PUMP AND VALVE ASSEMBLY

Filed July 16, 1963 4 Sheets-Sheet 1

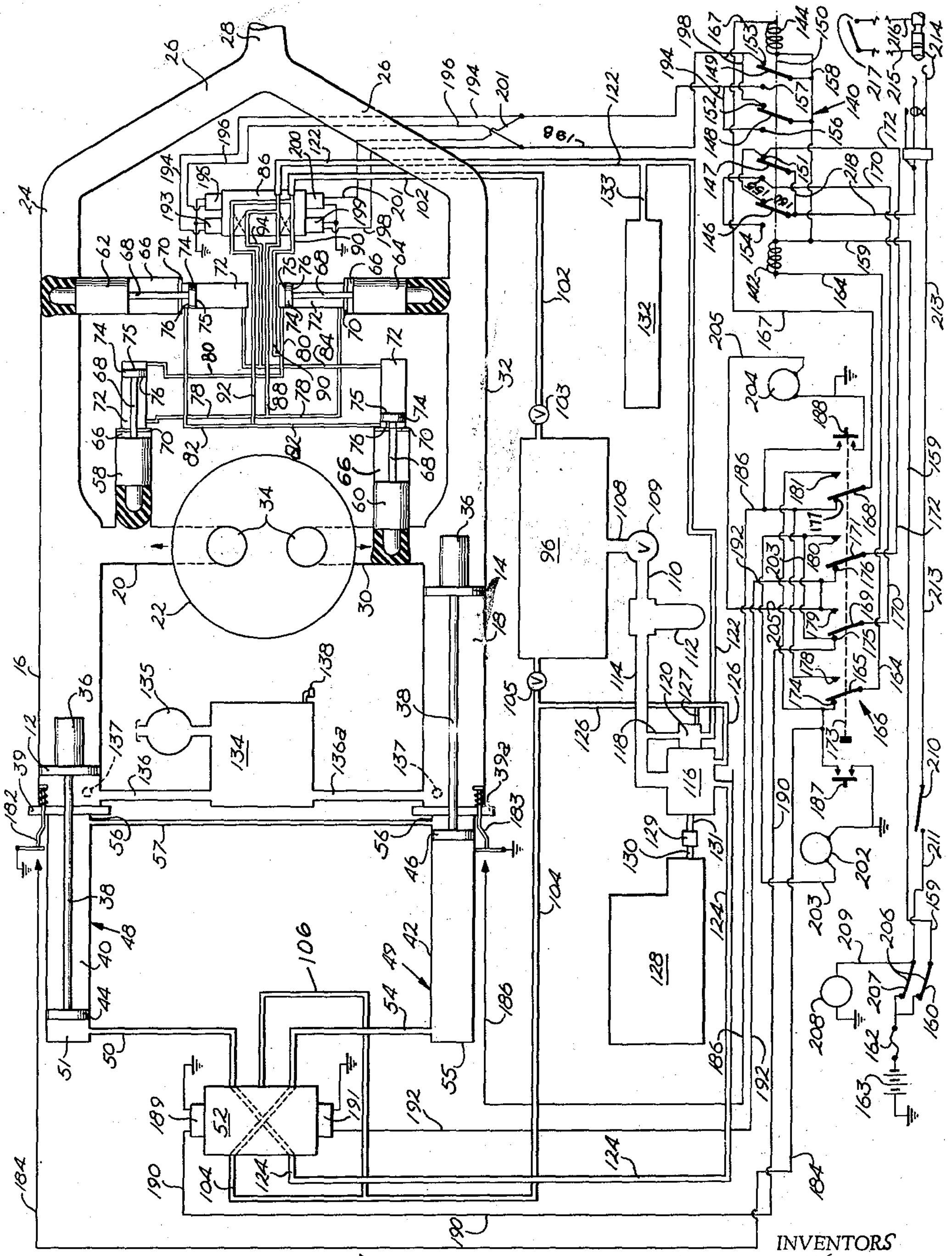

FIG. 1

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PUMP AND VALVE ASSEMBLY

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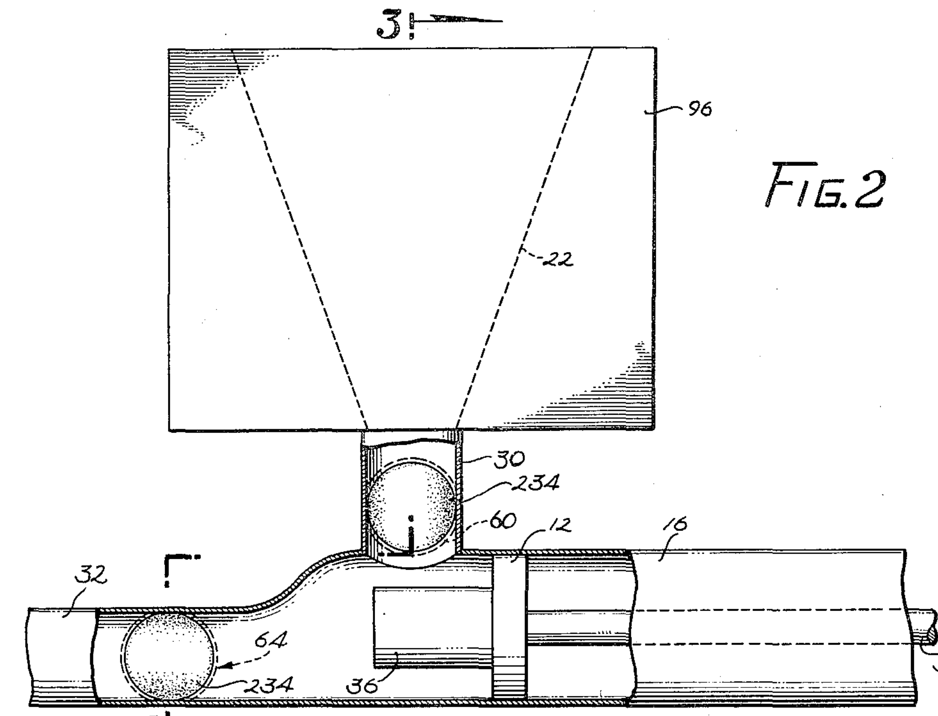

