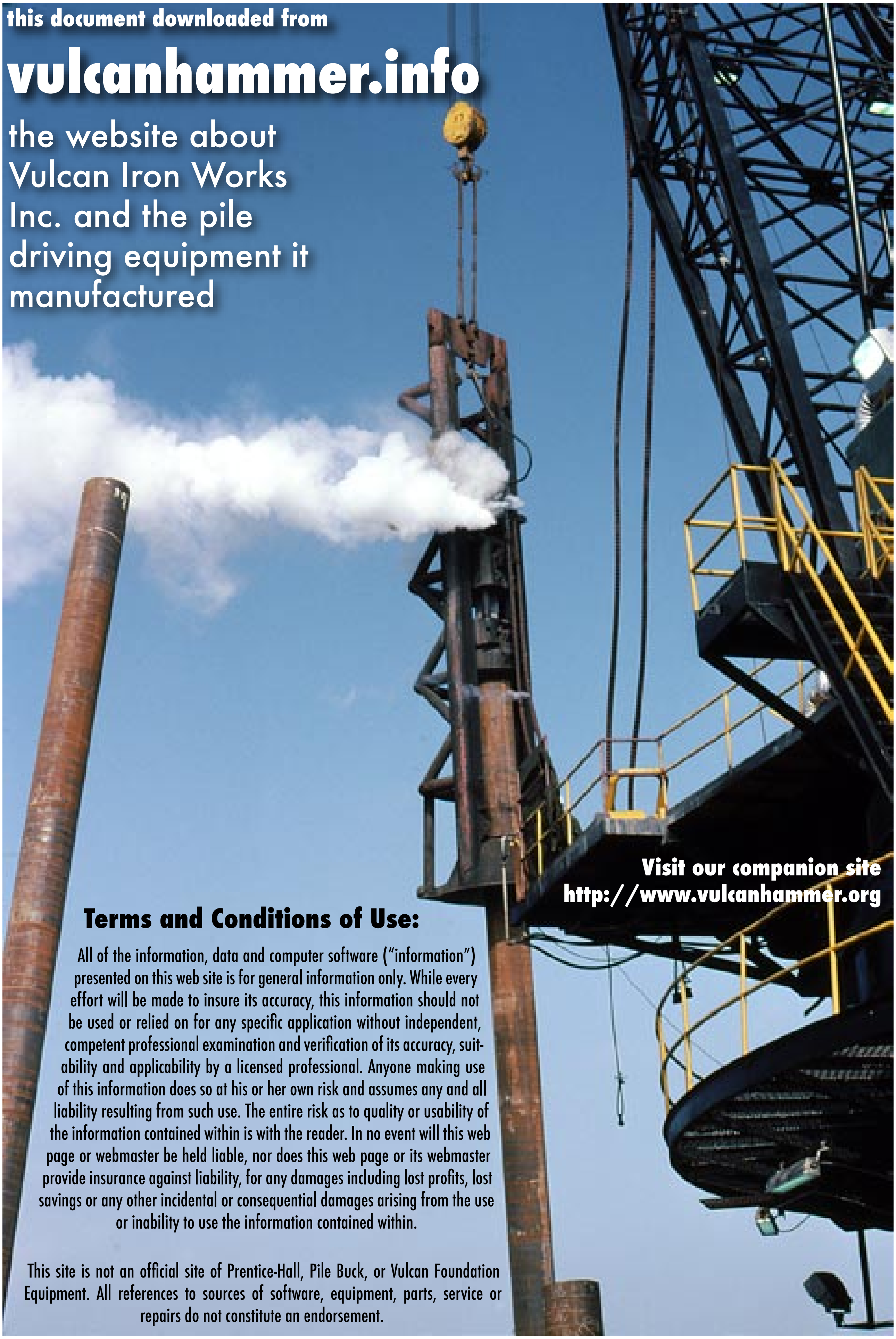

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Warrington

[11] **3,815,474**
[45] **June 11, 1974**

[54] **PILE DRIVING HAMMER**

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[73] Assignee: **Vulcan Iron Works Inc.,** Chattanooga, Tenn.

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[52] **U.S. Cl.** **91/352,** 92/110
[51] **Int. Cl.** **F01l 31/18**
[58] **Field of Search** 91/352, 349, 315, 345; 92/110

