AGGREGATE PUMPING APPARATUS

Filed Sept. 8, 1967 2 Sheets-Sheet 1

FIG.1

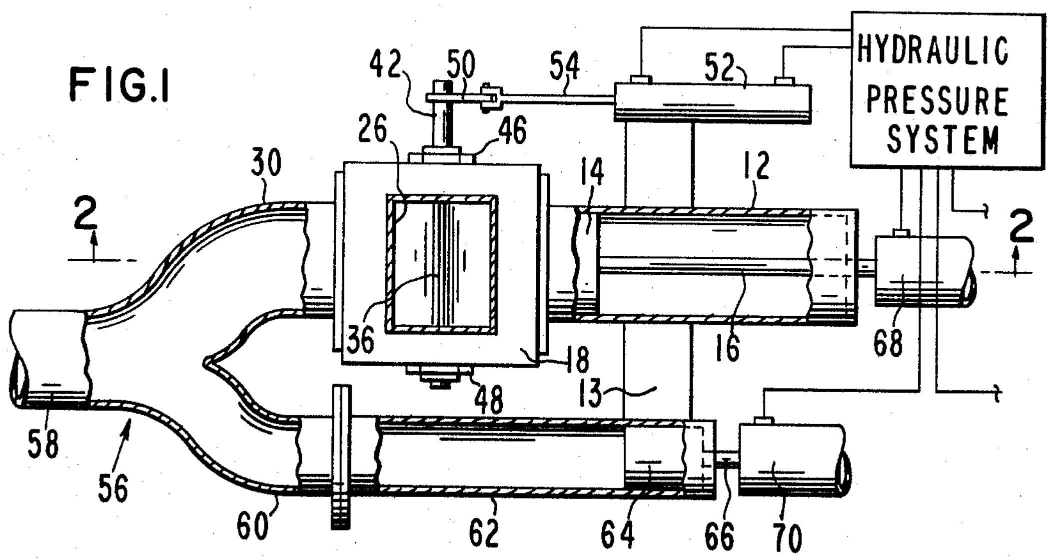
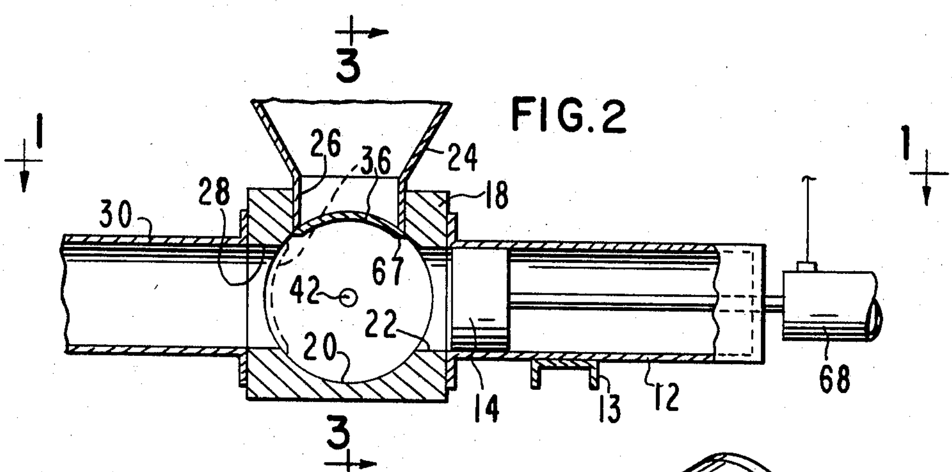