FIG. 2

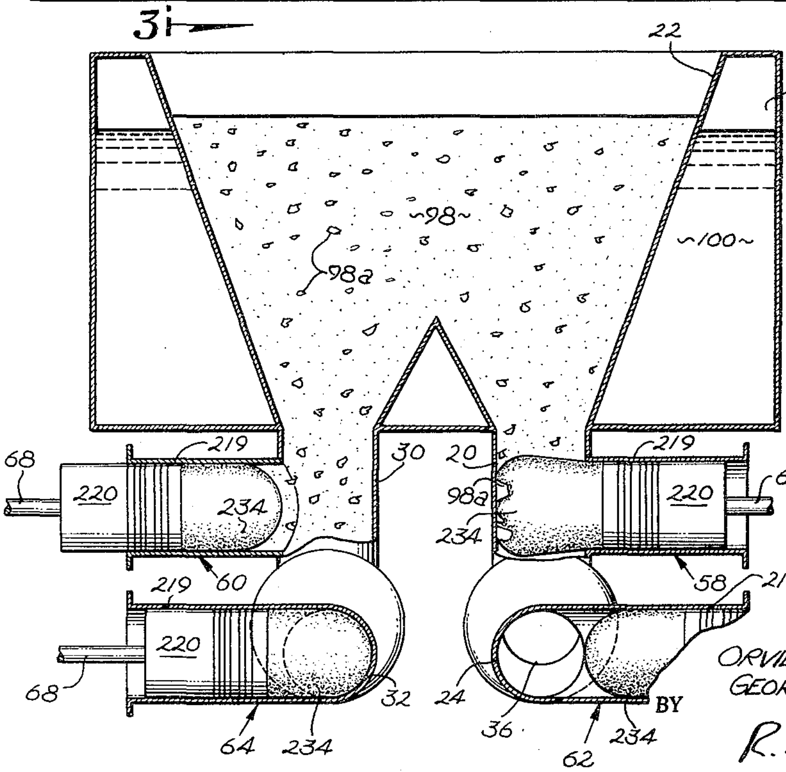

FIG. 3

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PUMP AND VALVE ASSEMBLY

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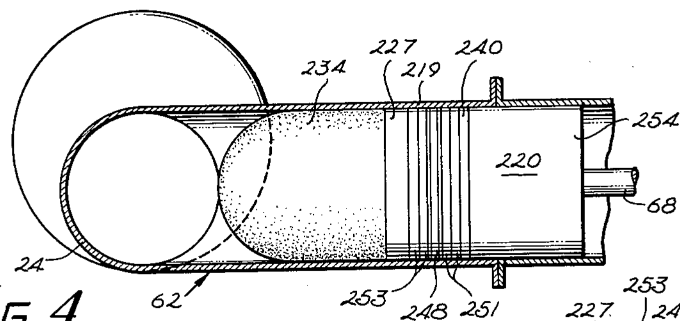