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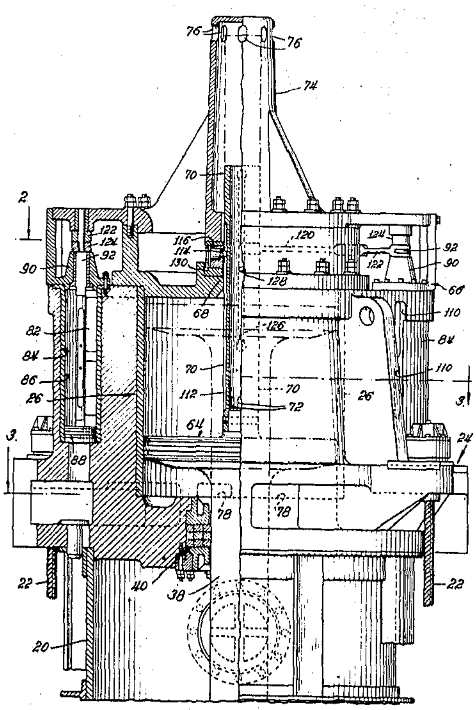
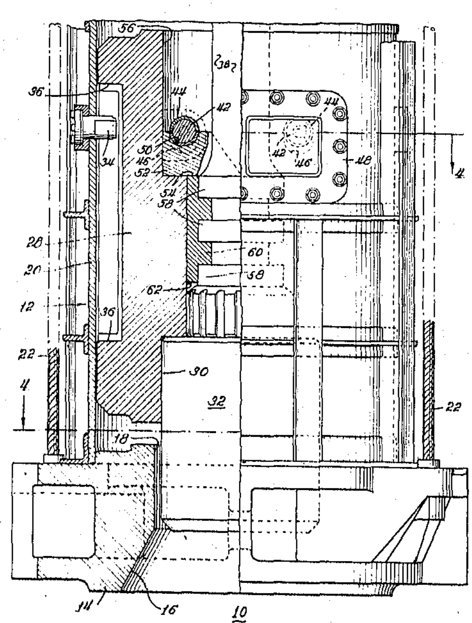
Primary Examiner—Paul E. Maslousky

[57] **ABSTRACT**

The pile driving hammer includes a fluid cylinder and a piston mounted in the cylinder for reciprocal movement and connected to drive a heavy hammer, a fluid passage for supplying pressurized fluid to and exhausting the same from a lower end of the cylinder below the piston, valve means operable between a supply position and an exhaust position for controlling fluid flow into and out of said lower end of the cylinder via said fluid passage means, operator means for controlling said valve means in response to the position of said piston in said cylinder includes a hollow stem extending axially upward of the piston for communication between the upper end of the cylinder and externally thereof, a cam surface carried by said stem and a follower linkage engaging said cam surface is connected with said valve means for moving the same between said supply and exhaust position as said piston moves up and down within said cylinder.