FIG.2



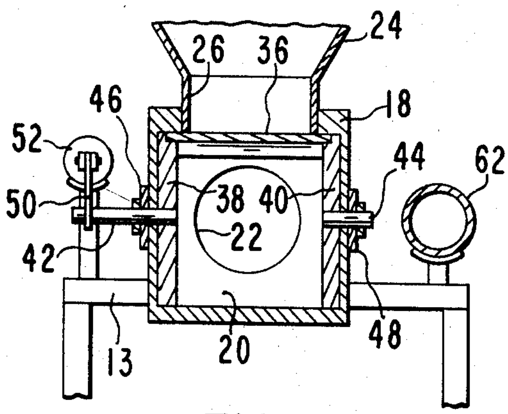


FIG.3

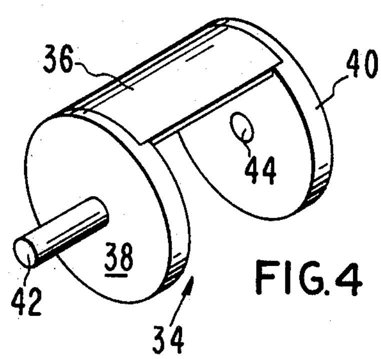


FIG.4

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AGGREGATE PUMPING APPARATUS

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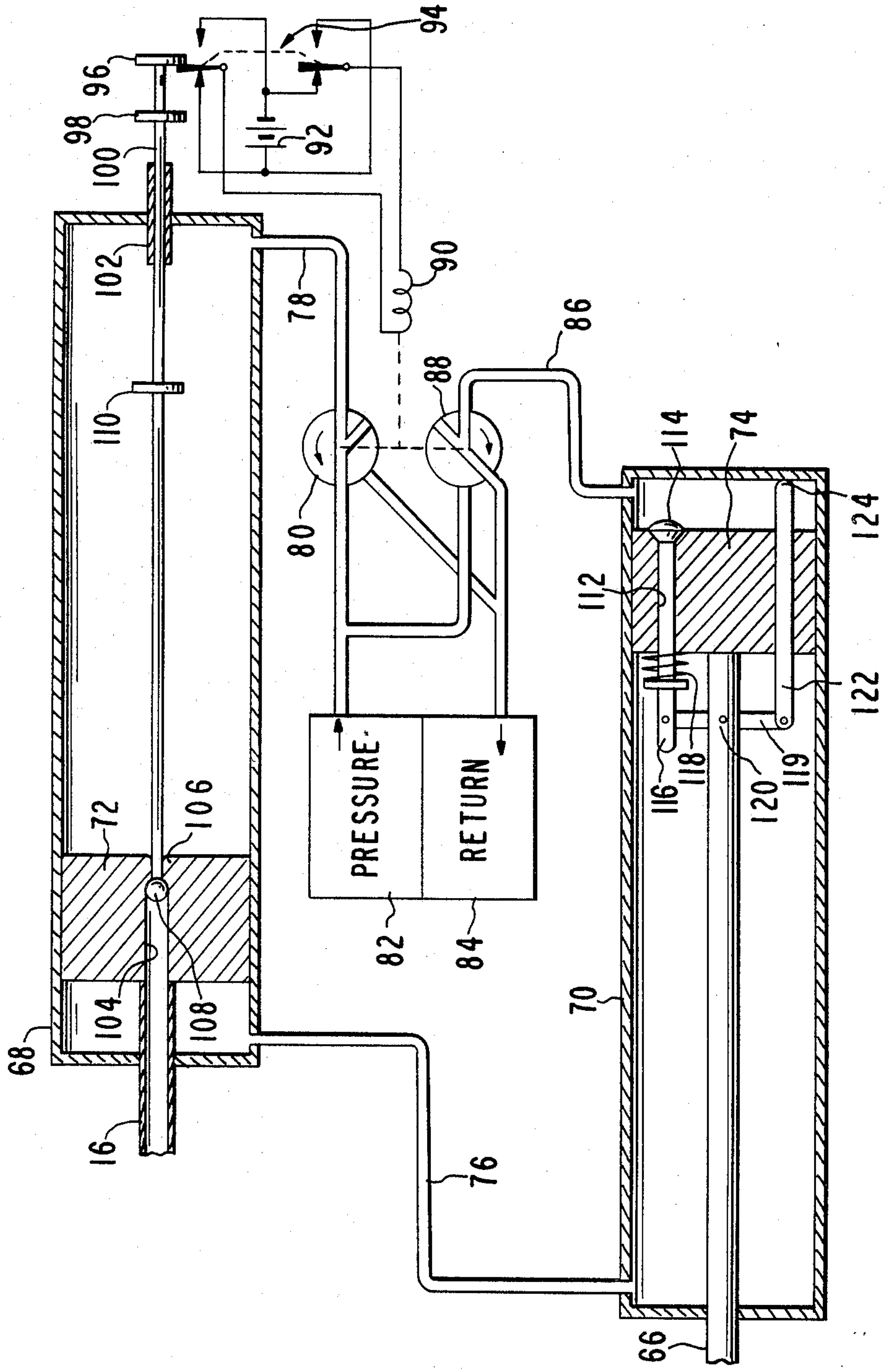