FIG. 4

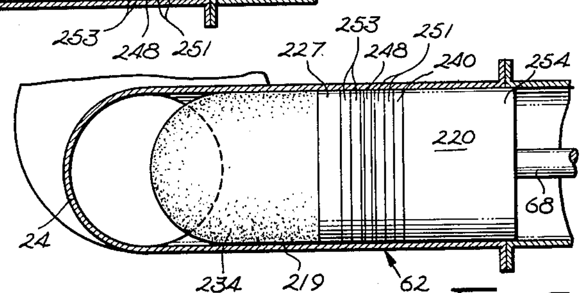

FIG. 5

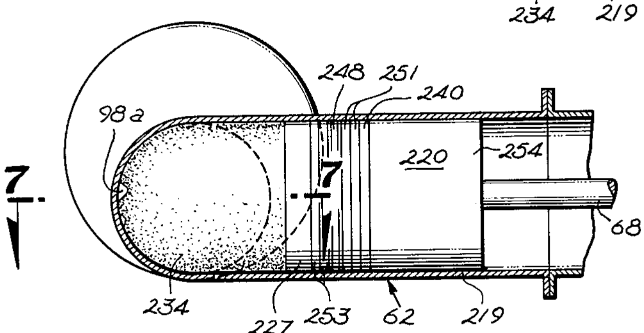

FIG. 6

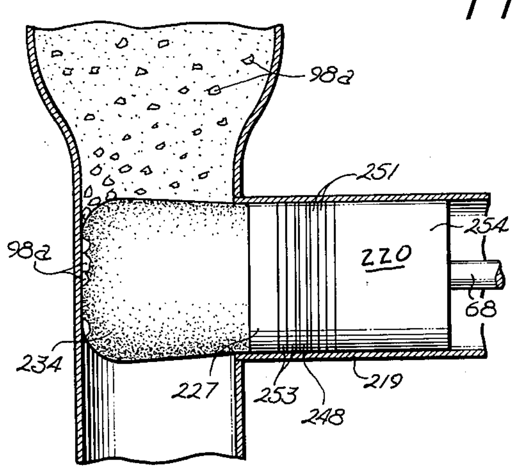

FIG. 7

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PUMP AND VALVE ASSEMBLY

Filed July 16, 1963 4 Sheets-Sheet 4

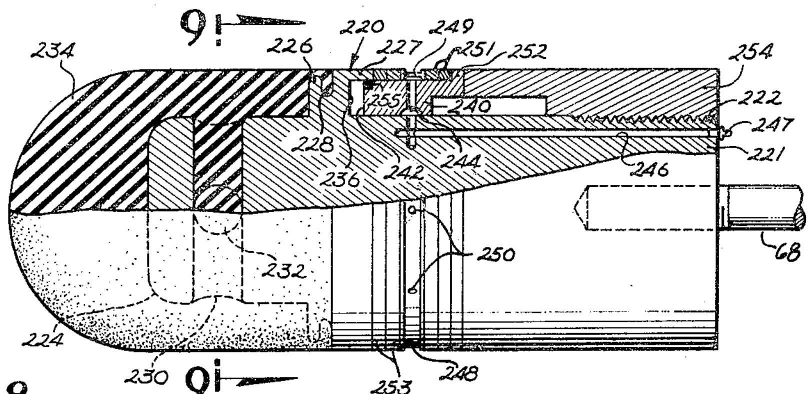


FIG. 8

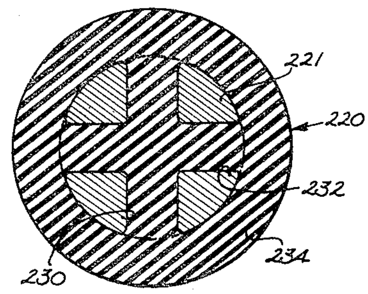
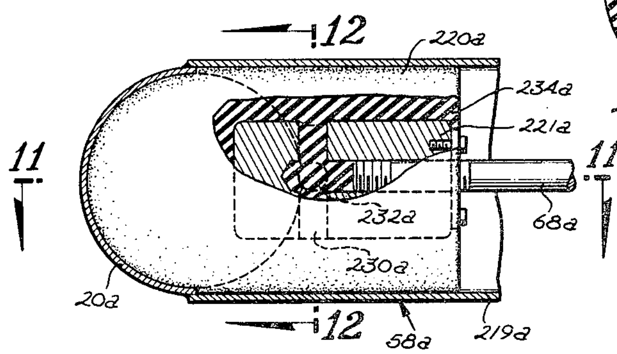


FIG. 9

FIG. 10



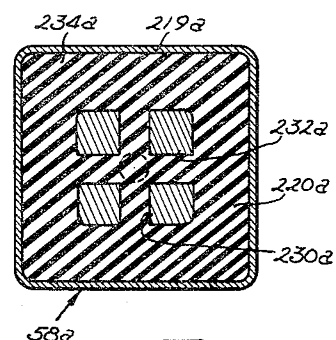


FIG. 12

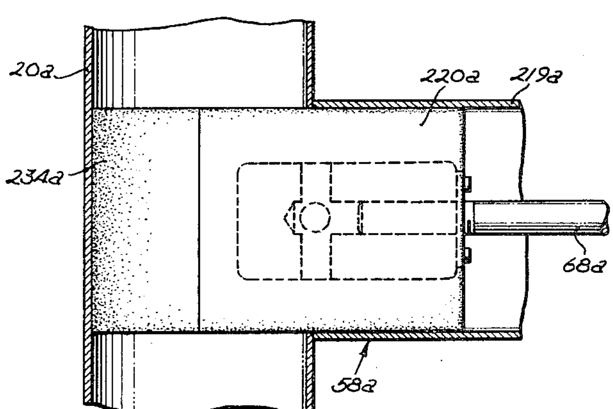


FIG. 11

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United States Patent O ce

3,205,906

Patented Sept. 14, 1965

3,205,906

PUMP AND VALVE ASSEMBLY

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Filed July 16, 1963, Ser. No. 295,334
2 Claims. (Cl. 137—246.22)

This invention relates to a pump and valve assembly and more particularly to a new and useful concrete pump employing a new and useful valve for controlling the flow of concrete and the like having large aggregate composition.

Prior art concrete pumps are available wherein concrete is pumped by pistons reciprocating within large cylinders in such a manner that, as one piston discharges its contents, the other piston draws material from a hopper to be pumped during the next half cycle. Valving is provided between each cylinder, its material supply source and its discharge line to control flow. While generally satisfactory, such concrete pumps do have certain disadvantages.

One disadvantage resides in the fact that the valves employed can only seat by crushing any aggregate which may be in the path of the valve gate as it closes on its seat. This prevents satisfactory sealing and permits separation of concrete "fines" and liquid from the aggregate. Separation of the fines and liquid from the aggregate leaves the aggregate in a mass to block the machine and interrupt the pumping cycle.

Another disadvantage resides in the fact that air sometimes leaks passed the delivery piston on the suction stroke causing some separation of fines and liquid from the aggregate.

Yet another disadvantage resides in the fact that prior art portable concrete pumps can not handle a satisfactory quantity of inch minus rock which necessitates using a lower strength, higher cost mix.

In view of the foregoing factors and conditions characteristic of pumps employed for pumping concrete, it is a primary object of the present invention to provide a new and useful concrete pump not subject to the disadvantages enumerated above and having a unique valving arrangement which satisfactorily seals aggregate-containing concrete efficiently, safely and expeditiously.

Another object of the present invention is to provide a pump for pumping concrete which incorporates a unique valving arrangement to control the flow of concrete from a hopper to a pair of discharge lines discharging into a common manifold.

Still another object of the present invention is to provide an improved valve for controlling the flow of concrete in a conduit.

