United States Patent [19]

Pepe

[11] **3,838,741**

[45] **Oct. 1, 1974**

[54] **PILE HAMMERS**

[76] Inventor: **Charles R. Pepe,** Old Quarry Rd., Closter, N.J. 07620

[22] Filed: **May 9, 1972**

[21] Appl. No.: **251,785**

[52] **U.S. Cl.** **173/115,** 91/234, 91/236, 92/8, 173/128, 173/136, 173/137

[51] **Int. Cl.** **E02d 7/08,** E02d 7/10

[58] **Field of Search** 173/128, 132, 136, 137, 173/138, 139, 134, 135, 1, 115; 61/53.5; 91/234, 277, 236, 243; 92/85, 8

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Primary Examiner—Henry C. Sutherland
Assistant Examiner—William F. Pate, III
Attorney, Agent, or Firm—Samuelson & Jacob

[57] **ABSTRACT**

Power hammer for driving piling, and the like, free of valve mechanism likely to require attention and comprising a working cylinder having an anvil at the lower end of the same and a ram operative as a piston in the cylinder, cooperative with the anvil and surrounding walls of the cylinder to form an expansion chamber, the ram having a flow passage extending from an annular groove near the top, down through the lower end to said expansion chamber and the cylinder having pressure supply and exhaust ports to register with said flow passage and to be uncovered by the ram, in lower and upper positions of the ram in the cylinder and whereby the essential functions of the hammer are automatically effected in the normal operation of the ram.

Pressure controlled valves may be added to automatically hold desired pressures and release opposing pressures on the ram.