FIG.5

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AGGREGATE PUMPING APPARATUS

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ABSTRACT OF THE DISCLOSURE

An improved, simplified pump for concrete aggregate. An improved valve for controlling flow of concrete aggregate. An improved hydraulic control system for controlling two actuators simultaneously in proper timed relation.

This invention relates to apparatus for pumping dense aggregates such as concrete aggregate.

Because of the high abrasive character of concrete aggregate, pumps adapted for handling such aggregate must be of simple and rugged construction. A pump according to the present invention provides such construction.

The essential elements of a concrete pump according to the present invention are a concrete hopper having a discharge outlet at the bottom, a piston chamber that supports a piston therein for reciprocal movement to draw aggregate into and expel aggregate from the chamber, and a valve controllably interconnecting the concrete hopper and the piston chamber so that in one phase of operation, concrete is transferred from the hopper into the piston chamber and in a second phase of operation, concrete is discharged from the piston chamber through an outlet in the valve.

An important object of the present invention is to provide a valve operable as described above that is of simple long-wearing construction and which requires only minimum power. Power required for operating the valve is minimized by providing a valve gate plate that is curved to define a segment of a cylindric surface and by actuating the gate plate around the central axis of such cylindric surface so that the plate moves transversely of the direction of concrete flow. Such direction of gate plate movement requires a minimum amount of power because movement in such direction renders unnecessary overcoming the pressure of the concrete.

Further contributing to the simplicity of the present invention is a valve housing in which the above described gate plate is supported. The housing has three passages therein that extend radially of the cylindric axis. With the first of these openings is associated the piston chamber; with the second of these openings is associated the concrete hopper. The third opening is the concrete discharge opening. The gate plate is rotatably movable so as to close either the concrete hopper opening or the discharge opening. Thus, the piston chamber communicates with the aggregate hopper during its loading stroke and with the discharge opening during its discharge stroke.

The present invention also includes in combination with the hopper piston chamber and valve described above, a second piston chamber that has a displacement volume equal to one-half the previously mentioned piston chamber. Such combination affords a continuous flow of concrete by operating to load the secondary piston chamber during the discharge stroke of the primary piston chamber and to discharge the secondary chamber into an outlet line while the primary chamber is being charged from the hopper. Thus, a steady discharge is achieved without complicated structures.

Another aspect of the invention resides in an improved hydraulic control system for controlling the valve and the primary and secondary pistons in proper timed relation.

The foregoing as well as other objects, features and advantages of the present invention will become more apparent after referring to the following specification and accompanying drawings in which:

FIG. 1 is a plan view of the apparatus of this invention, portions being broken away to reveal internal details thereof;

FIG. 2 is an elevation view taken along line 2—2 of FIG. 1;

FIG. 3 is a transverse cross section in elevation taken along line 3—3, of FIG. 2;

FIG. 4 is a perspective view of the valve gate plate of the present invention; and

FIG. 5 is a partially schematic view of the hydraulic control system of the present invention.

Referring more particularly to the drawing, reference numeral **12** indicates a primary piston chamber mounted on a frame member **13**. Piston chamber **12** supports a piston or plunger **14** which is reciprocally driven within the chamber in a charge stroke and a discharge stroke by a rod **16**. Piston chamber **12** is attached to a valve housing **18**, the valve defining a cylindric cavity **20** with which the interior of piston chamber **12** communicates through a port **22**.