A further object of the present invention is to provide a portable concrete pump which can pump concrete mixes having larger aggregate, less sand, less water and less cement than can be pumped with prior art device.

A still further object of the present invention is to provide a valve for controlling the flow of concrete in a conduit wherein the valve includes a resilient nose portion which is adapted to close upon and encompass aggregate or other material upon which it seats without damaging the valve or the material while effecting a satisfactory seal.

According to the present invention, a portable concrete pump employs a pair of pistons which reciprocate in large cylinders. As one cylinder is discharging its contents, the other cylinder is being loaded with material to be pumped during the next half cycle. Appropriate valving is provided so that the outflow of material into a common manifold from each delivery cylinder is essentially continuous. Actuation of the pistons within the cylinders is accomplished by hydraulic rams. A common hopper is employed to supply the material to the cylinders through a unique valving arrangement of the present invention. When one cylinder is being loaded with material from the hopper, its discharge line to the manifold is closed and its line to the hopper is open. While the other cylinder is discharging, its line to the hopper is closed and its line to the manifold is open.

The hydraulic rams which actuate the pistons in the delivery cylinders are interconnected in such a manner that one ram extends as the other retracts and vice versa. Travel limit switches are employed to achieve cycling of the delivery pistons by having each piston actuate a switch when it reaches the end of its cylinder-filling or loading stroke. The travel limit switch completes an electrical circuit to one solenoid of a solenoid-actuated four-way hydraulic valve which responds to pressurize the hydraulic ram of a corresponding delivery piston and connect the opposite hydraulic ram to a hydrauilc reservoir. When the opposite delivery piston reaches the end of its travel, it actuates its travel limit switch which, in turn, operates the other solenoid of the four-way hydraulic valve. The valve then responds to pressurize the hydraulic ram of the corresponding delivery piston and to connect the other ram to the hydraulic reservoir. Actuation of the travel limit switches also simultaneously operates the material loading and discharge control valves in the appropriate configuration to permit pumping into the common manifold as described above.

The material flow control valves are actuated by hydraulic, double-acting cylinders. A dual-stack, solenoid-actuated four-way hydraulic control valve is employed to activate the four, double-acting hydraulic cylinders.

The valves which control flow from the material supply hopper to the common manifold each includes a rubber nose portion which envelopes large aggregate when the valve is seated thereby effectively sealing the flow conduits to provide a positive shut off.

A rinse tank is mounted between the pumping cylinders and is connected to the non-deliver or back side of the delivery cylinders to supply fluid, such as water or mineral oil, to the back side of the delivery cylinders to prevent air from leaking past the cylinders, to dilute any material passing behind the delivery pistons, to lubricate the seals on the delivery piston and to generally assist the seals on the back side of the delivery piston in their physical sealing during the fill stroke.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view of a concrete pump of the present invention;

FIGURE 2 is a partial elevational view on an enlarged scale, with parts shown in cross-section, of a portion of the device of FIGURE 1;

FIGURE 3 is a vertical cross-sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is a transverse cross-sectional view, on an enlarged scale, of one of the valves of FIGURE 1 shown in a first operating position;

FIGURE 5 is a transverse cross-sectional view similar to FIGURE 4 showing the valve in transit to its seating position;

FIGURE 6 is a transverse cross-sectional view similar to FIGURE 4 showing the valve in a seated position;

FIGURE 7 is a transverse cross-sectional view taken along line 7—7 of FIGURE 6;

FIGURE 8 is an elevational view, with parts shown in cross section, of the gate or plug portion of the valve of the present invention;

FIGURE 9 is a transverse cross-sectional view taken along line 9—9 of FIGURE 8;

FIGURE 10 is a transverse cross-sectional view of a modified valve of the present invention;

FIGURE 11 is a cross-sectional view, with parts shown in elevation, as taken along line 11—11 of FIGURE 10; and

FIGURE 12 is a transverse cross-sectional view taken along line 12—12 of FIGURE 10.

Referring again to the drawings, and more particularly to FIGURE 1, the pump and valve assembly constituting the present invention, generally designated **10**, includes a pair of delivery pistons **12** and **14** which are reciprocally mounted in delivery cylinders **16** and **18**, respectively. A first conduit **20** places the cylinder **16** in communication with a material supply hopper **22** and a second conduit **24** places the cylinder **16** in communication with a Y-connection **26** having a discharge manifold **28**. A third conduit **30** places the cylinder **18** in communication with the hopper **22** and a fourth conduit **32** connects the cylinder **18** to the Y-connection **26**. Thus, the pistons **12** and **14** both discharge material which is drawn from the hopper **22**, in a manner to be hereinafter described, into the common manifold **28**. A supply line, not shown, may be connected to the manifold **28** so that the material, such as concrete or the like, pumped from the hopper **22** may be discharged at a remote location. The pistons **12** and **14** are reciprocated within the cylinders **16** and **18**, respectively, through means to be hereinafter described, in such a manner that, as one piston moves to the right, the other piston moves to the left, as viewed in FIGURE 1. As a piston moves to the left, it draws concrete or other material from the hopper **22** through a respective discharge port **34** into a respective cylinder. As a piston moves to the right, it discharges the material drawn from the hopper on a previous back stroke out the Y-connection **26** and manifold **28**. A scavenging horn **36** is connected to the front face of each piston to clear material from the junction of the lines from the hopper **22** and the discharge lines. A tail rod **38** is connected to the rear face of each piston. The tail rod **38** for the piston **12** extends through a partition **39** into a first cylinder **40** and the tail rod **38** for the piston **14** extends through a partition **39*a*** into a second cylinder **42**. The tail rods **38** are connected to pistons **44** and **46**, respectively. The pistons **44** and **46** and the cylinders **40** and **42** comprise hydraulic rams **48** and **49**, respectively. A first hydraulic supply line **50** connects the upstream end **51** of ram **48** to a solenoid-controlled four-way valve **52** and a second hydraulic supply line **54** connects the upstream end **55** of the ram **49** to the valve **52**. The downstream ends **56** of the rams **48** and **49** are interconnected with a common hydraulic supply line **57**.