11 Claims, 17 Drawing Figures

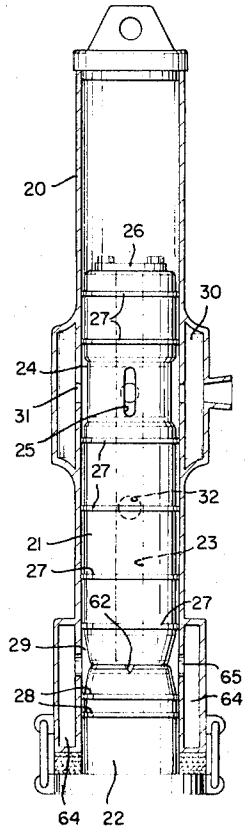


FIG. 3

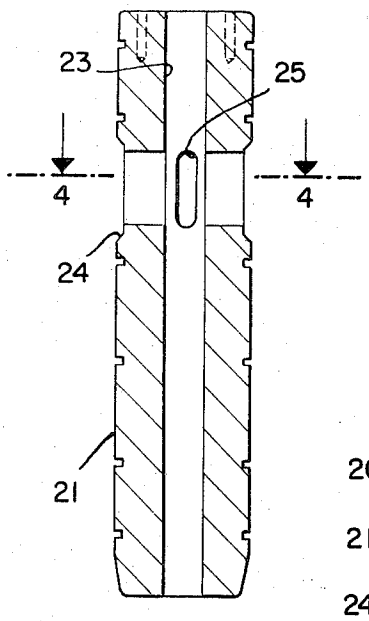


FIG. 1

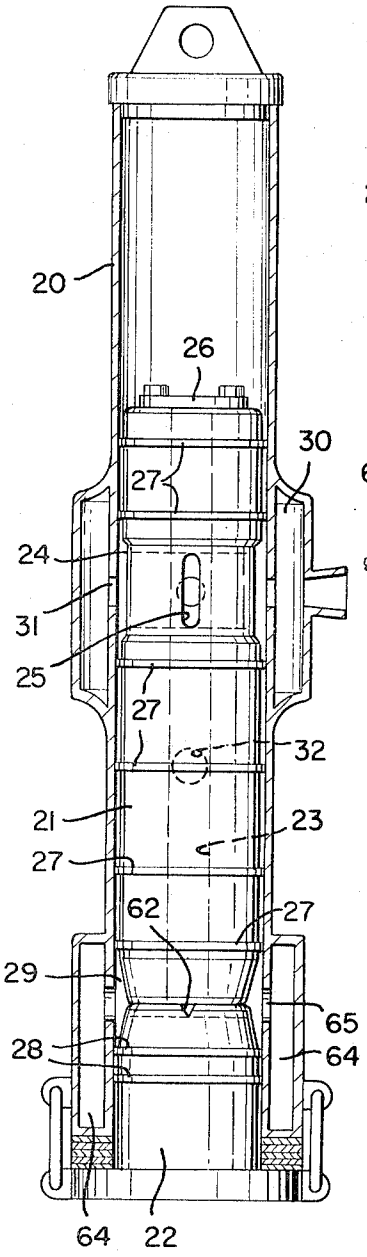


FIG. 4A

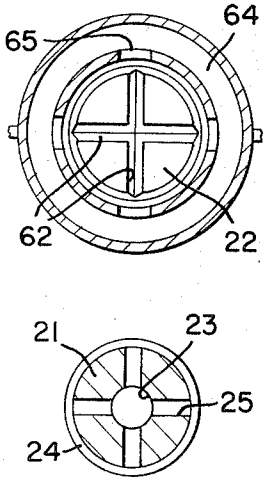


FIG. 4

FIG. 2

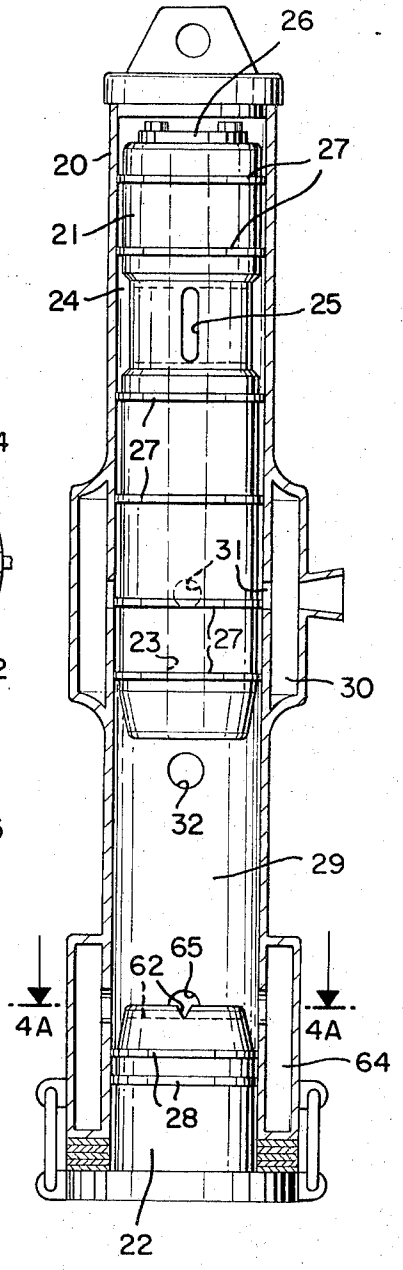


FIG. 7

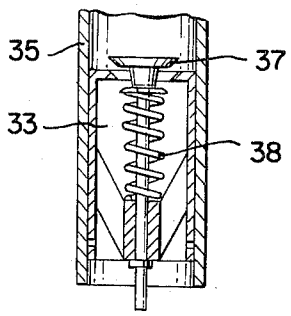
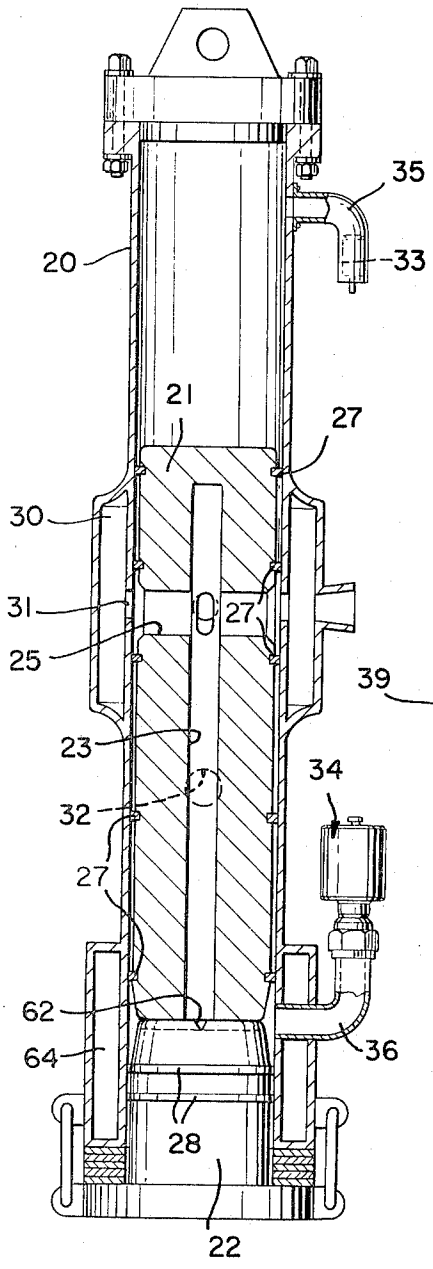


