-piling in either of its mirror-reversed positions. In this figure an odd numbered Z-piling **156** is shown in full lines and an even numbered Z-piling **158** in dotted lines.

When an odd numbered Z-piling **156** is to be gripped the rear flange **186** (as viewed in FIG. 5) is pressed between the movable jaw **178** and the adjacent end of the rear rod **176**. The front flange **188** is pressed between the remote end of the front rod **174** and the anvil **166**. The sloped web **190** angles across the space between the two posts **170**, **172**. The remote end of the rear rod **176** is pressed directly against the anvil **166**. The adjacent end of the front rod **174** is pressed directly against the movable jaw **178**.

When an even numbered Z-piling **158** is to be gripped its rear flange is pressed between the remote end of the rear rod **176** and the anvil **166**. Its front flange is pressed between the adjacent end of the front rod **174** and the movable jaw **178**. Its sloped web angles across the space between the two posts **170**, **172** in a mirror-reversed inclination to that of the web **190**. The adjacent end of the rear rod **176** is pressed directly against the movable jaw **178**. The remote end of the front rod **174** is pressed directly against the movable jaw **178**. The remote end of the front rod **174** is pressed directly against the anvil **166**.

Thus, simply by slightly relative axially displacing the front and rear rods the clamp **160** is prepared to receive a Z-piling in either of its mirror-reversed positions and will grip said piling when oil under pressure, supplied as per the circuit of FIG. 2, is then introduced into the hydraulic jack by actuating the button **138** to close its contacts.

FIG. 6 shows a modified hydraulic vibrodriver clamping system **192** in which the pile engaging clamp is hydraulically actuated while it is shiftable on (has freedom of movement with respect to) the vibrodriver and in which thereafter the pile engaging clamp is hydraulically fixed (locked) to the vibrodriver to render ineffective the aforesaid freedom of movement. A simple form of hydraulically actuated vise clamp has been shown similar to that illustrated in FIGS. 1 and 2; other more sophisticated forms of clamp can be substituted, such, for instance, as the clamp form shown in FIGS. 4 and 5.

The system **192** is carried by a head **14** mounted on a vibrodriver **12**. The system includes an intermediate block **194** having a T-shaped groove **196** in its upper surface. A T-shaped tenon **198** is slidable in the groove **196**, thereby permitting the intermediate block **194** to translate relative to the head **14** parallel to the length of the tenon **198**.

In order to selectively prevent relative movement between the intermediate block **194** and the head **14**, an auxiliary hydraulic jack **200** is provided including a cylinder **202** and a piston **204** slidable therein. The piston mounts a sturdy pin **206** slidable in a bore in the block **194** and having the tip thereof projecting into the base of the T-groove **196** adjacent the base of the tenon **198**. Conduits **208**, **210** are connected to opposite ends of the cylinder **202**, whereby when oil under pressure is admitted into the conduit **208** and the conduit **210** is connected to low pressure, as for instance, a reservoir, the pin **206** will forcefully engage the tenon **198** to lock the intermediate block in the position which it then occupies.

The lower end of the intermediate block **194** carries a pile engaging clamp **212** including a fixed anvil jaw **214** and a movable jaw **216**. The movable jaw is actuated by a principal hydraulic jack **218** which includes a cylinder **220** in the intermediate block and a piston **222** slidable in the cylinder. Mounted on the piston is a pin **224** which is integral with the movable jaw **216**. Conduits **226**, **228** lead to opposite ends of the cylinder **200** whereby when oil under high pressure is introduced into the conduit **226** and the conduit **228** is connected to a source of low pressure such as a reservoir, the movable jaw will be forced against a pile P located between it and the anvil.

Pursuant to the present invention, means is provided to supply oil under pressure to the conduits **208**, **226**, said means being such that the oil will be supplied under pressure to the conduit **226** before being supplied under pressure to the conduit **208** whereby the clamp **212** will be actuated to grip a pile before the auxiliary hydraulic jack **200** is actuated to lock the intermediate block to the head. This arrangement permits the clamp **212** to adjust itself to the pile and move relative to the head **14**, with the aid of the intermediate block **194**, before the block is locked in the self-adjusted position of the clamp. Such an arrangement is particularly advantageous where there are two clamps and, optionally, two intermediate blocks so that clamps carried by the same vibrodriver can self-adjust their positions with respect to two points to be gripped, the spacing between which may vary in similar objects to be driven.