6 Claims, 5 Drawing Figures





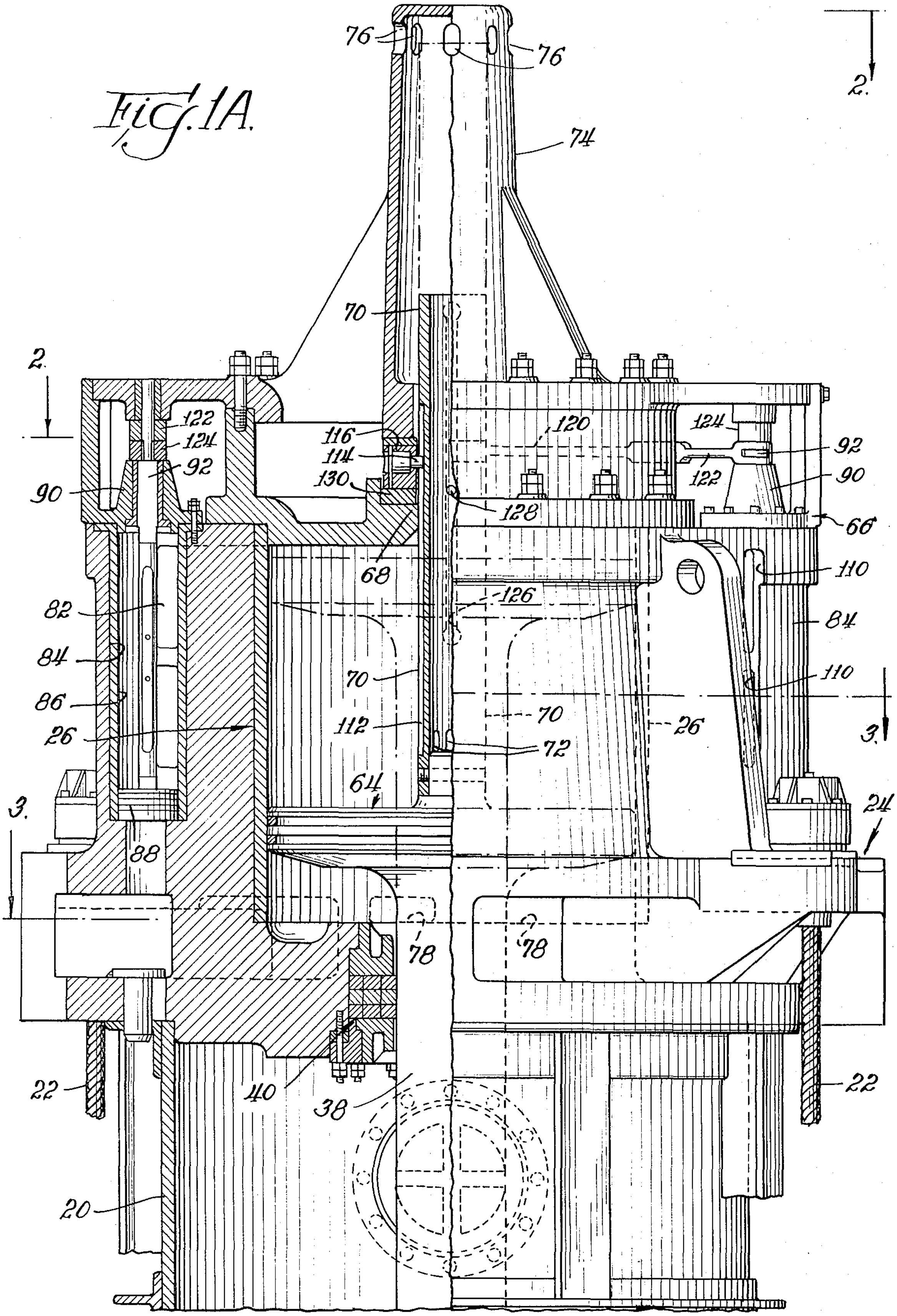

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Fig. 1A.

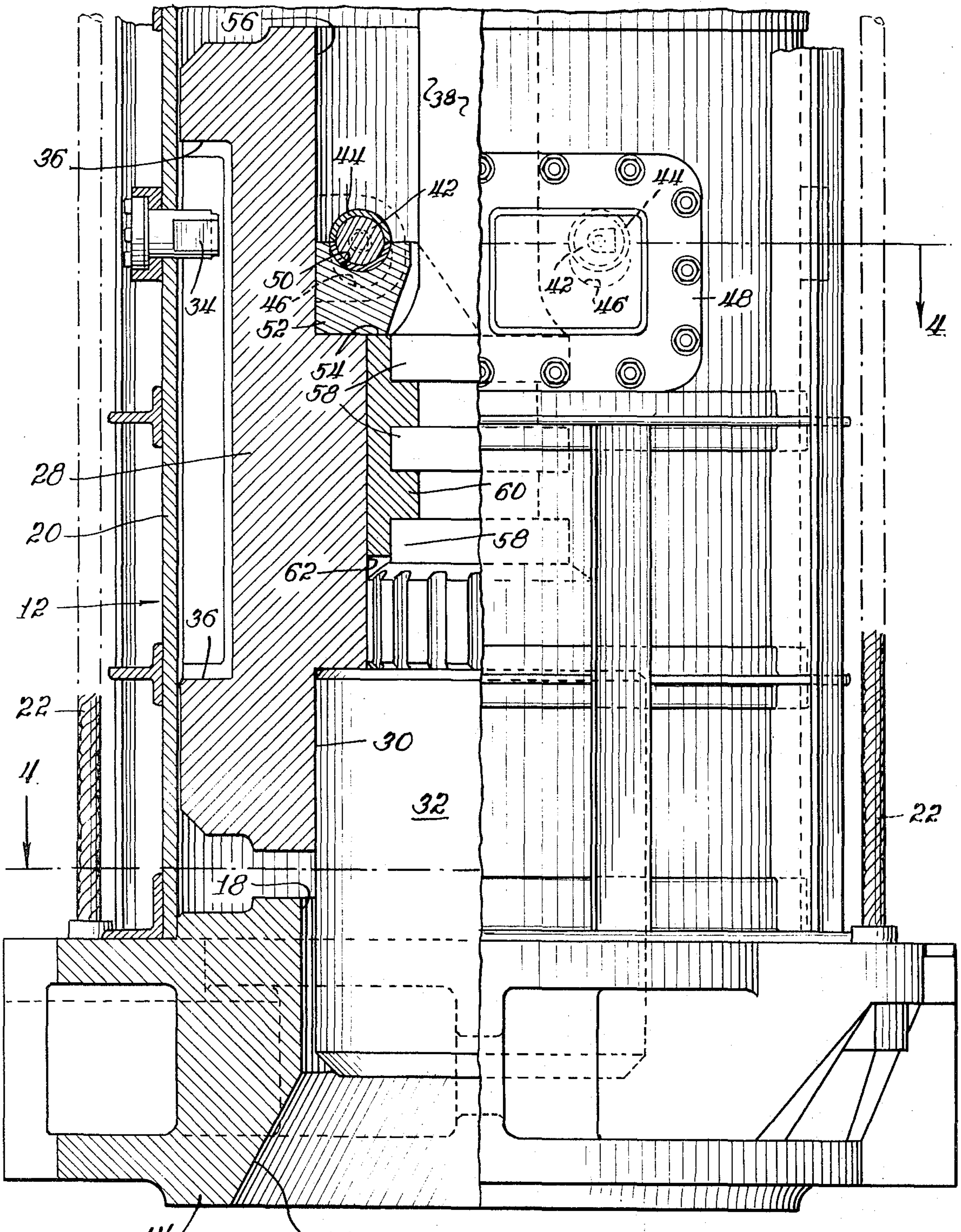
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Fig. 1B.