FIG. 5



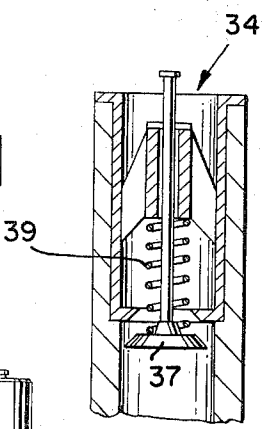


FIG. 8

FIG. 6

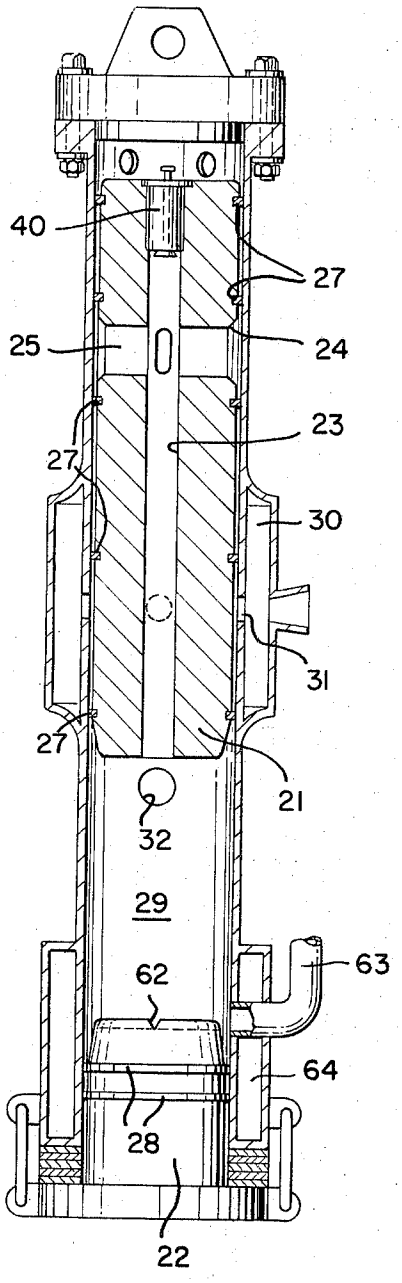


FIG. 11

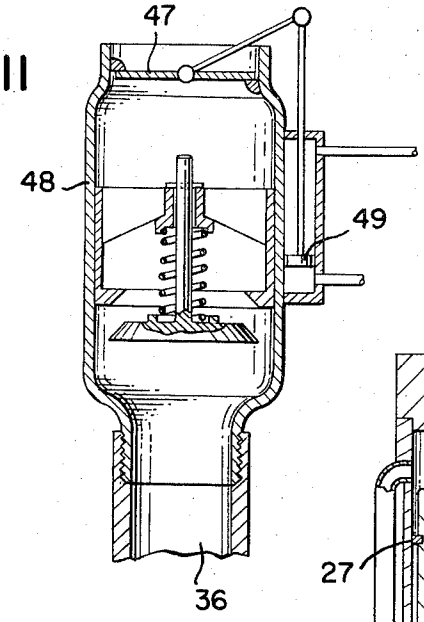
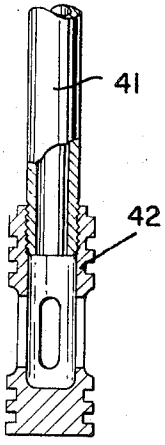