A pair of inlet valves **58** and **60** control the flow of material from the hopper **22** to the pistons **12** and **14**, respectively and a pair of discharge valves **62** and **64** control the flow of material through the discharge lines **24** and **32**, respectively. The valves **58**, **60**, **62** and **64** each includes a tail-rod **68** which extends through an end cap **70** into a hydraulic cylinder **72**. Each tail-rod **68** is connected to a piston **74** which is reciprocally mounted in its respective cylinder **72**. Each piston **74** includes an upstream face **75** and downstream face **76**. When the upstream faces **75** are pressurized with hydraulic fluid, their associated valves will seat in their respective conduits to interrupt the flow of material therethrough. When a downstream face **76** is pressurized, its associated valve is opened. When piston **12** is moving to the left, as viewed in FIGURE 1, on its suction or fill stroke, valve **58** will be opened to permit flow of material from hopper **22** through a respective outlet **34** into the cylinder **16** and valve **62** will be closed in conduit **24**. Simultaneously, piston **14** will be moving to the right, as viewed in FIGURE 1, on its discharge stroke and valve **60** will be seated in conduit **30** to prevent flow of material from cylinder **18** into the hopper **22** and valve **64** will be opened to permit material from cylinder **18** to discharge through the discharge conduit **32** into the manifold **28**. Thus, valves **58** and **64** may be open at the same time and valves **60** and **62** may be seated at the same time and vice versa. This is accomplished by connecting the downstream faces **76** and upstream faces **75** of the valves **58** and **64** together with common hydraulic supply lines **78** and **80**, respectively and by connecting the downstream faces **76** and the upstream faces **75** of valves **60** and **62** together with hydraulic supply lines **82** and **84**, respectively. Flow of hydraulic fluid to the valves **58**, **60**, **62**, and **64** is controlled with a solenoid-controlled, dual-stack, four-way valve **86**. Hydraulic-fluid conducting lines **88**, **90**, **92** and **94** connect the common lines **78**, **80**, **82** and **84**, respectively, to the valve **86**.

A hydraulic reservoir **96** is provided to store the hydraulic fluid employed to actuate the pistons **12** and **14** and the valves **58**, **60**, **62** and **64**. While the reservoir **96** is shown schematically in FIGURE 1 as being separated from the hopper **22**, the reservoir **96** actually encompasses hopper **22**, as shown in FIGURES 2 and 3, to conserve space and add rigidity to the hopper so that the concrete or other material **98** in the hopper **22** will cool the hydraulic fluid **100** in the reservoir **96**. A first hydraulic-fluid return line **102** connects the valve **86** to the reservoir **96** through a control valve **103** and a second hydraulic-fluid return line **104** connects the valve **52** to the reservoir **96** through a control valve **105**. A line **106** connects the control valve **52** to the return line **104** so that any internal leakage within the valve **52** will return to the reservoir **96**. Hydraulic fluid is drawn from the reservoir **96** through a first conduit **108**, a control valve **109**, a second conduit **110**, a filter **112**, and a third conduit **114**. The third conduit **114** discharges directly into the intake side of a hydraulic-fluid delivery pump **116** and a branch line **118** connects the third conduit **114** to the intake side of a control, hydraulic-fluid pump **120**. A first hydraulic-fluid supply line **122** connects the discharge side of the control pump **120** to the valve **86** and a second hydraulic fluid supply line **124** connects the discharge side of the delivery pump **116** to the valve **52**. A pump-case drain **126** connects the delivery pump **116** to the return line **104** and a branch pump-case drain **127** connects the control pump **120** to the pump-case drain **126**.

A prime mover **128** supplies power to the pumps **116** and **120** through a flexible coupling **129** and shafts **130** and **131**. A hydraulic accumulator **132** is connected in parallel with the control pump **120** through a line **133** and serves to supply hydraulic power to valve **86** at very high flow rates for short periods.

A rinse tank **134** is mounted between the delivery cylinders **16** and **18** and includes a surge chamber **135** which is vented to atmosphere. A pair of lines **136** and **136*a*** place the tank **134** in fluid communication with the cylinders **16** and **18**, respectively, so that the portion of the cylinders **16** and **18** between the rear faces of pistons **12** and **14** and the partitions **39** and **39*a*** may be filled with liquid from the rinse tank **134**. As the pistons reciprocate, the liquid will, of course, move back and forth between the tank **134** and the cylinders **16** and **18**. A drain **137** is provided in the bottom of each cylinder adjacent the partitions **39** and **39*a*** and a drain **138** is provided in the tank **134** so that the rinse liquid may be drained to waste when desired. The rinse liquid prevents air from leaking past the delivery pistons on their suction strokes and dilutes any material leaking past the delivery pistons. The fluid also lubricates the seals on the delivery pistons which is especially desirable during the filling or loading portion of the pumping cycle. The fluid used may be plain water or water having soluble oil added thereto. A mineral oil and like liquids may also be used. When operation of the pump 10 is terminated for any extended length of time, such as the end of a working day, the drains 137, 137*a* and 138 are preferably opened so that the fluid may flow out, thus removing any diluted materials which may have leaked past the delivery pistons 12 and 14.