Also secured to valve body **18** is a concrete hopper fragmentarily indicated at **24** which communicates to cavity **20** through an opening **26**. Valve body **18** finally includes a discharge port **28** which communicates to an outlet pipe fitting **30**.

Supported interior of valve casing **18** is a valve body assembly designated generally by reference numeral **34** in FIGURE 4. The assembly includes a curved gate plate **36** that forms a segment of a cylinder. The gate plate is mounted at its ends to two circular end members **38** and **40**. Stub shafts **42** and **44** are respectively secured centrally of circular plates **38** and **40**.

Valve housing **18** is bushed at **46** and **48** to respectively support for rotation stub shafts **42** and **44**, so that gate plate **36** is concentric with the surface of cavity **20**. The valve assembly **34** is movable between a position at which gate plate **36** closes port **26** (see FIG. 2) and a position at which the gate plate overlies outlet port **28** (indicated by broken lines in FIG. 2). A lever arm **50** is attached to shaft **42** to effect such movement of the gate plate, a hydraulic cylinder **52** having a rod **54** connected to lever arm **50** being provided to so drive the lever arm.

Outlet pipe fitting **30** defines one leg of a Y fitting **56** which has an outlet pipe **58** and a branch **60**. Branch **60** is attached to a secondary piston chamber **62** which is mounted on frame **13** generally parallel with primary chamber **12**. Secondary piston chamber **62** supports interior thereof a piston or plunger **64** which is driven through a discharge stroke and a charging stroke by a piston rod **66**. Secondary piston chamber **62** has a cross-sectional area equal to one-half the cross-sectional area of piston chamber **12** so that when piston **64** moves an amount equal to the movement of piston **14** the displacement from chamber **62** is one-half that of chamber **12**. In one pump designed according to the present invention a piston **12** having an inside diameter of 11¼ inches was used with a chamber **62** having an inside diameter of 8 inches.

The operation of my improved valve and pump can be understood by assuming that hopper **24** is full of concrete aggregate and that gate plate **36** is in the position shown by solid lines in FIG. 2. Piston **14** is at the beginning of the charging stroke in chamber **12**, that is, the piston is at its left extremity of movement as viewed in the figure. First, hydraulic cylinder **52** is energized to move gate plate **36** in a counter-clockwise direction to the broken line position as viewed in FIG. 2, simultaneously with which piston **14** is moved rightwardly by hydraulic systems to be described hereinbelow. Concrete aggregate enters cavity **20** by gravity and is drawn into chamber **12** as piston **14** moves rightwardly in its charging stroke. Simultaneously, with such movement, piston **64** moves in a discharge stroke within chamber **62** that is, piston **64** moves leftwardly as seen in FIG. 1. When piston **14** has completed its charging strokes so that chamber **12** is filled with aggregate, hydraulic cylinder **52** is again actuated to move the valve assembly clockwise as viewed in FIG. 2 so that gate plate **36** closes port **26** and opens port **28**. Such movement of the gate plate takes relatively little power since the gate is moving in a direction transverse to the direction of concrete flow. Also, minimizing the power necessary to close the gate is a bevel indicated at **67** in FIG. 2 that is formed on the edges of gate plate **36**. Movement of the gate plate to a position closing port **26** inhibits further delivery of concrete from hopper **24**. On leftward movement of piston **14** through a discharge stroke, aggregate is moved leftwardly as viewed in the figure through port **28** and into conduit **30**. Because substantial resistance exists downstream of outlet pipe **58**, some of the aggregate will flow into branch **60**. Moreover, movement of piston **64** rightwardly in chamber **60** draws the aggregate into chamber **62**. Because chamber **62** has a displacement equal to one-half that of chamber **12**, one-half of the aggregate discharged from chamber **12** is conveyed out through pipe **58** and one-half is loaded into chamber **62**. When pistons **14** and **64** return to the positions shown in FIG. 1, gate plate **36** again moves counterclockwise to close port **28**. Piston **64** is then driven in a discharge stroke, leftwardly as viewed in the figure, so as to discharge the contents of cylinder **62** through outlet conduit **58**. Also occuring at this time, as a consequence of rightward movement of piston **14**, is charging of cylinder **12** with aggregate from hopper **24**. Thus, chamber **12** is loaded for the next stroke, and the sequence of operations described continues in alternation to deliver a continuous flow of concrete through outlet **58**.