FIG. 12



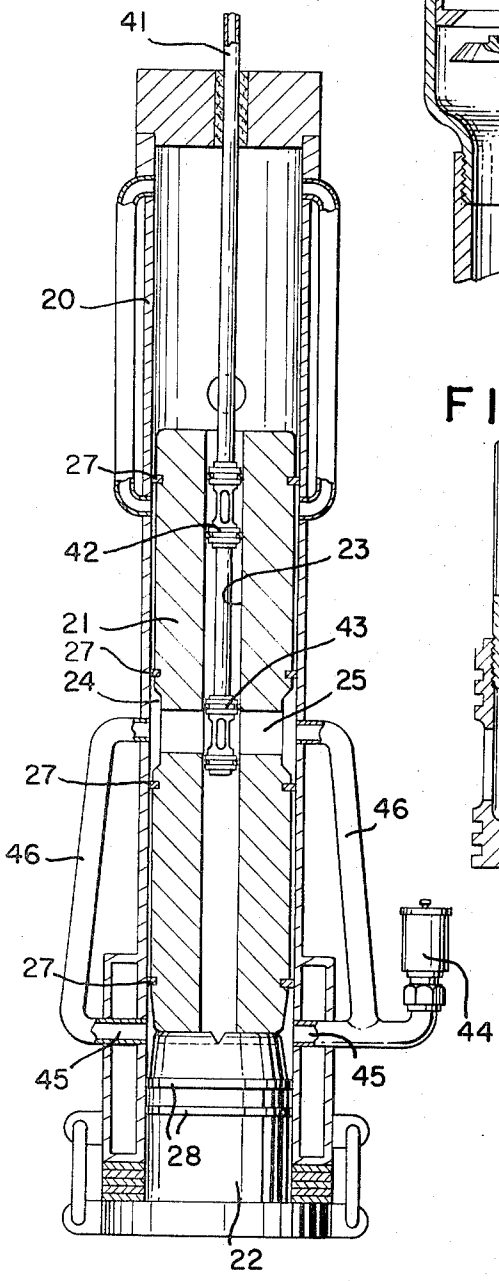


FIG. 9

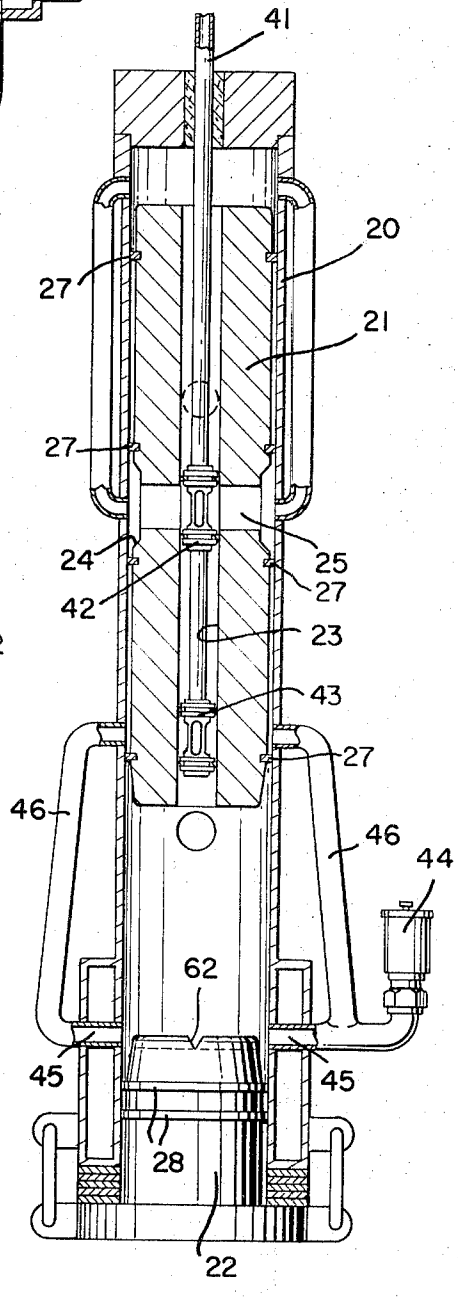


FIG. 10

FIG. 13

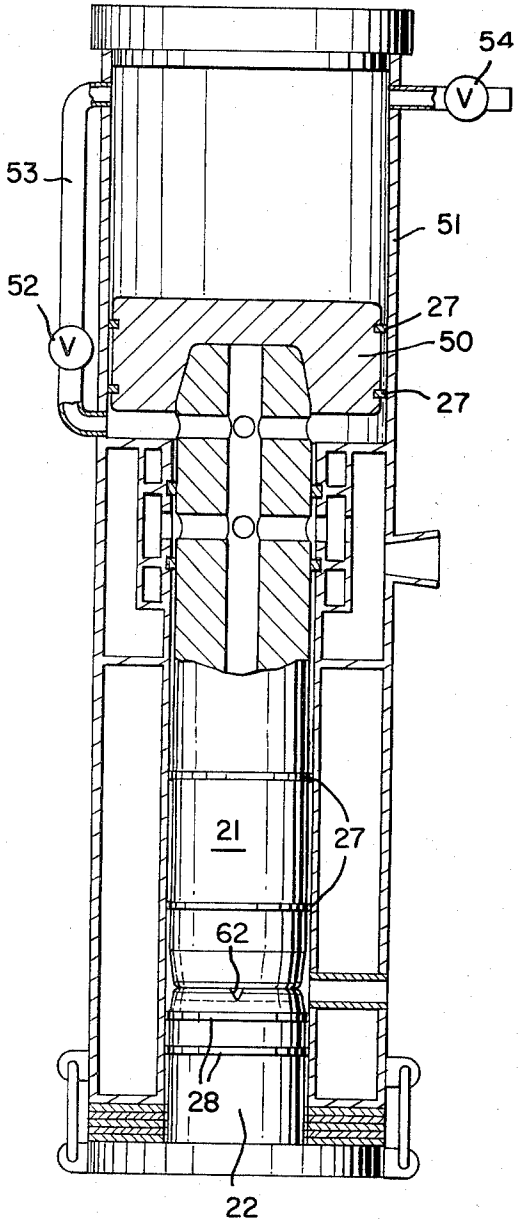

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FIG. 14

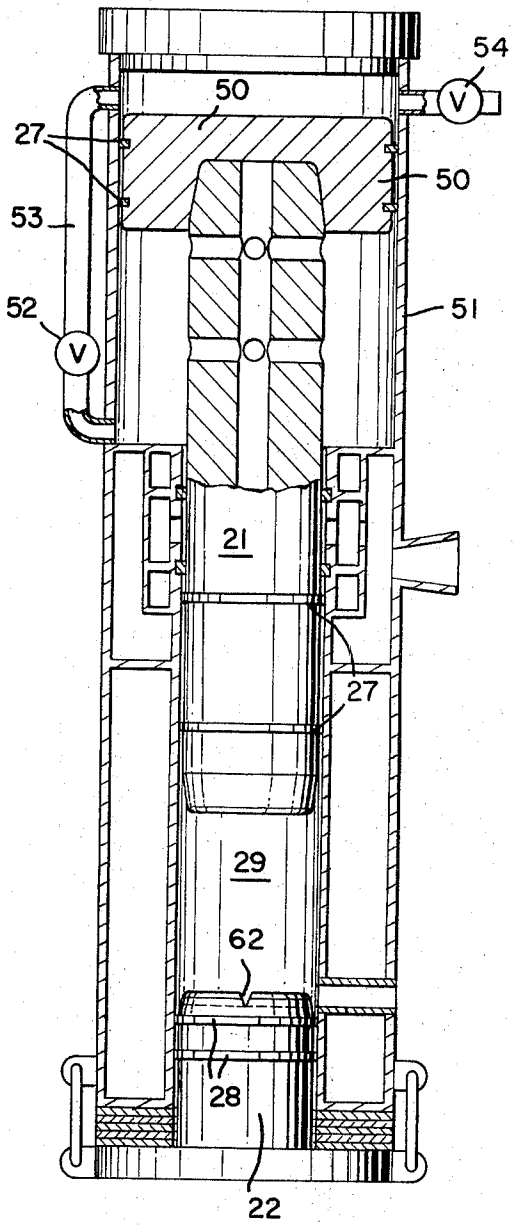
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FIG. 15