The solenoids, to be hereinafter described, of values 52 and 86 are controlled through an electrical switching system including a latching relay 140 having a pair of coils 142 and 144 and four, single-pole, double-throw switch blades 146, 147, 148 and 149. A soft iron rod or core 150 is connected to the blades 146–149 and extends into the coils 142 and 144. When the coil 144 is energized, the rod 150 will move to the right, as viewed in FIGURE 1, so that the blades will be closed on contacts 150, 151, 152 and 153, respectively, as shown in FIGURE 1. When the coil 142 is energized, the rod 150 is drawn to the left, as viewed in FIGURE 1, swinging the blades 146–149 into engagement with the contacts 154, 155, 156 and 157, respectively. A lead 158 connects the coil 144 to a lead 159 which, in turn, connects the coil 142 through a switch blade 160 and a fuse 162 to a source of power comprising a storage battery 163. A lead 164 connects coil 142 to a blade 165 of a reversing switch 166 and a lead 167 connects the coil 144 to a blade 168 of the reversing switch 166. A third blade 169 of reversing switch 166 is connected by a lead 170 to the contacts 154 and 155 in the latching relay 140. A fourth blade 171 of the reversing switch 166 is connected by a lead 172 to the contact 151 of the latching relay 140. The blades 165, 169, 171 and 168 are connected to a rod 173 which may be positioned as shown in FIGURE 1 to close blades on contacts 174, 175, 176 and 177, respectively. The rod 173 may be moved to the right as viewed in FIGURE 1, to bring the blades 165, 169, 171 and 168 into engagement with contacts 178, 179, 180 and 181, respectively.

The latching relay 140 is controlled by a pair of delivery-piston, travel limit switches 182 and 183 which are closed by the pistons 12 and 14, respectively, when they reach the end of their travel to the left, as viewed in FIGURE 1. A lead 184 connects the switch 182 to the contact 174 and a lead 186 connects the switch 183 to the contact 177.

A manually-operated push-button switch 187 is connected in the circuit with the switch 182 so that the switch 182 may be overridden manually when desired. A similar push-button switch 188 is connected in the circuit with the switch 183 for overriding it.

The latching relay 140 controls the operation of the valves 52 and 86 by actuating their respective solenoids through a number of different circuits which will now be described. A first solenoid 189 of valve 52 is connected by a lead 190 to the contact 175 in reversing switch 166 and a second solenoid 191 in switch 52 is connected by a lead 192 to the contacts 176 and 179. A first solenoid 193 in the switch 86 is connected by a lead 194 to the contacts 156 and 157 in the latching relay 140. A second solenoid 195 in switch 86 is connected by a lead 196 to a lead 198 which, in turn, connects a third solenoid 199 to the terminals 152 and 153 in the latching relay 140. A fourth solenoid 200 in the valve 86 is connected by a lead 201 to the lead 194.

A first indicating lamp 202 is connected by a lead 203 to the contacts 175 and 180 and a second indicating lamp 204 is connected by a lead 205 to the contacts 179 and 176. The indicating lamps 202 and 204, when energized, indicate which discharge line is supplying material to the manifold 28.

A master control switch 206 includes the blade 160 previously mentioned and a second blade 207. A third indicating lamp 208 is connected by a lead 209 to the switch 206 and indicates when the master switch is closed so that the system may be energized. A first "start-stop" switch 210 is connected by a lead 211 to the switch 206 and by a lead 213 to a jack 214 which, in turn, is connected by cables 215 and 216 to a second "start-stop" switch 217. The cables 215 and 216 may be of any desired length so that the switch 217 may be located at the discharge end of a line, not shown, discharging concrete from the manifold 28 to a point of application. Thus, the operator handling the discharge line can control the outflow of the material from the remote point of application. A circuit is completed through the jack 214 and the start-stop switch 210 by a lead 218 which connects the jack 214 to the blades 146 and 147 of the latching relay 140.

The control valves 58, 60, 62 and 64 are important features of the invention because they permit controlling the flow of a material, such as concrete, containing large particles, such as aggregate 98*a* (FIGURE 3) by forming an effective seal in a conduit without crushing the aggregate 98*a* or damaging the valve member. Referring now to FIGURES 2–9, these valves may be of identical construction and each includes a valve body 219 in which a plug or gate 220 is slidably mounted. Each plug or gate 220 includes a core 221 (FIGURES 8 and 9) having external threads 222 at one end, a rubber-gripping nose portion 224 at its other end and an annular dam 226 intermediate its ends. An annular skirt 227 is formed on core 221 adjacent the dam 226 and an annular groove 228 encompasses the core 221 intermediate the dam 226 and the skirt 227. The dam 226 prevents the nose plug 234 from becoming unseated from the groove 228 when the nose plug 234 is compressed by the seating of gate 220.

The nose portion 224 includes transverse bores 230 and 232 which lie at right angles to each other. The resilient nose plug 234, which may be made of gummed rubber or a suitable synthetic material such as polybutadiene, is molded to the core 221 in such a manner that the nose plug 234 firmly grips the annular groove 228 and the transverse bores 230 and 232. The skirt 227 forms a recess 236 with the core 221 to accommodate a pressure ring 240 which encompasses the core 221 with an end 242 slidably mounted in the recess 236. The pressure ring 240 includes a grease passageway 244 which communicates with a similar passageway 246 contained in core 221. A grease fitting 247 is connected to the passageway 246 so that a suitable lubricant, such as water pump grease, may be supplied to the periphery of the gate 220. The grease is distributed about the periphery of plug or gate 220 by a lantern ring 248 which encompasses pressure ring 240 and has an annular channel 249 communicating with passageway 244. A plurality of apertures 250 are spaced about the periphery of ring 248 to admit the grease from channel 249 to the periphery of gate 220.