Fig. 2

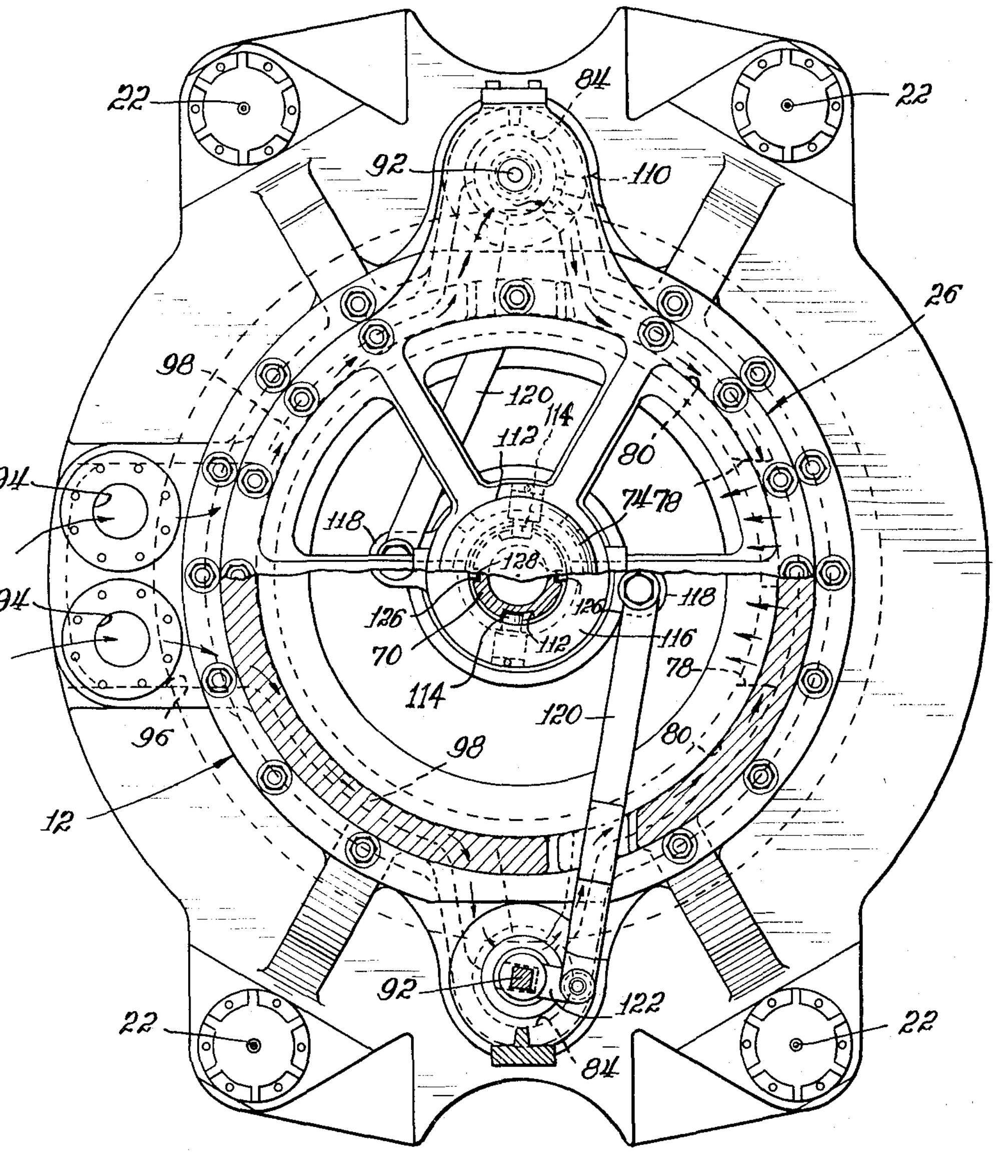
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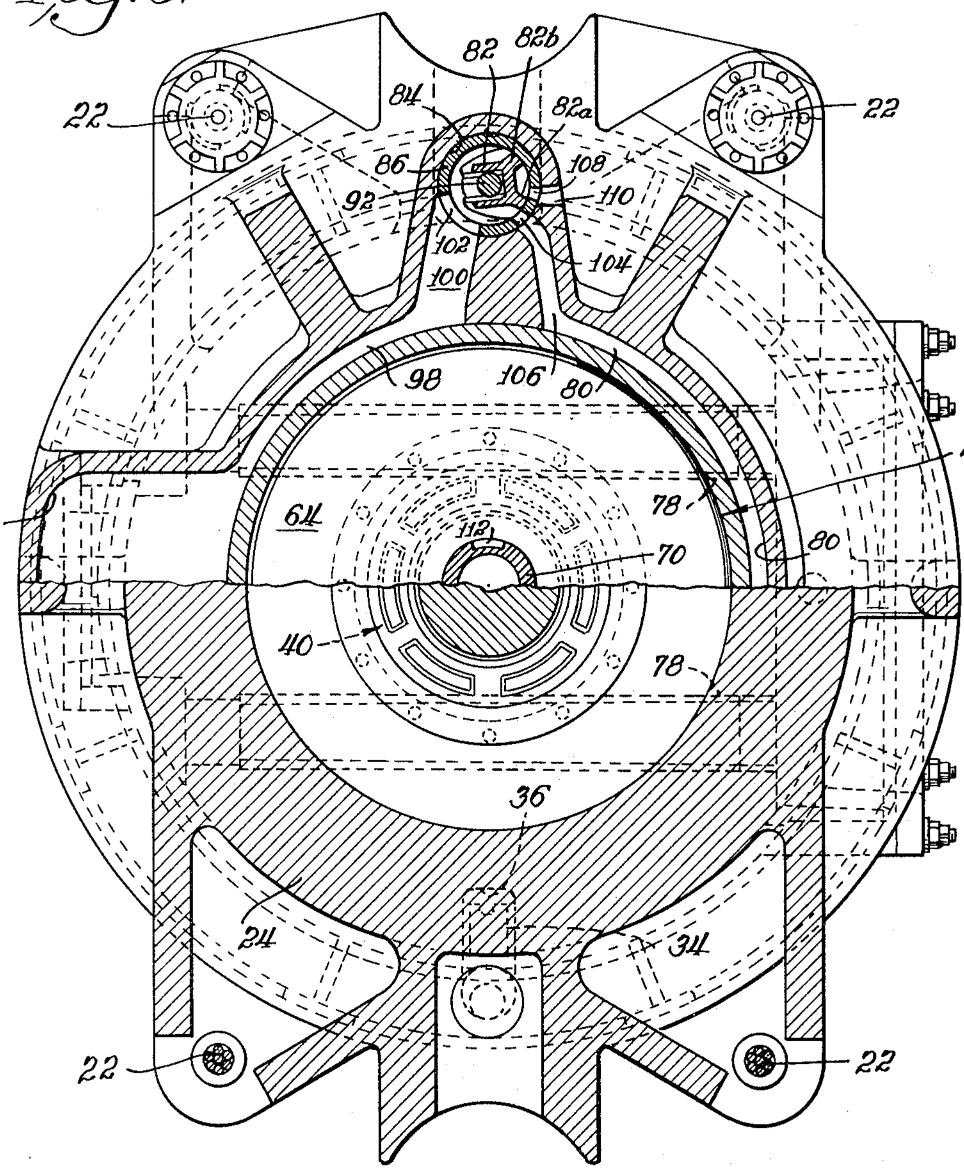
