

PISTON VALVE FOR MULTI-TYPE HYDRAULIC PILING HAMMER

TECHNICAL FIELD

This invention relates to a piston valve for controlling hydraulic cylinders in multi-type hydraulic piling hammer to drive the hammer weight up and down. The same valve may also be used to control hydraulic cylinders in other applications.

BACKGROUND ART

Hydraulic piling hammers are widely used in foundation works. There are many types of such hammers which are based on the concept of a piston rod pulling up or pushing up a hammer weight to the required height and then allowing the hammer weight to drop down to impact the pile under gravity. Depending on the type of cylinder, a single rod or double rod can be used, and according to the connection between the rod and the hammer weight, pushing up or pulling up action may be used. The piling hammer can be divided into four types being: single-rod-pulling-up, single-rod-pushing-up, double-rod-pulling-up and double-rod-pushing-up. Generally, each hammer has a special control valve. A typical example may be seen in European patent 0119726A1, where a type of single-rod-pulling-up piling hammer is used. In this particular case the control valve is integrated within the cylinder, and the manufacturing cost and the servicing cost are very high.

OBJECT OF THE INVENTION

It is a primary object of the invention to provide a valve which can be used in different types of hydraulic piling hammer.

It is another object of the invention to make the hydraulic piling hammer easy to manufacture and to service. Because the valve can be used in different types of hammer, the electrical control box and the hydraulic power pack of the piling hammer also can be used for different types of hammer. Furthermore, since the valve can be made separately from the cylinder, it would be easier and less costly to manufacture and to service.

BRIEF DESCRIPTION OF DRAWING

FIG. 1 shows a cross-sectional view of the valve configuration. The valve is composed of a fixed part 10 (valve body with four ports 11, 12, 13, 15 and one inside port 14) and a movable part 20 (valve piston with three ports 24, 25, 26). The valve piston 20 moves in the valve body 10 so that the ports 11, 12, 13, 15, 24, 25, 26 have different connections depending on the position of the valve piston in the valve body.

FIG. 2 shows a view of the valve used in a single-rod-pulling-up system as used in a hydraulic piling hammer. Port 12 connects to the side 84 of piston rod 82 of the cylinder 80 (downside), port 13 connects to the side 83 of piston 81 of the cylinder 80 (upside), together with an accumulator 70 linking with return line 50. Port 11 connects with system pressure line 30, to which an accumulator 60 can be added. Port 15 connects with the control line 40.

FIG. 3 shows a view of the valve used in a single-rod-pushing-up system as used in a hydraulic piling hammer. Port 12 connects to side 93 of piston 91 and side 103 of piston 101 of the cylinders 90 and 100 (downside). Port 13 connects to side 94 of piston 91 with piston rod 92 and to side 104 of piston 101 with piston rod 102 of the cylinders 90 and 100 (upside) and connects to return line 52, 50. Port 11 connects

to system pressure line **30** to which an accumulator **60** can be added. Port **15** connects to the control line **40**.

FIG. 4 shows a view of the valve used in a double-rod-pulling-up (one cylinder only) and a double-rod-pushing-up (two cylinders) system used in a hydraulic piling hammer. Port **12** connects to downside of the cylinders, port **13** connects to upside of the cylinders and connects return line **50**. Port **11** connects to system pressure line **30** to which an accumulator **60** can be added. Port **15** links to the control line **40**.

DISCLOSURE OF INVENTION

As shown in FIG. 1, the piston valve comprises a valve body **10** and a valve piston **20**. The valve piston **20** inside the valve body **10** may move to the left position or to the right position depending on the controlling fluid pressure acting through port **15**.

When the effect of hydraulic fluid pressure from port **12** acting on the area **23** and the effect of fluid pressure from port **13** via port **14** acting on the area **22** exceed the effect of fluid pressure from port **15** acting on the area **21**, the valve piston moves to the right. The valve piston moves to the left when the magnitudes of the forces produced by the differential fluid pressures are reversed. This may be done by increasing the controlling fluid pressure acting through port **15**, such that the effect of the hydraulic fluid acting on areas **22** and **23** is less than the effect of the fluid acting on area **21**.

When the valve piston is in the right position, ports **12** and **13** are connected via ports **24** and **26**. With the valve piston in the left position ports **11** and **12** are connected via ports **25** and **24**. With port **11** connected to a hydraulic system pressure line **30** and port **13** connected to the hydraulic system return line the valve

can be used to move the cylinder(s) of a hydraulic piling hammer connected to port 12 of the valve. By controlling the time of port 15 connecting to high pressure fluid the height of hammer weight going up can be controlled, and by controlling the time of port 15 connecting to low pressure fluid the interval of the hammer weight falling can be controlled. Because the valve can be used for different types of hammer, the electrical control box and the hydraulic power pack of the piling hammer can be used for different types of hammer.

Based on the different arrangement of the valve, the cylinder(s) and accumulator(s), the hydraulic system will have different functions or operating characteristics..

EXAMPLES

The following examples show four types of the different systems used in an hydraulic piling hammer and are described to illustrate and not limit the invention, as changes and modifications may be made therein which are within the full intended scope of the invention.

Example 1

Fig 2 shows an application of the valve with a single-rod pulling-up system as used in a hydraulic piling hammer.

When the controlling fluid pressure at port 15 delivered through 40 is high and valve piston 20 is at the left position, pressurised fluid from system pressure line 30 combining with the pressurised fluid from accumulator 60 via line 32 will connect to cylinder 80, side 84 via line 31, port 11, 25, 24, 12 and line 85. Under the action of

the pressurised fluid on area **84**, piston **81** and piston rod **82** move up and the piston rod **82** will pull up the hammer weight. The hydraulic fluid in side **83** will go into accumulator **70** via line **54, 53** and return to line **50** via line **52**.