A first set of packing rings 251 encompasses the pressure ring 240 between the lantern ring 248 and an annular land 252 formed on the ring 240 and a second set of packing rings 253 encompasses the pressure ring 240 between the lantern ring 248 and the skirt 227. A nut 254 threadedly engages the threads 222 and bears against the pressure ring 240. The packing rings 251 and 253 prevent material, whose flow is to be controlled by the plug 220, from flowing past the plug 220, and are compressed between the skirt 227 and the land 252 by tightening the nut 254 against the pressure ring 240 causing it to slide further into the recess 236. The material whose flow is being controlled and the lubricant are prevented from flowing into the recess 236 by an O-ring 255 which encompasses the end 242 and bears against the inner wall of the skirt 227. The nut 254 may be tightened to compensate for wear on the packing rings 251 and 253. The cylindrical portion of core 221 which engages the valve body during reciprocation of the valve includes the skirt 227 and the nut 224 and the length of this cylindrical portion is greater than its diameter in order to provide sufficient bearing area with the valve body to resist the pressure developed on the nose plug when in the closed position of FIGURE 7. Also the length of the nose portion 224 is more than one-half the total length of the nose plug 234 to prevent the nose plug from twisting off the nose portion when subjected to high concrete pressures.

A modified valve 58*a* is shown in FIGURES 10–12 as controlling the flow of material through a conduit 20*a* and is substantially similar to the valve 58 previously described except that it is of a square configuration. The valve 58*a* includes a square body portion 219*a* in which a gate 220*a* is slidably mounted. The gate 220*a* includes a core 221*a* having transverse bores 230*a* and 232*a*. A tail rod 58*a* threadedly engages the core 221*a*. A resilient nose portion 234*a* is molded to the core 221*a* and is of sufficiently resiliency that it will seat against the conduit 20*a* and envelope any aggregate which may be trapped between the plug or gate 220*a* and the conduit 20*a*.

Operation of the device will be described in connection with FIGURE 1. Assuming that the hooper 22 is filled with a material, such as concrete, to be pumped by the pump 10 and that the prime mover 128 is energized to pressurize the hydraulic system, then switches 206 and 210 may be closed to energize the solenoids of valves 52 and 86. Assuming further that, when the electrical system is energized, the reversing switch 166 and the latching relay 140 are in the positions shown in FIGURE 1. When the electrical system is energized, current will flow from the battery 163 to the solenoid 191 through the fuse 162, the blade 207 of switch 206, lead 211, switch 210, lead 213, jack 214, lead 218, blades 146 and 147 of latching relay 140, lead 172, blade 171, contact 176 and lead 192. Current also flows from battery 163 to the solenoids 195 and 199 in valve 86 through fuse 162, blade 160, lead 159, lead 158, blades 148 and 149 and leads 198 and 196.

Energization of solenoid 191 positions valve 52 in such a manner that fluid under pressure from pump 116 flows from line 124 through valve 52, and line 54 into ram 49 pressurizing cylinder 42 causing piston 46 to move to the right, as viewed in FIGURE 1. Piston 46 forces hydraulic fluid out end 56 of cylinder 42, through line 57 and into the end 56 of cylinder 40. This pressurizes ram 48 causing piston 44 to move to the left, as viewed in FIGURE 1, exhausting hydraulic fluid out end 51 of cylinder 40 through line 50, valve 52, return line 104 and valve 105 into reservoir 96.

Energization of solenoids 195 and 199 positions valve 86 in such a manner that hydraulic fluid under pressure from line 122 flows through valve 86, line 94 and line 84 to pressurize faces 75 of valves 60 and 62 forcing the valves to seat in conduits 30 and 24, respectively. Fluid under pressure from line 122 also flows through valve 86, lines 88 and 78 into valves 58 and 64 pressurizing faces 76 of the respective pistons thereby opening the valves 58 and 64. The valve 86 is also positioned in such a manner that return fluid will flow from the faces 75 of pistons 74 in valves 58 and 64 through lines 80 and 90, valve 86, return line 102 and valve 103 into the reservoir 96. With the valves thus positioned, the movement of piston 12 to the left, as viewed in FIGURE 1, by ram 48 draws material from hopper 22 through outlet 34, conduit 20, and into cylinder 16 filling it. As piston 14 simultaneously moves to the right, as viewed in FIGURE 1, due to the force exerted by ram 49, material in cylinder 18 is forced through conduit 32 and Y-connection 26 into manifold 28. The scavenger horn 36 on piston 14 clears the material from the juncture of conduits 30 and 32. As delivery piston 12 moves to the left, it will also force rinse liquid from cylinder 16 through line 136, tank 134, line 136*a* and into cylinder 18 behind the piston 14 to prevent air from leaking past pistons 12 and 14 and to dilute any material that might have leaked past the cylinder 14.

When piston 12 reaches the end of its travel to the left, it closes travel limit switch 182 completing a circuit through lead 184, contact 174, blade 165, lead 164, coil 142, lead 159, blade 160, fuse 162 and battery 163. This energizes coil 142 drawing the soft iron core 150 to the left, as viewed in FIGURE 1, to bring the blades 146, 147, 148 and 149 into engagement with the contacts 154, 155, 156, and 157, respectively. This energizes solenoids 189 in valve 52 and solenoids 193 and 200 in valve 86 by placing the leads 190, 194, and 201 in a circuit with battery 163 through the latching relay 140.