Fig. 3.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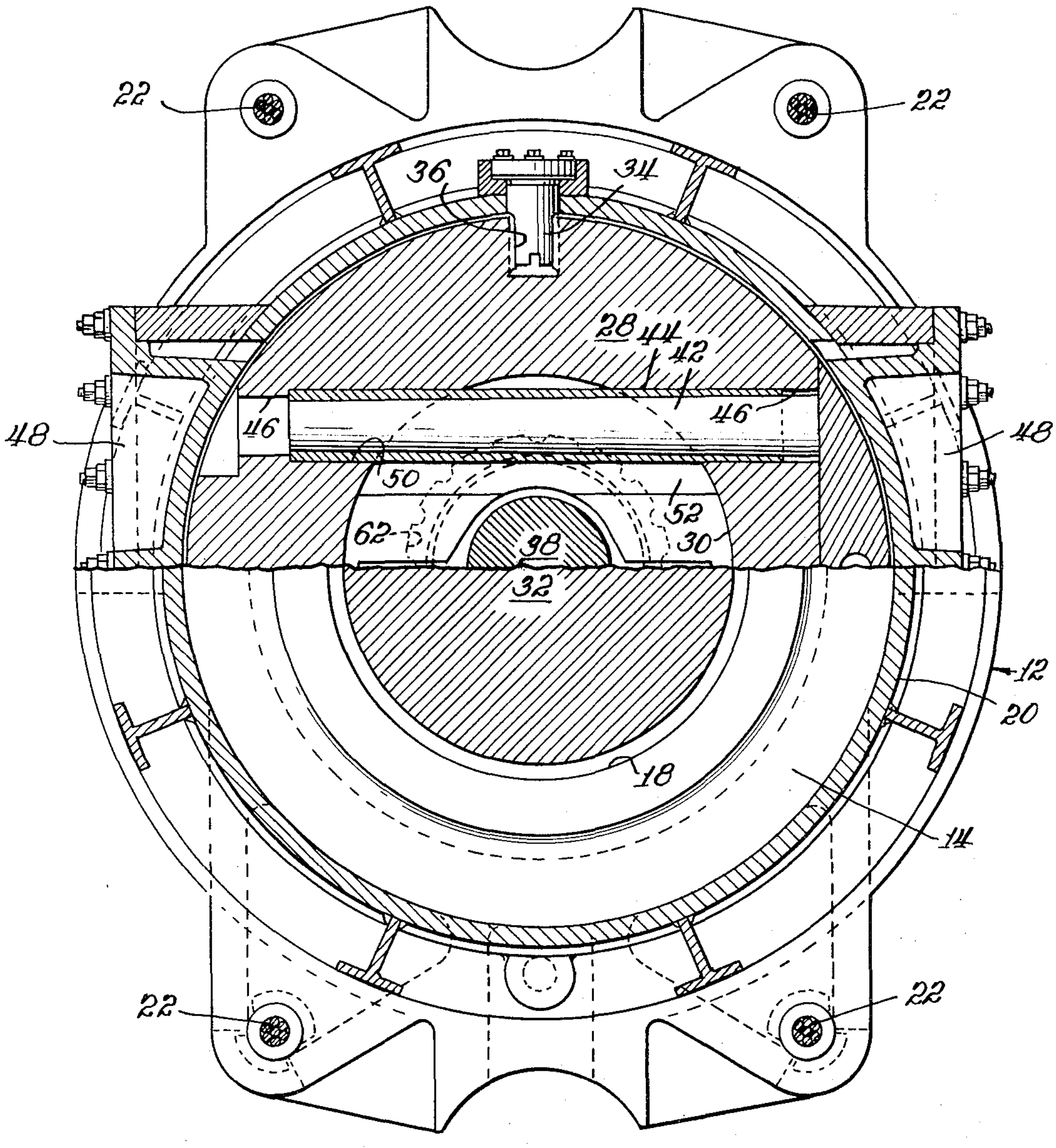

Fig. 4.