For efficiently operating pistons **14** and **64**, a hydraulic actuator **68** is connected in driving relation to rod **16** and a hydraulic actuator **70** is connected in driving relation to rod **66**. The operation and control of these actuators is shown in more detail in FIG. 5.

A piston **72** is mounted for reciprocating movement within actuator **68**; piston **72** is attached to rod **16** which extends into actuator **68**. Correspondingly, a piston **74** is attached to rod **66** and is disposed in actuator chamber **70** for reciprocating movement therein. The left or rod ends of actuators **68** and **70** are connected to one another through a tube **76**. To the opposite end of actuator chamber **68** is connected a fluid line **78** which, through a solenoid valve **80**, is selectively connected to a source of hydraulic fluid under pressure **82** and a return reservoir **84**. On the opposite end of actuator chamber **70** a fluid line **86** is connected to a solenoid valve **88** which is also selectively connectable to pressure source **82** and hydraulic fluid return reservoir **84**. Valves **80** and **88** are operated in unison by an electro-magnetic solenoid coil **90**. The coil **90** is connected to a battery **92** through a double pole, double throw reversing switch **94**. The moving contacts of the switch are operatively associated with spaced apart discs **96** and **98** which discs are mounted on an actuator rod **100**.

Actuator rod **100** is carried in a guide **102** in the end of actuator chamber **68**. The inner end of rod **100** is supported in a central bore **104** of piston **72**. Bore **104** has a reduced diameter portion **106** and rod **100** has an enlargement **108** which cooperate to move disc **96** leftwardly so as to effect reversal of switch **94** when piston **72** reaches its leftward extremity of travel. When piston **72** reaches the rightward extremity of its movement within actuator chamber **68**, enlargement **110** on actuator rod **100** is engaged by piston **72** so as to move disc **98** into contact with the reversing switch **94**. Rod **16** is hollow so as to permit rightward movement of piston **72** without interference with actuator rod **100**.

The operation of this portion of the hydraulic system can be understood if it is assumed that pressurized hydraulic fluid is being delivered through valve **80** and fluid line **78** into actuator chamber **68** so as to drive piston **72** leftwardly. As the piston reaches its leftward extremity, a position that it has just reached in FIG. 5, the disc **96** will move the armature or moving arm of reversing switch **94** to the left and will energize coil **90** so as to actuate valves **80** and **88**. When valves **80** and **88** are rotated in the direction of the respective arrows by about 45 degrees, valve **80** connects fluid line **78** to return reservoir **84**, and valve **88** connects fluid line **86** to pressurized fluid source **82**. The consequence of the latter actuation is that piston **74** will be moved to the left and piston **72** will be moved to the right until the latter piston encounters enlargment **110** and moves rod **100** so that disc **98** reverses switch **94** again. Thus, it will be seen that pistons **14** and **64** will be reciprocated so as to discharge concrete aggregate as described herein above.

It has been found that even the highest quality hydraulic piston or actuator has a certain amount of leakage which, if uncompansated, would soon permit the two pistons to operate out of the proper phase. To compensate for such leakage as may occur, piston **74** is provided with a valve assembly to assure proper cooperation of the pistons. Piston **74** is formed with a fluid passage **112** therethrough at the high pressure or right end of which is formed a chamfered seat that is normally closed by a valve **114**. Valve **114** has a stem **116** that extends through passage **112**; a compression spring **118** is mounted in circumscribing relation to the valve stem for normally biasing valve **114** to a closed position. a lever **119** pivotly mounted to rod **66** at **120** is attached at one end to valve stem **116** and at the other end to an actuator rod **122**. Rod **122** extends through a bore in piston **74** and extends beyond the face of the piston as at **124**.