To the foregoing end the conduits **208**, **226** are jointly connected to a conduit **230**, the conduit **208** through a pair of oppositely acting check valves **232**, **234**. The check valves are connected in shunt with one another between the conduit **230** and the conduit **208**. The check valve **232** is arranged to permit flow from the conduit **230** to the conduit **208**. The check valve **234** is arranged to permit flow in the reverse direction from the conduit **208** to the conduit **230**. The check valve **232** is heavily biased against opening by an adjustable spring. The check valve **234** is lightly biased against opening. Its spring need not be adjustable.

The check valve **232** is so heavily biased against opening that it will not open until the principal hydraulic jack **218** has closed its clamp **212** against a pile disposed between its jaws with sufficient strength to firmly grip the pile. By such time the clamp **212** will have self-adjusted its position to accommodate to the location of the pile, the intermediate block **194** shifting with respect to the head **14** to permit such self-adjustment. At this time, when a high pressure has been developed in the cylinder **220**, the check valve **232** will open to permit high pressure oil to flow into the cylinder **202**, so as to actuate the auxiliary hydraulic clamp **200** and thereby lock the intermediate block **194** to the head **14**. Thereupon the vibrodriver **10** can be set into operation. Thus, the check valve **232** constitutes a delay means which ensures actuation of the principal hydraulic jack **218** before actuation of the auxiliary hydraulic jack **200**, and, concurrently, operation of the clamp **212** before the intermediate block is fixed to the vibrodriver head.

The check valve **234** is employed to enable the auxiliary hydraulic jack **200** to be de-actuated.

Both of the hydraulic jacks have been illustrated as of the opposite acting type where hydraulic pressure is employed both to close and open the jacks rather than only to close the jacks, as in the jack **20** shown in FIG. 1. It will be appreciated that, if desired, the simple form of jacks can be used in the system **192**. However, the more sophisticated form has been shown by way of illustration.

The conduits **210** and **228** are connected to a conduit **236** which is designed to be connected either to high pressure or to the reservoir, as is the conduit **230**, depending upon the desired mode of actuation of the two jacks, that is to say, when the conduit **230** is connected to high pressure oil and the conduit **236** to the reservoir the jacks are actuated. They are de-actuated when the connections are reversed.

A valve **238** is provided to effect the aforesaid selective connection of the conduits **230**, **236**. Said valve includes an inlet port **240** connected by a conduit **242** to the outlet of a motor driven oil pump **244**. A port **246** is connected to the conduit **230**. A port **248** is connected to the conduit **236**. Ports **250** and **252** are connected to a reservoir. The ports are disposed in a valve casing **254** in which a valve body **256** is translatable under the manual control of an operator. The valve body has a right-hand position, illustrated in FIG. 6, and can be shifted to a left-hand position. The body **256** has two passageways **258**, **260**. The passageways are so disposed that in the right-hand position illustrated in FIG. 6 they connect the high pressure port **240** to the port **246** and the low pressure port **252** to the port **248**, thereby connecting the conduit **226** and, after a short time delay, the conduit **208** to the high pressure conduit **242**, while the conduits **210**, **228** are connected to low pressure.

The passageways in the left-hand position of the body **256** connect the conduit **236** to high pressure and the conduit **230** to low pressure, thus allowing oil under pressure to open both hydraulic jacks, the check valve **234** permitting return flow of oil from the cylinder **202** on the opening stroke of the auxiliary hydraulic jack **200**.