PILE DRIVING HAMMER

The present invention relates to a new and improved fluid powered pile driving hammer and is an improvement over the pile drivers shown and described in U.S. Pat. Nos. 3,566,977 and No. 3,357,315, both of which patents are assigned to the same assignee as the present application.

Fluid powered pile driving hammers generally include a cylinder and piston operatively positioned therein with motor fluid being supplied to automatically operate the piston for driving a heavy weight hammer or ram connected thereto. The hammer or ram in turn directs impact driving blows against pilings, or shoring members or other elements to be driven. One common type of pile driver is classified as a single acting hammer and this type utilizes motive fluid for elevating the piston in only one direction to raise the ram and thereafter when the fluid is exhausted from the cylinder, the piston and ram free fall downwardly to strike a pile driving blow. The present invention relates to a single acting type of hammer.

It is an object of the present invention to provide a new and improved pile driving hammer.

Another object of the present invention is to provide a new and improved single acting, fluid powered pile driving hammer of the character described.

Yet another object of the present invention is to provide a new and improved pile driving hammer of the character described having a novel fluid passage and valve system and operator for controlling the action of the hammer.

Another object of the invention is to provide a new and improved pile driving hammer of the character described wherein a hollow exhaust stem connected to the piston is provided for exhausting the upper end of the cylinder and for activating the fluid controlling valve system to cycle the piston through driving in return strokes.

The foregoing and other objects and advantages of the present invention are accomplished in an illustrative embodiment comprising a pile driving hammer having a fluid cylinder and a piston mounted in the cylinder for reciprocal power and return strokes and connected to drive a heavy weight hammer or ram. Fluid passage means is provided for supplying pressurized fluid to and exhausting the same from a lower end of the cylinder below the piston. Valve means movable between a supply position and exhaust position is provided for controlling the fluid flow into and out of the lower end of the cylinder via the fluid passage means which is controlled thereby. The hammer includes a dual purpose valve operator means in the form of a hollow stem extending axially upward of the piston for controlling the valve means in response to the position of the piston in the cylinder, and for providing communication between the upper end of the cylinder and the atmosphere. A cam surface is provided on the stem and a follower linkage engageable by the cam is connected with the valve means to control the same for moving the piston on driving and return strokes.

For a better understanding of the invention reference should be had to the detailed description taken in conjunction with the drawings in which:

FIGS. 1A and 1B comprise a vertical elevational view of a new and improved fluid operated pile driving hammer constructed in accordance with the features of the present invention with portions shown in section;

FIG. 2 is a transverse sectional view taken substantially along line 2—2 of FIG. 1A, and

FIG. 3 is another transverse sectional view taken substantially along lines 3—3 of FIG. 1A, and

FIG. 4 is another transverse sectional view taken substantially along lines 4—4 of FIG. 1B.

Referring now more particularly to the drawings therein is illustrated a new and improved fluid operated pile driving hammer constructed in accordance with the features of the present invention and generally referred to by the reference numeral **10.** The pile driver **10** is adapted to be activated by compressible fluid such as steam or compressed air which is supplied from a convenient source at the desired operating pressure. The size and weight of the pile driver **10** is designed and selected for a particular operating pressure range in accordance with the power requirement needed for driving a particular type of piling or the like.

The pile driver includes an elongated cylindrical body **12** having an annular base structure at the lower end in the form of a centering ring **14.** The centering ring is adapted to align the pile driver in coaxial vertical alignment with the piling to be driven and is formed with a frustroconical segment **16** at the lower end of an axial bore **18.** The ring **14** is supported at the lower end of a lower cylinder **20** by means of a plurality of tension members **22** the upper ends of which are extended through ears formed on an intermediate wall structure **24** which divides the driver body **12** and separates the lower cylinder **20** from an upper fluid cylinder **26.**

In the lower cylinder **20** a heavy weight hammer or ram **28** is mounted for vertical sliding movement and the ram is formed with an axial bore therein having an enlarged portion **30** at the lower end in which is carried an anvil member **32** adapted to impact the top end of the pilings with the heavy force required to drive the same. Rotation on the ram within the cylinder **20** during reciprocal movements is prevented by one or more keys **34** secured to the wall of the cylinder and adapted to extend into a slot **36** provided in the ram.

The heavy weight hammer or ram **28** is interconnected to the lower end of a piston shaft **38** which extends upwardly from the anvil **32** through a fluid tight annular seal structure **40** in the intermediate wall structure **24.** The lower end of the shaft **38** is coupled to the ram by pairs of horizontal tapered pins and sleeves **42** and **44** on opposite sides of the shaft. The pins and sleeves are supported at opposite ends in oblong slots **46** formed in sidewall of the ram around the upper portion of the axial bore thereof and are removable through window structures **48** provided on the walls of the lower cylinder **20** as best shown in FIG. **1B** and FIG. **4.** The pin and sleeves rest in grooves **50** provided in a pair of stop members **52** on opposite sides of the piston shaft **38** and seated on an annular shoulder **54** at the lower end of the enlarged upper section **56** of the axial bore of the hammer **28.** The shaft **38** is enlarged at its lower end and is provided with several spaced apart annular rings **58** which are seated in grooves provided in an annular coupling member **60** carried in the middle portion **62** of the hammer bore between the enlarger lower and upper portions **30** and **56.**

The upper end portion of the piston shaft **38** passes through the sealing unit **40** in the intermediate wall structure **24** into the lower end of the fluid cylinder **26** and is integrally connected to a piston **64** mounted in the cylinder to supply the power for lifting the hammer **28.** The upper end of the fluid cylinder is closed by an upper end wall structure or cylinder head **66** and an annular sealing structure **68** is mounted at the center of the head to seal around a hollow piston stem **70** extending upwardly from the piston **64.** The stem is open at its upper end to communicate with the atmosphere and is provided with a plurality of wall ports **72** adjacent the lower end in communication with the interior of the fluid cylinder **26** above the piston **64** so that the upper end of the cylinder is maintained substantially at atmospheric pressure during movement of the piston on power and return strokes to lift and drop the hammer **28.** When the piston is in a fully elevated upper position as shown in dotted lines in FIG. **1**A, the ports **72** of the hollow stem are adjacent or above the level of the seal **68** in the cylinder head **66** so that a small volume of air is entrapped in the upper end of the fluid cylinder **26** to act as a cushion and prevent the piston from striking the underside of the cylinder head with great force.

As best shown in FIG. **1**A, the upper end portion of the piston stem **70** is open to exhaust the upper end of the cylinder and the stem is slidable within an upstanding stem housing or enclosure **74** secured to the cylinder head **66** and provided with a plurality of ports **76** adjacent the upper end on the side wall of the housing.

In order to lift the piston **64** on an upward stroke to raise the hammer **28** to a position ready for release on a downward impact stroke, the cylinder is supplied with compressed fluid such as air or steam at the desired pressure through a pair of radial ports or passages **78** formed in the wall of the cylinder adjacent the lower end (FIGS. **1**A, **2** and **3**). These ports are in communication with the lower end of a pair of circumferential passages **80** (FIG. **3**) formed in the wall structure of the fluid cylinder **26.** Fluid flow into and out of the circumferential passages is controlled by a pair of rotary valves **82** disposed on opposite sides of the cylinder and supported for rotation in cylindrical valve housings **84** integrally formed in the wall of the cylinder. The valve housings are provided with cylindrical, replaceable wall liners **86** having ports therein as best shown in FIG. **3** and the housings are parallel with and on opposite sides of the central axis of the main fluid cylinder **26** and the piston stem **70.**

Each valve housing is closed at the lower end by an annular end wall **88** (FIG. **1**A) and at the upper end by a frustroconically shaped upstanding bearing structure **90** attached to the cylinder head **66.** The valves **82** are of the cross section shown in FIG. **3** and are position controlled by valve stems **92** journalled at their lower ends in the members **88** and at their upper ends by the structures **90.** Fluid is supplied to the pile driver from a suitable source connected to a pair of inlet ports **94** (FIG. **2**) on the upper end wall of an integrally formed plenum chamber **96** (FIG. **3**) spaced midway between the valve chambers **84** and opposite the cylinder inlet ports **78.** Fluid is delivered from the plenum chamber to the valve chambers via a pair of circumferential passages **98** formed in the wall of the fluid cylinder **26.**

Referring now to FIG. **3,** with the valves **82** in the position shown, pressurized fluid from the plenum chamber **96** flows via the passages **98** and short radial passages **100** through inlet ports **102** formed in the valve chamber wall liner **86.** This fluid fills the valve chambers and passes through cylinder ports **104** in the liners, via radial passages **106** into the passages **80** in communication with the cylinder wall ports **78** below the piston **64.** The pressurized fluid entering the lower end of the cylinder **26** cause the piston to move upwardly therein to elevate the hammer **28** ready for a downward impact stroke. When the piston reaches its upper position (dotted lines FIG. **1**A) the valves **82** have been rotated approximately 15° in a clockwise direction by their control stems **92** so that the supply of incoming pressurized fluid to the cylinder port **104** is cut off by a rib **82***a* of the valve which is now positioned between the fluid inlet port **102** and the cylinder port **104.** A second rib **92***b* of the valve prevents inlet fluid from passing around the back side of the valve chamber and out of an exhaust port **108** formed in the liner to communicate with exhaust ports **110** formed in the wall of the valve housing **84** (FIGS. **1**A and **3**). With the valve **82** in the shifted or exhaust position as described, fluid from the underside of the piston **64** can pass rapidly out of the cylinder **26** via the ports **78,** passages **80** and **106,** and ports **104** and **108** to the atmosphere through the valve chamber wall exhaust ports **110.** When the underside of the piston **64** is vented to the atmosphere as described, the piston and hammer **28** fall rapidly downward on a power or driving stroke until the under surface of the driving anvil **32** strikes the upper end or top surface of the piling on which the pile driver **10** is seated. At this point, downward travel of the piston **64** in the fluid cylinder **26** is arrested before the piston strikes the wall structure **24** closing off the lower end of the cylinder.

With the piston at its lower position (FIG. **1**A) at the end of a downward power or driving stroke, the valves **82** are shifted by rotation in a counterclockwise direction approximately 15° back to the supply position as shown in FIG. **3** and the cycle is repeated for as many drive strokes as are needed to complete driving of the piling. On the fluid powered upward or return stroke of the cycle, the last portion of the stroke is cushioned by entrapped air in the upper end of the cylinder as the ports **72** in the hollow stem are covered by the upper seal structure **68.** On the downward power stroke the piston is stopped short of the wall structure **24** by the contact of the anvil member **32** with the piling. Both power and return strokes are thus automatically dampened at the end of the travel.

In order to operate the valves **82** in synchronism with the reciprocation of the hammer in response to the position of the piston the stem **70** is provided with a pair of elongated grooves **112** disposed on opposite sides and extending at an acute shallow angle with respect to the longitudinal axis of the hollow stem. Opposite sides of each groove serve as cam surfaces for engagement with follower pins **114** which project into the grooves and are supported on the inside of an annular actuating collar **116** (FIG. **2**) mounted on the stem between the upper bearing **68** and the lower end of the stem housing **74** (FIG. **1**A). The collar **116** is rotatable on the stem **70** and includes a pair of diametrically opposed ears **118** which are pivotally interconnected to the inner ends of a pair of valve actuating arms **120.** The arms **120** are pivotally interconnected at their outer ends with short stem actuating arms **122** which are connected to rotate the upwardly projecting end portions of the valve stem **92.** As shown in FIG. **1**A, a radially extending arm **122** is keyed to rotate the stem **92** and is pivotally connected at its outer end to the outer end of one of the actuating arms **120**. Collars **124** are provided as spacers on the stems **92** so that arms **122** are staggered for connection with the actuating arms. In order to prevent the stem **70** from rotatably driving reciprocal strokes of the piston **64** the stem is provided with another pair of grooves **126** which are engaged by keys **128** on the inside of a fixed seal collar **130** above the upper cylinder seal **68**.

From the foregoing it will be seen that the hollow piston stem **70** serves a dual purpose in maintaining a continuous venting of the upper end of the cylinder **26** during piston reciprocation and providing an actuating cam action for synchronizing the operation of the valves **82** and the piston **64**.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. The combination in a pile driving hammer comprising: a fluid cylinder, a piston mounted in said cylinder for reciprocal movement on upstrokes and downstrokes and connected to drive a hammer below said cylinder, fluid passage means for supplying pressurized fluid to and exhausting the same from a lower end of said cylinder below said piston, valve means operable between a supply position and an exhaust position for controlling fluid flow into and out of the lower end of said cylinder via said fluid passage means, and operator means for controlling said valve in response to the position of said piston in said cylinder, said operator means including a hollow stem extending axially upwardly of said piston and in communication between the upper end of said cylinder adjacent said piston and externally of said cylinder adjacent the upper end of said stem, a cam surface carried by said stem and a follower linkage engaging said cam surface and connected with said valve means for moving the same between said supply position and said exhaust position when said piston moves between a lower position and an upper position in said cylinder.

2. The combination of claim **1** wherein said valve means includes a pair of rotary valves on opposite sides of said cylinder rotatively movable between a first position supplying pressurized fluid through said passage means to the lower end of said cylinder and a second position for exhausting the fluid from the lower end of said piston to the atmosphere via a portion of said passage means.

3. The combination of claim **2** wherein said follower linkage includes a collar rotatably mounted on said stem including follower means in engagement with said cam surface carried thereby for rotatively oscillating said collar as said piston reciprocates, arm means interconnecting said oscillating collar and said rotary valves to rotate the latter between said first and second positions.

4. The combination of claim **3** wherein said cam surface includes elongated groove means formed on the outer surface of said stem and angularly inclined with respect to the longitudinal axis of said stem and means for preventing axial rotation of said stem as said piston reciprocates.

5. The combination of claim **3** wherein said passage means includes a first set of supply passages extending from a common fluid input chamber in opposite directions around said cylinder to said rotary valves and a second set of passages extending from said valves around said cylinder to a position opposite said input chamber and in communication with said lower end of said cylinder via at least one radial port in the cylinder wall.

6. The combination of claim **5** wherein said passage means includes a pair of exhaust passages for communication between said rotary valves and the atmosphere, each valve including a rotary element operable to interconnect a supply passage with a passage of said second set when in said first position and to interconnect a passage of said second set with an exhaust passage when in said second position.

* * * * *