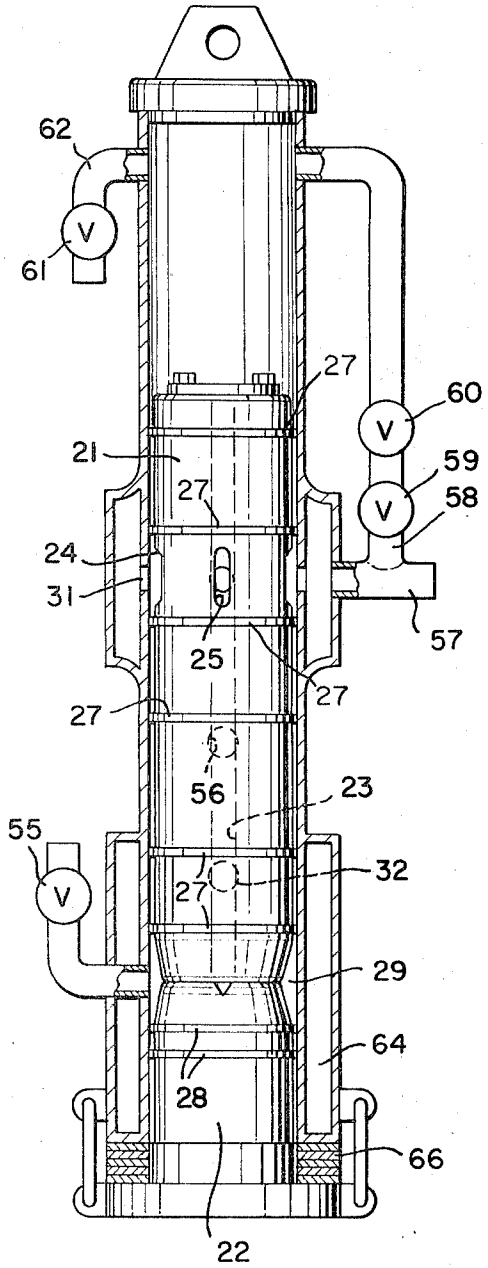
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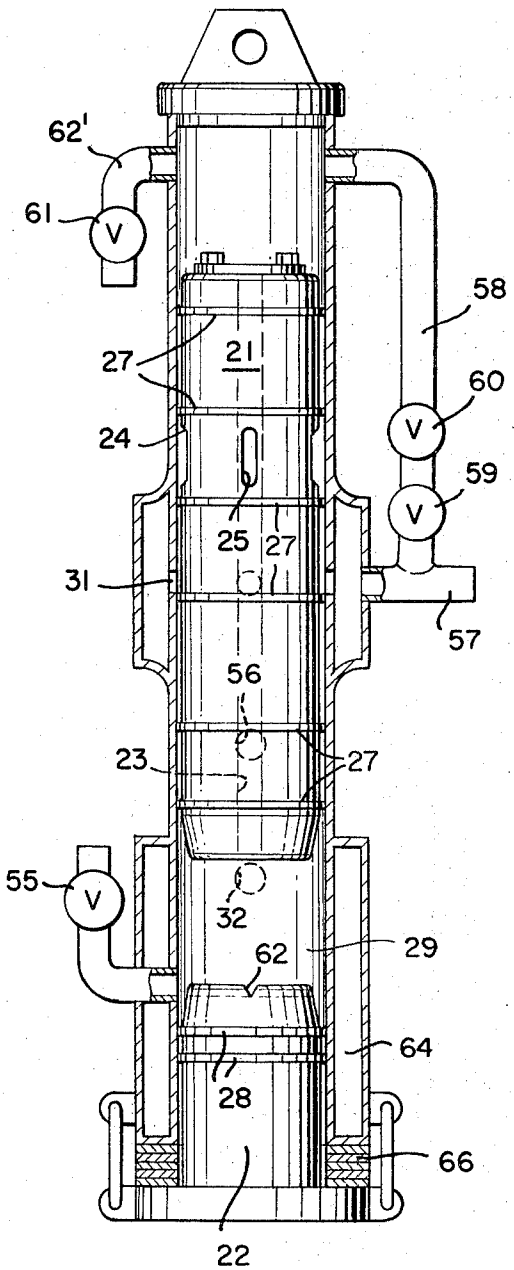
FIG. 16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PILE HAMMERS

Generally stated, objects of the invention have been to provide a hammer of simple, sturdy construction, which could be produced at reasonably low cost, which would have greater power output and speed of action than hammers of conventional design, which would be controllable to meet existing operating conditions and which would be practical in all respects.