When the controlling fluid pressure at port **15** is lowered so that the valve piston is now at the right hand position, the hydraulic fluid on side **83** of piston **81** and in accumulator **70**, and on side **84** of piston rod **82** will all connect to return line **50** via lines **51, 52, 53, 54, 85** and ports **12, 24, 26, 13**. The hammer weight drops down under the weight of the hammer and the differential force of the hydraulic fluid acting on differential area. The cycle is repeated by alternately increasing and reducing the controlling fluid pressure at port **15**.

More than one cylinder may be connected in the pulling-up mode as required.

Example 2

The novel valve may also be used to control one or more cylinders in the push-up mode as in Fig 3.

When the controlling fluid pressure is high at port **15** and the valve piston **20** is at the left position, pressurised fluid from system pressure line **30** combining with the pressurised fluid from accumulator **60** via line **32** will connect to cylinders **90** and **100** on side **93** and **103** via line **31**, port **11, 25, 24, 12** and line **105, 95**. Under the effect of the pressurised fluid on areas **93, 103**, piston **91, 101** and piston rods **92, 102** move up, pushing up the hammer weight. The fluid in piston rod side **92, 102**, acting on areas **94, 104** will feed into the return line **50** via line **96, 52**.

When the controlling fluid is at the lower pressure and the valve piston is at the right position, the fluid on side **93** and side **103** and side **94** and **104** will all connect to the

return line **50** via lines **51, 52, 95, 96, 105** and ports **12, 24, 26, 13**. The hammer will fall under its own weight, pushing down pistons **91, 101** and piston rods **92, 102**.

The cycle is repeated by alternately increasing and decreasing the controlling fluid pressure at port **15**.

Example 3

The novel valve may also be used to control one or more cylinders in the double-rod-pulling-up and a double-rod-pushing-up system as in Fig 4.

When the controlling fluid pressure is high at port **15** and the valve piston **20** is at the left position, pressurised fluid from system pressure line **30** combining with the pressurised fluid from accumulator **60** via line **32** will connect to cylinders **110, 120** on sides **113, 123** through line **31**, port **11, 25, 24, 12** and line **125, 115**. Under the effect of the pressurised fluid on areas **113, 123**, piston **111, 121** and piston rod **112, 122** move up, and piston rod **112a, 122a** will push up the hammer weight, or the piston rod **112b, 122b** will pull up the hammer weight. The fluid on piston side **114 and 124** will pass to return line **50** via line **116, 52**.

When the controlling fluid is at the lower pressure and the valve piston is at the right position, the fluid on both sides of the piston **111, 121** will connect together, the fluid on sides **113, 123** will go to sides **114, 124** and the hammer weight will push down or pull down the piston **111, 121** and piston **112, 122**.

The cycle is repeated by alternately increasing and decreasing the controlling fluid pressure at port **15**.



CLAIMS

1. A piston valve for controlling a pile driving hammer, the valve comprising a valve body and a valve piston moving inside the valve body between two positions; at one position, a first port on the valve body being connected to a second port through a passageway in the piston and at another position said first port being connected to a third port on the valve body through a further passageway in the piston, the piston being movable by a control fluid fed through a control line, the second port being connected to a supply system pressure line preferably including an accumulator, the first port being connected to the downside of the hammer drive cylinder(s), the third port being connected to the upside of the hammer drive cylinder(s) and to a return line which preferably includes second accumulator.
2. A piston valve according to Claim 1, wherein a first, head end, of the piston has a front face in communication with the control fluid line and a rear face communicating with the third port through a bleed passageway.
3. A piston valve according to Claim 1 or 2, wherein the second, base end, of the piston communicates with the first port, the pressure differential between the first and third ports on the one hand and the control line serving to move the piston within the valve body.
4. A system for controlling a hydraulic cylinder movable in one direction by hydraulic fluid pressure and in a second direction by a restoring force, the system incorporating the piston valve of any preceding claim operatively connected into the hydraulic circuit and wherein on movement of the piston to the one position by hydraulic control through the control line supply pressure is fed through the second port, the piston passageway and the first port to the driving side of the hydraulic cylinder fluid from the idle side of the hydraulic cylinder being bled through a return



line, movement of the piston to the second position removing the supply system pressure and connecting the first port to the third port to allow fluid from the drive side of the hydraulic cylinder to feed the return, the piston being actuated by the control line cyclically to produce periodic repetitive movement of the hydraulic cylinder.

5. A system in accordance with Claim 4, wherein the hydraulic cylinder comprises a part of a pile driving installation, the restoring force being the fall of a pile driving hammer under gravity.
6. A system in accordance with claim 4 or 5, wherein hydraulic accumulator means are included in the supply system pressure line and in the return line.
7. A pile driving hammer embodying the piston control valve or the system of any preceding Claim.
8. A pile driving hammer according to Claim 7, comprising a single rod pulling-up hydraulic system.
9. A pile driving hammer according to Claim 7, comprising a single rod pushing-up hydraulic system.
10. A pile driving hammer according to Claim 7, comprising a double rod pulling-up hydraulic system.
11. A pile driving hammer according to Claim 7, comprising a double rod pushing-up hydraulic system.
12. A control valve or a pile driving system incorporating same substantially as herein described and as illustrated in Fig.1 and in Figs 2, 3 and 4 of the drawings.