The operation of the fluid leakage compensation system is as follows:

If a piston **74** is driven rightwardly as viewed in FIG. 5 by fluid forced through line **76** by leftward movement of piston **72** and such movement is excessive, actuator rod end **124** will contact the right end wall of actuator chamber **70** before reversing switch **94** is operated by disc **96**. The consequence of such contact by rod end **124** is that lever **119** rocks to open valve **114** so as to permit fluid to pass piston **74** without driving the piston. If pressurized fluid is now supplied to chamber **70** through valve **88** and line **86** (that is, on the right face of piston **74**) and if leakage past piston **72** occurs, piston **74** can reach the leftward extremity of actuator chamber **70** before piston **72** urges disc **98** into contact with the reversing switch **94**. If such happens, the left extremity of valve stem **116** contacts the left end wall of actuator chamber **70** and forces valve **114** open against the force of spring **118**. This permits fluid to bypass piston **74** until piston **72** moves rightwardly by an amount sufficient to effect reversal of switch **94**. By a relatively uncomplex valve structure hydraulic fluid leakage is compensated to the end that pistons **72** and **74** are in proper phase relation at all times.

It will thus be seen that the present invention provides an improved valve for concrete aggregates, an improved pump system for pumping concrete aggregates, and an improved electro-hydraulic control system for such pump. Because of the relatively few simple moving parts in the system, extremely long trouble-free operation can be achieved.

Although one embodiment of the invention has been shown and described, it will be obvious that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

I claim:

1. Apparatus for pumping concrete aggregate comprising first and second plunger chambers each having an outlet opening and first and second plungers slidably supported in said chambers for reciprocal movement towards respective said openings in a discharge stroke and away from respective said openings in a charge stroke, hydraulic actuators for actuating said plungers, each actuator comprising a cylinder, a piston axially movably disposed in the cylinder and rod means interconnecting a plunger and a piston, the apparatus further including first conduit means interconnecting end portions of the cylinders which are adjacent the position of the pistons at the end of the respective discharge strokes of the plungers, and valve means for maintaining the pistons in phase during the operation of the hydraulic actuators, the valve means being mounted to one of said pistons and comprising a closure member axially movably mounted in a passage defined by said one piston, means biasing said closure member in a passage closing position, and means moving said closure member in a passage opening position when said piston approaches the respective cylinder ends, whereby a premature arrival of said one piston at one of said ends, relative to the position of the other piston, causes the opening of a hydraulic fluid bypass by said closure member and prevents further movement of said one piston until the fluid pressure acting thereon is reversed.

2. Apparatus according to claim **1** including second conduit means communicating a source of pressurized fluid with the end of said cylinders opposite the ends thereof coupled by said first conduit means, control valve means disposed in said second conduit means for alternatingly coupling said source with one or the other of said cylinders, solenoid means operating said control valve means, and a solenoid actuator comprising a rod coupled to one of said pistons, projecting past a cylinder end and including solenoid actuating members disposed on the portion of the rod projecting past said cylinder end.

3. Apparatus according to claim **2** wherein said solenoid actuating rod moves over a distance substantially less than the length of a work stroke of said one piston, wherein said one piston includes an axial bore axially movably mounting said rod, and wherein said rod includes spaced-apart first and second piston engaging members for causing said limited axial movement of said solenoid actuating rod.

4. In an apparatus for pumping concrete aggregate and having a pair of reciprocating plungers slidably disposed in chambers for movement of the plungers in charge and discharge strokes, a hydraulic actuator for each of the plungers, the hydraulic actuators including axially movable pistons disposed in cylinders, and control means for alternatingly pressurizing one or the other side of the pistons, the improvement comprising:

valve means mounted to at least one of the pistons and having a closure member positioned to close a passageway fluidly communicating portions of the cylinder disposed on each side of the one piston;

means for biasing the closure member in a passage closing position, and means acting in opposition to the biasing means for moving the closure member into its passage opening position in response to an out-of-phase relationship between the pistons, whereby a fluid pressure build-up in the pressurized portion of the cylinder due to an out-of-phase movement of the one piston disposed in the cylinder is prevented and pressurized fluid is permitted to drain through the passageway to the unpressurized portion of the cylinder until the pistons are in phase again.

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103—228; 137—625.47