The drawings accompanying and forming part of this specification illustrate certain present practical embodiments of the invention, but structure may be further modified and changed, as regards the immediate illustration, all within the true intent and scope of the invention, as hereinafter defined and claimed.

FIG. 1 is a longitudinal sectional view of one of the new hammers, with the ram shown at the bottom of its stroke, in engagement with the anvil and closing the exhaust port in the side of the cylinder.

FIG. 2 is a similar view showing the ram at the top of its stroke, in position opening the exhaust port.

FIG. 3 is a longitudinal sectional view of the ram.

FIG. 4 is a cross sectional view of the ram on substantially the place of line 4—4 of FIG. 3.

FIG. 4A is a cross section on line 4A—4A of FIG. 2.

FIG. 5 is a sectional view similar to FIG. 1, showing automatic pressure control valves added at opposite ends of the cylinder.

FIG. 6 is a like sectional view showing a pressure control valve seated in the upper end of the ram.

FIGS. 7 and 8 are enlarged broken sectional views of the upper and lower control valves shown in FIG. 5.

FIGS. 9 and 10 are broken sectional views illustrating a piston form control valve incorporated in the ram, making the hammer a "double acting" hammer.

FIG. 11 is a sectional detail of a "choke" form of pressure control.

FIG. 12 is an enlarged sectional detail of the piston valve appearing in FIGS. 9 and 10.

FIGS. 13 and 14 are sectional views of a "compound" form of the hammer.

FIGS. 15 and 16 are longitudinal sectional views of a convertible form of the hammer, designed to operate, for example, as a single action, 36 inch stroke, 80 blows per minute hammer, or as a double acting 18 inch stroke, 100 blows per minute hammer.

FIGS. 1 to 4 show the hammer as made up of a working cylinder, 20 of uniform diameter, and a companion uniform diameter ram 21, operating as a piston therein, in cooperative relation with an anvil 22, closing the lower end of the cylinder.

The ram is specially designed, to operate as a valve maintaining the essential functions or phases of the hammer.

Thus it is shown as having a central bore or passage 23, extending from the top, down through the bottom of the same and a shallow annular groove 24, in the side of the same, near the top, in communication with the bore, by equally spaced radial slots 25.

The bore may be a central or off-center passage, functioning as it does, as a conduit for the motive fluid, usually steam or compressed air. It is shown in FIGS. 1 and 2, closed at the top by a cover plate 26.

The ram and the anvil are sealed in the cylinder, as by piston rings, indicated at 27 and 28, forming cooperatively an expansion chamber 29, beneath the lower face of the ram.

Motive fluid is supplied from a chest 30, surrounding the cylinder, having a plurality of equally spaced ports, 31, in the cylinder, placed to register with the groove in the side of the ram, when the ram is at or about the lower end of its stroke.

An exhaust port 32, in the side of the cylinder, is positioned to be covered by the ram in the lower portion of its stroke, as indicated in FIG. 1.

In operation, motive fluid passes from supply chest 30, through ports 31, into the groove 24 in the ram, with the ram in the lower portion of its stroke, and thence through radial ports 25, into the upper end portion of the down passage 23, to the expansion chamber 29 beneath the ram.

Cutoff is determined by passage of the grooved portion of the ram above the inlet ports 31, as in FIG. 2 and exhaust is effected when the sealed lower end portion of the ram overreaches the exhaust port 32 in the cylinder.

In FIG. 5 the hammer is shown equipped with pressure-operated automatic valves 33 and 34, with connections 35, 36 to opposite ends of the cylinder.

These valves are alike in that they are each spring-opened and pressure-closed. Thus the upper, upwardly faced valve 33, as shown in detail in FIG. 7, is in the nature of a one-way check valve or poppet valve, having a conical valve member or element 7, held seated in closing position by pressure in the cylinder connection 35 and sustained in open relation by spring 38.

The upper valve shown in FIG. 7 will thus stand open to atmosphere on down travel of the ram to prevent vacuum buildup and retarding effect on downstroke of the ram and will remain thus open until pressure generated on return stroke of the ram becomes sufficient to overcome the valve opening spring force.

This vacuum relief valve thus promotes full live action of the ram and buildup of a cushion and pressure source at start of the downstroke.

The lower valve 34, as shown in FIG. 8, opens downwardly, with the spring 39 holding it open to atmosphere to relieve back pressure on the downstroke of the ram and until pressure builds up beneath the ram, this valve closes, ready for the next upstroke of the ram.

The release of pressure on opening of exhaust port 32 enables opening of the back pressure valve relief as shown in FIG. 8 in proper timing.

These control valves facilitate and contribute to the full power development and speed of the hammer.

FIG. 6 shows how an automatic back pressure relief valve 40, like that shown in FIG. 8, may be incorporated in the head of the ram, seated in the upper end of the bore 23, left open in this case to receive the valve.