Energization of solenoid 189 positions valve 52 in such a manner that fluid under pressure from line 124 will be directed through the valve 52 and line 50 into the end 51 of ram 48 pressurizing the piston 44 in such a manner that the ram 48 will cause delivery piston 12 to move to the right as viewed in FIGURE 1. The solenoid 189 will also position the valve 52 in such a manner that return fluid flowing from the ram 48 through line 57 pressurizes piston 46 causing it to move to the left, as viewed in FIGURE 1, exhausting the fluid from cylinder 42 through line 54, valve 52, line 104, and valve 105 into reservoir 96.

Energization of solenoid 193 will cause valve 85 to be positioned in such a manner that fluid under pressure in line 122 flows through valve 86, lines 92 and 82 pressurizing valves 60 and 62 on the faces 76 of their respective pistons to unseat the valves. The valve 86 is also positioned in such a manner that return fluid from the valves 60 and 62 flows through lines 84 and 94, valve 86, line 102, and valve 103 into the reservoir 96. Energization of the solenoid 200 positions valve 86 in such a manner that fluid under pressure in line 122 also flows through valve 86, lines 90 and 80, into cylinders 72 to pressurize faces 75 of valves 58 and 64 causing them to seat in their respective conduits and through valve 86, lines 92 and 82 into cylinders 72 to pressurize the faces 76 of valves 60 and 62 causing them to open. Thus, the valves 60 and 62 will open and valves 58 and 64 will be closed so that movement of the piston 12 to the right, as viewed in FIGURE 1, will force material previously drawn into the cylinder 16 out the cylinder 16 into conduit 24, Y-connection 26 and out manifold 28. Simultaneously, piston 14 moves to the left, as viewed in FIGURE 1, drawing material from hopper 22, through opening 34 and line 30 into the cylinder 18 filling it with material to be delivered on the next stroke. Movement of piston 14 to the left forces the rinse liquid behind the piston in cylinder 18 out cylinder 18 through line 136*a*, rinse tank 134, and line 136 into the cylinder 16 behind its piston keeping the area behind piston 12 in cylinder 16 filled with rinse liquid as the piston 12 moves to the right. When the piston 14 reaches the end of its travel to the left, as viewed in FIGURE 1, it closes its travel limit switch 183 completing a circuit through lead 186, contact 177, blade 168, lead 167, coil 144, lead 158, lead 159, blade 160, and fuse 162 to battery 163. This energizes coil 144 drawing soft iron core 150 to the right, as viewed in FIGURE 1, swinging blades 146, 147, 148 and 149 into engagement with the contacts 150, 151, 152 and 153 to again energize the solenoids 191, 195 and 199 preparing the pump 10 for its next one-half cycle of operation.

Should it be desired to reverse the above sequence of operation, the reversing switch 166 may be adjusted for such operation by sliding the rod 173 to the right, as viewed in FIGURE 1, to bring the blades 165, 169, 171, and 168 into engagement with the contacts 178, 179, 180 and 181, respectively. This reverses the circuits through the latching relay 140. The travel limit switch 182 may be manually overridden by depressing button 187 to by-pass the circuit to coil 142. Similarly, the limit travel switch 183 may be manually overridden by depressing the button 188 to by-pass the coil 144 in latching relay 140.

The accumulator 132 insures immediate hydraulic response through the valve **86** by making a high flow of fluid available at all times so that fluid will flow through the valve **86** the instant the solenoids therein are energized.

The above described cycle of operation will repeat itself continuously as long as the electrical circuit is energized. The circuit may be de-energized to interrupt the flow of material from hopper **22** from a remote location by assembling jack **214** and then opening switch **217** to interrupt the circuit from the battery **163**.

While the particular concrete pump and valves herein shown and described in detail are fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that they are merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims.

What is claimed is:

1. A valve for controlling the flow of material containing discrete particles comprising:

a valve body having a seat;

a valve gate reciprocally mounted in a cylindrical opening in said body;

said valve gate comprising a core of rigid material having a cylindrical portion and a reduced nose portion at one end thereof;

a resilient nose plug covering said nose portion and secured thereto;

said nose plug comprising a dome-shaped end surface connecting with a cylindrical surface surrounding said nose portion, said cylindrical surface having the same diameter as said cylindrical portion of said core to be coextensive therewith;

said cylindrical portion being in full engagement with said cylindrical opening when said valve is closed by moving said nose plug against said seat and having a length greater than its diameter to provide sufficient bearing area to resist the pressure applied to said nose plug when the valve is closed;

said nose portion extending into said nose plug by a distance of more than half the length of said nose plug against pressure applied thereto when in said closed position; and

an annular dam extending outwardly from the end of said nose portion adjacent said cylindrical portion of said core, said dam comprising an annular wall separated from said cylindrical portion by a cylindrical groove; the diameter of said wall being smaller than said cylindrical surface of said nose plug so that said nose plug passes around said wall and is anchored in said groove.

2. A valve as defined in claim **1** having a depression in the surface of said cylindrical portion;

a grease distributing ring located within said depression and having apertures in communication with grease supply passage means in said core; and

packing means located in said depression on opposite sides of said ring.

References Cited by the Examiner

UNITED STATES PATENTS

2,366,417	1/45	MacMillin	103—49 X
2,485,208	10/49	Longenecker	103—204
2,690,715	10/54	Pope	103—49
2,962,047	11/60	Obermaier	137—525
2,998,781	9/61	Triebel	103—49
3,068,806	12/62	Sherrod	103—169
3,077,204	2/63	Bennett et al.	137—525
3,091,260	5/63	Milanovits et al.	251—191 X

FOREIGN PATENTS

520,456	1/56	Canada.
870,187	6/61	Great Britain.

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