It thus will be seen that there have been provided systems which achieve the several objects of the invention and which are well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments above set forth, it is to be understood that all matter herein described or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A vibrodriver clamping system including a clamp, a hydraulic jack operating the clamp, a hydraulic conduit connected to the jack for leading high pressure hydraulic liquid to the jack to close the clamp against a pile, a hydraulic pump having its high pressure side connected to the conduit, an electric motor driving the pump, and a pressure sensitive switch having contacts in the motor electric supply circuit and having a pressure sensing element exposed to the pressure in the conduit, said pressure sensing element opening the contacts to idle the motor and pump when the pressure in the conduit reaches a predetermined allowable limit for the system and the pressure sensing element closing the contacts to run the motor and pump when the pressure in the conduit drops to a predetermined low value which is the minimum operating value for holding the clamp closed for vibrodriver operation.

2. A vibrodriver clamping system as set forth in claim 1 wherein means is included to trap the high pressure hydraulic liquid in the conduit when the contacts are opened by the pressure sensing element.

3. A vibrodriver clamping system as set forth in claim 2 wherein the trapping means is a check valve oriented to pass liquid in a direction from the pump to the jack.

4. A vibrodriver clamping system as set forth in claim 2 wherein the trapping means is a controlled check valve oriented to pass liquid in a direction from the pump to the jack, wherein the controlled check valve includes a mechanism to open said valve for reverse flow when the clamp is to be rendered ineffective, and wherein means further is included to connect the conduit to low pressure through the reversed opened check valve at such time.

5. A vibrodriver clamping system as set forth in claim 2 wherein an accumulator is connected to the conduit, said accumulator having a body of gas therein to smooth out pressure variations in the conduit and to protract running and idle periods of the pump.

6. A vibrodriver clamping system as set forth in claim 1 wherein a relief valve is connected across the pump to provide supplementary protection for the system, said valve opening to connect the high pressure side to the low pressure side of the pump when the pressure at the high pressure side exceeds the allowable system limit.

7. A vibrodriver clamping system as set forth in claim 1 wherein an accumulator is connected to the conduit, said accumulator having a body of gas therein to smooth out pressure variations in the conduit and to protract running and idle periods of the pump.

8. A vibrodriver clamp for engaging either of mirror-reversed Z-pilings, said clamp including an anvil, a movable jaw opposed to the anvil, a hydraulic jack for actuating the jaw, a pair of rods between the jaw and anvil, means supporting the rods with the longitudinal axes thereof parallel and mounted between the movable jaw and anvil, said last named means permitting longitudinal sliding movement of the rods relative to the movable jaw and anvil, whereby the flanges of a Z-piling will either be gripped, depending upon which of the mirror-reversed positions the Z-piling is in, between the movable jaw at one end of a first one of the rods and between the anvil and one end of the second one of the rods, or will be gripped between the movable jaw and the other end of the second rod and between the anvil and the other end of the first rod.

9. A vibrodriver clamp as set forth in claim 8 wherein the means supporting the rods comprises a pair of posts located between the movable jaw and the anvil and spaced apart transversely of the span between the movable jaw and the anvil to admit the sloped web of a Z-piling in either of its mirror-reversed positions.

10. A vibrodriver clamp including a head secured to a vibrodriver, an intermediate block, means mounting the block on the head with at least one degree of freedom of movement of the block relative to the head, an auxiliary jack, means mounting the auxiliary jack to lock the intermediate block to the head when said auxiliary jack is actuated, a pair of clamping jaws, a principal hydraulic jack, means mounting the principal hydraulic jack to open and close the jaws, a high pressure source of hydraulic liquid and selectively operable means to connect the high pressure source of hydraulic liquid first to the principal hydraulic jack and thereafter after the principal hydraulic jack has been actuated to the auxiliary hydraulic jack so as to permit the jaws to grip a pile and accommodate itself in proper position thereon and only thereafter to fix the position of the intermediate block with respect to the vibrodriver head.

11. A vibrodriver clamp as set forth in claim 10 wherein the selectively operable means includes a delay mechanism in a hydraulic conduit running to the auxiliary hydraulic jack.

12. A vibrodriver clamp as set forth in claim 11 wherein the delay mechanism is a heavily loaded check valve oriented to pass hydraulic liquid from the source of supply to the auxiliary hydraulic jack, said check valve opening at a pressure in excess of that required to operate the principal hydraulic jack.

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