This valve closes upwardly by pressure admitted to the bore at start of the upstroke of the ram and opens to atmosphere to relieve back pressure on downstroke.

In the double acting form of the hammer shown in FIGS. 9 and 10, a valve inlet stem 41 is supported in the head of the cylinder, carrying piston valve elements 42, 43 spaced to register with the feed groove 24 in the ram, in the down (FIG. 9) and up (FIG. 10) positions of the ram.

A back pressure relief valve **44,** like that shown in FIG. **8,** is provided in the motive fluid connections **45, 46** to the lower portions of the cylinder.

FIG. **11** shows how a pivoted "choke" **47** may be incorporated in a control valve **48,** like that shown in FIG. **8,** with a remote control operating piston **49.**

The purpose of this choke is to retard or vary energy output by increasing back pressure.

In the "compound" type of hammer shown in FIGS. **13, 14,** the ram carries a larger diameter piston head **50** operating in a larger diameter cylinder extension **51,** a control valve **52,** like that in FIG. **8** is placed in the connection **53** between opposite ends of the upper cylinder and a valve **54,** like that shown in FIG. **7** is connected with the upper end of the upper cylinder **51.**

FIGS. **15** and **16** show how the hammer may be built in a "convertible" form, to operate as a single action, slower and longer stroke, hammer, or as a double acting, faster and shorter stroke hammer.

A spring-loaded, normally open control valve **55,** like that in FIG. **8,** is connected with the expansion chamber **29** and a second exhaust port **56** is spaced above the first exhaust port **32,** to be uncovered in the longer stroke operation of the ram.

The pressure supply line **57** is branched at **58** into the top of the cylinder above the ram and provided with a pressure-regulating valve **59** and above that with an on and off ball valve or equivalent control **60.**

An upper cylinder vacuum relief valve **61,** like that in FIG. **7,** is connected into the upper end of the cylinder at **62'.**

The lower short-stroke exhaust port **32** may be closed by an inserted plug, or closing off the port with a valve, when operating as a slower, longer stroke hammer and with the ball valve in closing position and using the upper exhaust port **56.**

The "convertible" form of the hammer provides an extensive choice of speeds and energy output. Without an upper cylinder compression and vacuum relief valve **61,** the hammer may operate, for example, with a four-foot stroke and a speed of 50 to 55 blows per minute.

With an upper cylinder compression holder and vacuum relief valve **61** in place, this hammer may, in the example, be run at a speed of 80 blows per minute on a three-foot stroke, single acting.

With the lower exhaust port **32** open to atmosphere, the ball valve open, inlet pressure at 100 psi, and a constant down pressure on the upper face of the ram reduced by regulating valve **59** to, say, 40 psi, the hammer will then operate with an 18-inch stroke, 100 blows per minute.

In all forms of the invention, ample clearance for entering motive fluid is provided, assuring quick immediate action.

The face of the anvil is shown with crossed V-grooves **62** FIG. **4–A,** providing instant access of entering live steam or compressed air to the lower lifting area of the ram.

By reversing the hammer, end for end, and providing pile attaching means, the hammer may be used as a pile extractor.

The choke added to the exhaust back pressure valve **48** in FIG. **11** is shown as a simple choke plate which can be closed by compressed air or steam motor **49** to create back pressure in the lower cylinder for softening or cushioning the blow of the ram.

All forms of the hammer are of simple, sturdy, low-cost construction.

Clearance volume to provide room for air compressed ahead of the descending ram may be provided by closed end tubes connected with the expansion chamber as shown at **63** in FIG. **15** or by chest **64** surrounding the expansion chamber and open thereto by ports **65.**

Rest position of the ram and start and finish of stroke may be governed to a desirable extent by the number of steel and shock absorbing spacing shims **66** used between the anvil and end of the cylinder. No "cushion block" is required.

The hammer forms a compact unit free of objectionable valve or other projections and may be operated underwater as well as on dry land.

The hammer may be made self-stopping by lowering the anvil below the point of registration of ram inlet slots with the cylinder inlet ports.

The controls illustrated enable the hammer to be adjusted to meet many different or changing operating conditions.

What is claimed, is:

1. A power hammer comprising:

a normally upright cylinder having an upper end and a lower end;

an anvil at the lower end of the cylinder, the anvil having an upper face;

fluid pressure supply connections having a plurality of equally spaced inlet ports opening in through the side of the cylinder;

a ram in said cylinder operating in cooperative relation with the anvil, said ram being movable between a lower position, wherein the ram is against the anvil, and an upper position, wherein the ram is away from the anvil and adjacent the upper end of the cylinder;

the cylinder including an expansion chamber at the lower end thereof;

the ram having an upper end and a lower end, an annular groove in the side thereof, a passage in the interior thereof and a plurality of openings in the groove connecting the groove and the passage, the passage extending from the said plurality of openings through the lower end of the ram to communicate with the expansion chamber, and the annular groove having upper and lower ends; and

upper and lower sealing means located, respectively, adjacent the upper and lower ends of the annular groove for establishing a pressure fluid seal between the ram and the cylinder;

the annular groove being located so as to register with the inlet ports in the lower position of the ram to thereby supply pressure fluid through the openings and the passage to the expansion chamber to lift the ram and operate the same as a piston, said upper and lower ends of the annular groove being spaced apart to provide the groove with a length great enough to admit sufficient pressure fluid to the expansion chamber, as the ram is lifted and before the sealing means cut off communication between the openings in the ram and the inlet ports, to lift the ram to the upper position thereof;

the cylinder having an exhaust port through the side thereof which is covered by the ram when the ram is in the lower position and uncovered to communicate with the expansion chamber when the ram is

in the upper position, the exhaust port being spaced upwardly from the lower end of the cylinder a distance sufficient to permit expansion of the pressure fluid in the expansion chamber to raise the ram and enable the expanded pressure fluid to be exhausted from the expansion chamber to allow the ram to fall freely downward and strike the anvil.

2. The invention of claim 1 wherein:

the anvil has crossed V-section grooves in its upper face opposed to the lower end of the ram to provide clearance for the pressure fluid admitted down through the passage in the ram.

3. The invention of claim 1 including:

valve means biased to its open position mounted near the upper end of the cylinder;

said valve means being open to atmosphere on the downstroke of the ram to prevent vacuum build-up and retardation of the downstroke;

said valve means closing on the upstroke of the ram when the pressure generated is sufficient to overcome the bias to thereby build up an air cushion and pressure source for the subsequent downstroke.

4. The invention of claim 3 including:

second valve means biased to its open position mounted near the lower end of the cylinder;

said second valve means being open to atmosphere to relieve back pressure on the downstroke of the ram;

said second valve means closing as the pressure beneath the ram is sufficient to overcome the bias and remaining closed on the upstroke until the pressure fluid exits through the exhaust port.

5. The invention of claim 1 including:

valve means biased to its open position mounted near the lower end of the cylinder;

said valve means being open to atmosphere to relieve back pressure on the downstroke of the ram;

said valve means closing as the pressure beneath the ram is sufficient to overcome the bias and remaining closed on the upstroke until the pressure fluid exits through the exhaust port.

6. The invention of claim 5 wherein said valve means is spring biased to its open position.

7. The invention of claim 1 wherein:

there are two such exhaust ports spaced apart in a vertical direction such that when the lower of said exhaust ports is closed, the pressure fluid is exhausted through the upper exhaust port to thereby obtain a longer stroke of the ram.

8. The invention of claim 7 including:

a first spring-opened, pressure-closed valve mounted in the cylinder at a level adjacent the upper face of the anvil;

a second spring-opened, pressure-closed valve mounted in the cylinder adjacent the upper end thereof;

a pressure fluid, supply connection extending to said inlet ports and having a branch extending to the cylinder above the ram and having pressure regulating means therein for reducing the downward pressure of the pressure fluid on the ram as opposed to the greater upward pressure of the pressure fluid used for lifting the ram.

9. The invention of claim 8 including means for precluding flow of pressure fluid in the branch.

10. The invention of claim 1 including:

a first spring-opened, pressure-closed valve mounted in the cylinder at a level adjacent the upper face of the anvil;

a second spring-opened, pressure-closed valve mounted in the cylinder adjacent the upper end thereof;

a pressure fluid, supply connection extending to said inlet ports and having a branch extending to the cylinder above the ram and having pressure regulating means therein for reducing the downward pressure of the pressure fluid on the ram as opposed to the greater upward pressure of the pressure fluid used for lifting the ram.

11. A power hammer comprising:

a normally upright cylinder having a head, an upper end and a lower end;

an anvil at the lower end of the cylinder;

a ram in said cylinder operating in cooperative relation with the anvil, said ram being movable between a down position, wherein the ram is against the anvil and an up position, wherein the ram is away from the anvil and adjacent the upper end of the cylinder, said ram having:

an upper end and a lower end;

an annular groove in the outer perimeter of the side thereof;

a passage in the interior from the top to the bottom; and

a plurality of openings connecting the annular groove and the passage;

a tube mounted in the head of the cylinder and carrying vertically spaced upper and lower piston valve elements positioned within the passage to register with the annular groove in the down and up positions of the ram;

the lower piston valve element being in register with the annular groove in the down position of the ram;

the upper piston valve element being in register with the annular groove in the up position of the ram;

a first fluid connection in the cylinder in register with the annular groove in the down position of the ram and communicating with the lower end of the cylinder; and

a second fluid connection in the cylinder in register with the annular groove in the up position of the ram and communicating with the upper end of the cylinder.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,838,741 Dated October 1, 1974

Inventor(s) Charles R. Pepe

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In applicant's address "Closter" should read --Alpine--
Column 2, line 29, "element 7" should read --element 37--
Column 2, lines 42-43, "atmopshere" should read --atmosphere--
In FIG. 15, reference numeral "62" in the upper left should be --62'--

Signed and Sealed this

twenty-eight Day of *October 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks