United States Patent

Shaddock

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[45] **Oct. 24, 1972**

[54] **DOUBLE-ACTING TANDEM PISTON PUMP**

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[73] Assignee: **Myers-Sherman Company**, Streator, Ill.

[22] Filed: **Aug. 23, 1971**

[21] Appl. No.: **173,767**

Related U.S. Application Data

[62] Division of Ser. No. 857,424, Sept. 12, 1969, Pat. No. 3,658,589.

[52] **U.S. Cl.** **417/404,** 417/390, 91/275

[51] **Int. Cl.**.....**F04b 9/08,** F04b 17/00, F04b 35/00, F01l 25/08

[58] **Field of Search** 417/390, 404; 91/275, 313, 91/384

[56] **References Cited**

UNITED STATES PATENTS

2,087,713	7/1937	Whiteside et al.	417/404 X
2,854,826	10/1958	Johnston	417/404
2,726,490	12/1955	Lowe	91/275 X
2,842,108	7/1958	Sanders	123/102

Primary Examiner—Robert M. Walker
Attorney—Carlton Hill et al.

[57] **ABSTRACT**

A high pressure tandem piston pump reciprocated by pressured oil from a vehicle engine driven hydraulic pump to surge water at high pressure from a vehicle tank or other source through a hose and nozzle to create a jumping action or jack hammer driving of the nozzle forcing it through and around obstructions in a sewer pipe. The engine driven pump pumps oil to opposite sides of one of the pistons of the tandem pump causing it to reciprocate the piston for high pressure surging delivery of water. Oil flow to opposite sides of the driving piston to is controlled from a valve tripped by a switch which is actuated by a control rod slidable in a recess of the connecting rod between the two pistons of the tandem pump and arranged to be pushed to a switch tripping position at one end of the stroke of the pump admitting high pressure oil which further ejects the control rod and holds it in an extended position until pulled to a retracted locked position at the opposite end of the stroke of the pump permitting the switch to again be tripped for reversing the flow from the engine driven pump.

7 Claims, 3 Drawing Figures

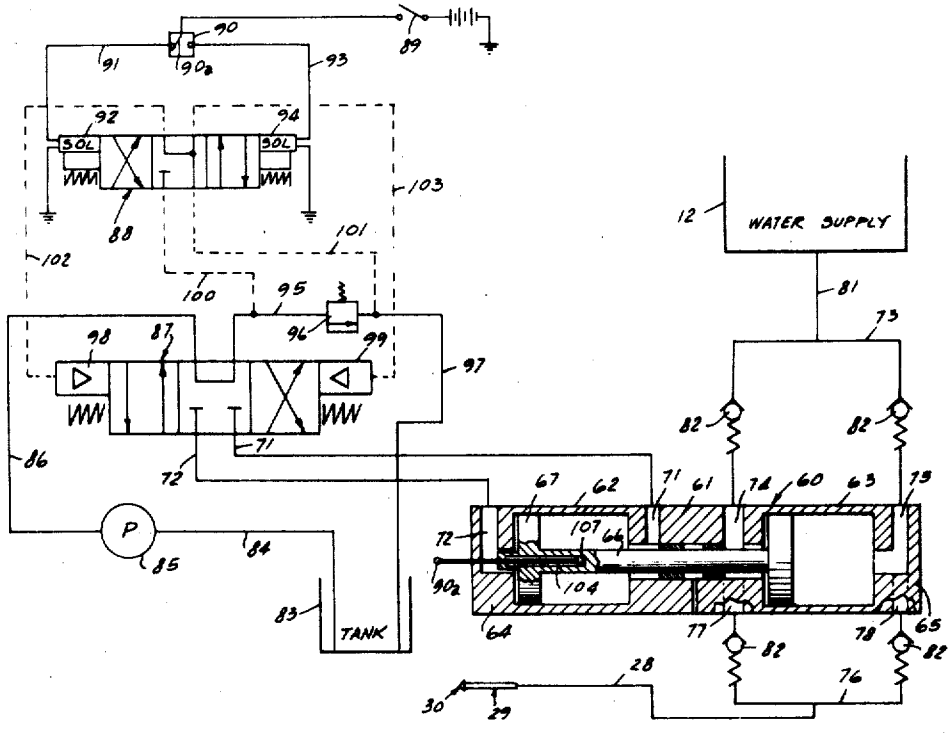
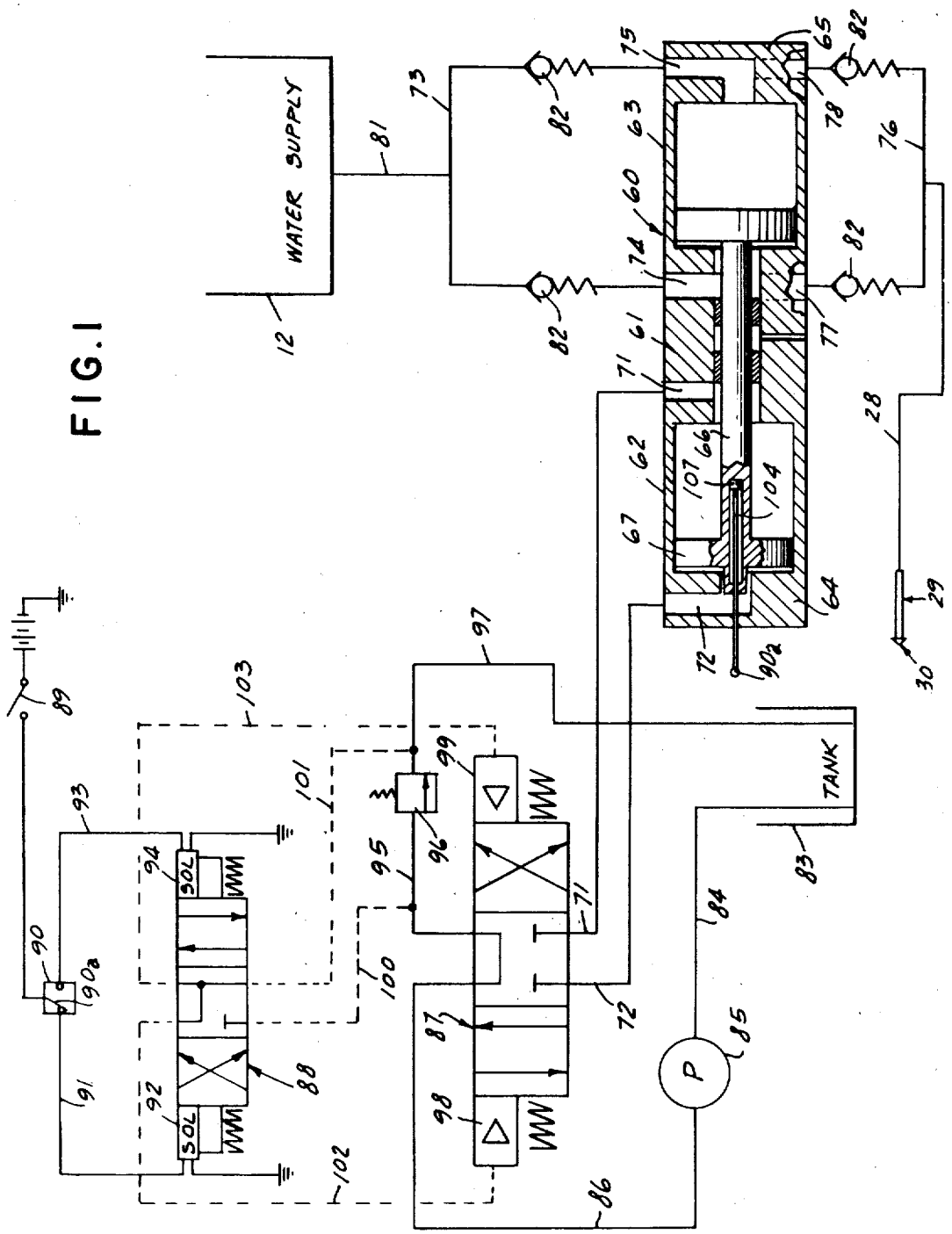


FIG. 1



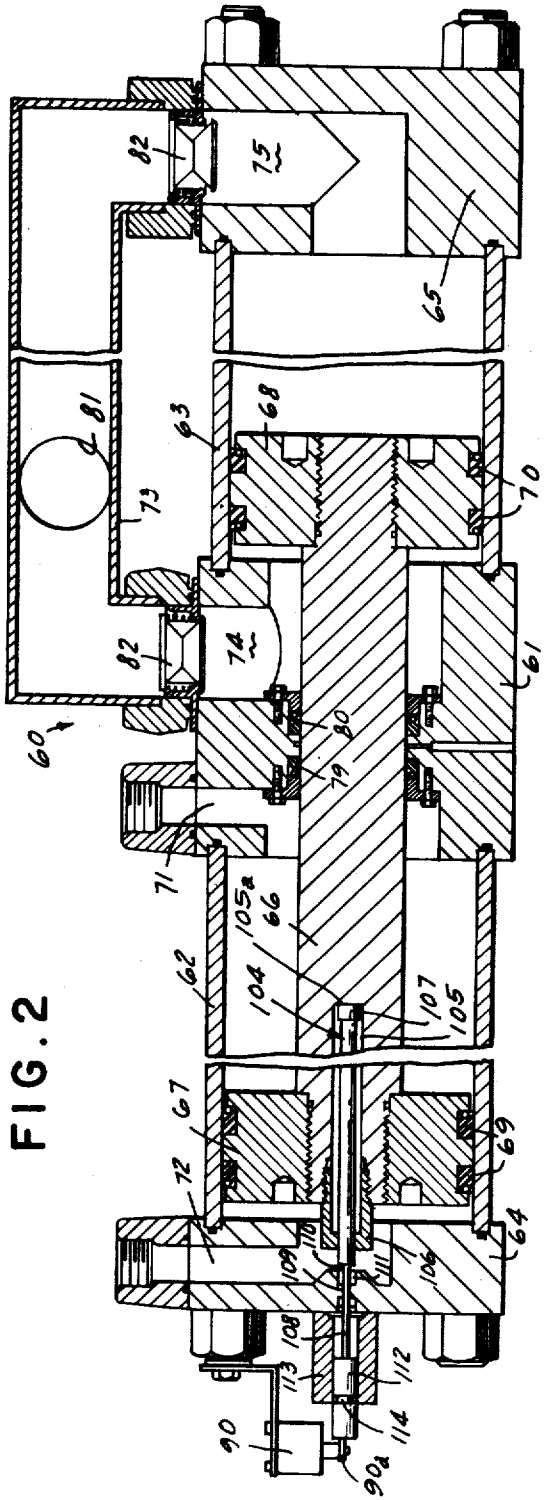

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FIG. 2

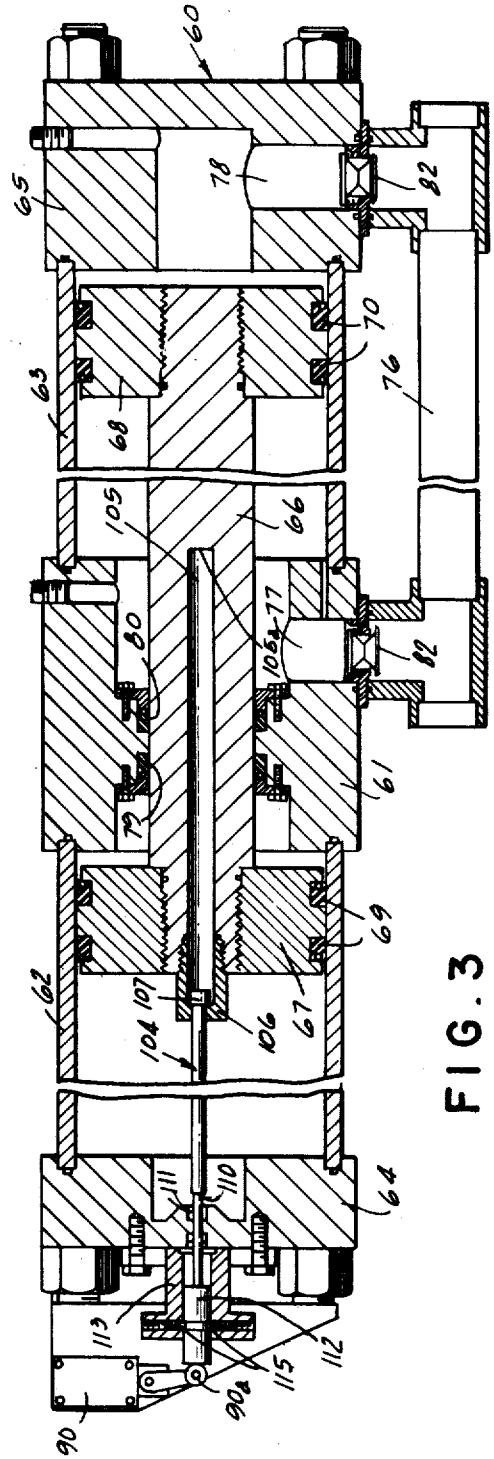
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FIG. 3

DOUBLE-ACTING TANDEM PISTON PUMP

RELATED APPLICATION

This application is a division of my application entitled "Catch Basin and Sewer Pipe Cleaner," U.S. Ser. No. 857,424 filed Sept. 12, 1969, now U.S. Pat. No. 3,658,589, granted Apr. 25, 1972.

BRIEF SUMMARY OF THE INVENTION

In my aforesaid parent application, there is described and claimed a single vehicle for vacuum cleaning of catch basins and flushing of sewer pipes with water surged through a hose and nozzle at pressures of about 2,000 to 3,000 pounds per square inch causing the hose to jump and move the nozzle for seeking its way around and through obstructions in a sewer pipe or the like in the manner of a jack hammer. The present invention now relates to the double-acting tandem piston pump disclosed in my parent application for producing the high pressure surging of water through the hose and nozzle.

The tandem piston pump of this invention is mounted on the single vehicle disclosed in my parent application and has a first piston reciprocated by pressurized oil from a hydraulic pump conveniently driven through a conventional power take-off from the vehicle engine. This first piston reciprocates a second piston to surge water from the vehicle tank through a hose which is reeled on the front of the vehicle and carries a self-propelling nozzle on its leading end.

The tandem piston water pump of this invention forces water through the hose at pressures of 2,000 to 3,000 pounds per square inch, but as the pumping piston reaches the end of its stroke and is reversed, there is a momentary lull in the water flow creating a pulsing action which causes the hose to jump and moves the nozzle to seek its way around and through obstructions in the manner of a jack hammer.

Since the tandem piston pump is hydraulically driven, it can be conveniently located anywhere on the vehicle close to or remote from an engine driven oil pump and driven at any rate controlled by the pressure of the hydraulic fluid.

In its preferred embodiment, the double-acting tandem piston pump of this invention has a central body portion with cylinders of the same or different diameters extending from both sides thereof. A piston rod extends through the central body into both cylinders and piston heads are secured on the ends of the rod. One of the pistons is actuated by oil from the engine driven pump to drive the other piston for surging the water at high pressure. A feature of the invention includes a control rod slidable in a recess in the piston rod and extending through the head of the oil cylinder to trip a switch controlling a valve which controls oil flow to and from the opposite ends of the oil cylinder. This control rod is pushed to a switch tripping position by the piston rod and is ejected to a further extended position by the oil pressure introduced into the end of the cylinder for reversing the piston stroke. Then when the oil piston reaches the end of its stroke remote from the cylinder head, the control rod is pulled from its extended position to a locked retracted position permitting the switch to return to an initial position for reversing the oil flow control valve. The control rod thus only has a short stroke being moved only when the oil piston approaches the ends of its stroke.

It is then an object of this invention to provide a tandem pump having a driving piston actuated hydraulically from a rotary pump and a driven piston delivering high pressure water at surging flow rates.

A further object of this invention is to provide a double-acting tandem piston pump with a driving piston in a first cylinder of a selected size and a driven piston in a second cylinder of selected size connected by a common piston rod which trips a control rod to effect reversal of the stroke of the pistons.

A further object of the invention is to provide a double-acting piston pump with a common central body, cylinders of selected sizes on opposite sides of the body, pistons slidable in the cylinders connected by a common piston rod extending through the body, and a control rod actuated from the piston rod for effecting reversal of flow of pressurized fluid to opposite sides of the driving piston which control rod is urged by driving fluid pressure on one side of the piston to an extended position and pulled to a retracted locked position by the piston rod.

A still further object of the invention is to provide an oil trap protecting the control rod against impact when driven to its extended position.

Other and further objects of this invention will be apparent to those skilled in this art from the following description of the annexed sheets of drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view of the water and oil circuits for the tandem pump which is illustrated in longitudinal cross-section;

FIG. **2** is a broken longitudinal cross-sectional view of the tandem piston pump of this invention;

FIG. **3** is a view similar to FIG. **2** but on a section line 90° therefrom and showing the pistons at the opposite ends of their stroke.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The tandem pump **60** of this invention is conveniently mounted on the catch basin and sewer pipe cleaning vehicle disclosed in my aforesaid parent application, Ser. No. 857,424, and receives water from a tank diagrammatically illustrated at **12** in FIG. **1** to surge the water through a hose diagrammatically illustrated at **28** with a high pressure self-propelling spray nozzle **29** on its front end and having a hollow head **30** with rearwardly opening orifices.

This pump **60** has a central cylindrical body **61** with a first cylinder **62** extending from one side thereof and a second cylinder **63** extending from the other side thereof. These cylinders can be of the same or different diameters for a purpose to be more fully hereinafter described.

The cylinder **62** has an end head **64** thereon. The cylinder **63** has an end head **65** thereon.

As best shown in FIGS. **2** and **3**, a piston rod **66** extends through the central body **61** into both the cylinders **62** and **63**. A first piston head **67** is secured to an end of the piston rod **66** in the cylinder **62**, and a second piston head **68** is secured to the opposite end of the rod in the cylinder **63**. Piston rings **69** are carried in grooves in the piston **67** and sealingly engage the cylinder wall **62**. Similar piston rings **70** are carried in

grooves in the piston **68** and engage the cylinder wall **63**. These piston rings include a plastic ring body with a groove in the end wall thereof facing the cylinder chamber receiving an O-ring which sealingly connects the end face of the ring with the piston ring groove and which causes an expansion of the ring body against the cylinder wall under the influence of pressure in the cylinder.

In the illustrated form of the pump **60** the piston **67** is the driving piston and is actuated by oil under pressure from an engine-driven hydraulic pump. Oil is selectively circulated to and from opposite faces of the piston **67** through a first port **71** in the central body **61** and a second port **72** in the end head **64**. The piston **68** is the water pumping piston, and the cylinder **63** receives water into the opposite ends thereof from a common manifold **73** through a port **74** in the central body **61** and a port **75** in the end head **65**. Water pumped by the piston **68** is discharged from opposite ends of the cylinder **63** into a common outlet **76** from a first port **77** in the central body **61** and a second port **78** in the end head **65**.

Packings **79** and **80** in the central body **61** sealingly engage the piston rod **66** to prevent leakage between the oil and water sides of the pump.

As shown in FIG. **1**, the inlet manifold **73** for the water side of the pump receives water from the supply tank **12** of the vehicle through a conduit **81** and the water is discharged through the manifold **76** and hose **28** to the nozzle **29**.

Check valves **82** are provided in each of the ports **74**, **75**, **77** and **78**. These valves are spring-loaded to closed positions, and are arranged in the ports so that the valve **82** in the port **74** will be closed as the piston is moved to the left-hand end of its stroke, while the valve in the port **77** will be open to discharge the water being pumped into the manifold **76**. At the same time the valve in the port **75** will be opened to admit water to the right-hand side of the piston **68**, while the valve in the port **78** will be closed. The valves are operated by pressure differentials, with the water inlet valves opening on the suction stroke, closing on the pressure stroke, and with the outlet valves closing on the suction stroke and opening on the pressure stroke. These valves, therefore, alternately admit water from the supply tank to opposite sides of the piston and alternately discharge the water on the pressure stroke of the piston, with one inlet valve being opened on one side of the piston and one discharge valve being opened on the opposite side of the piston at the same time, while the other two valves are closed.

The driving piston **67** alternately receives oil on opposite sides thereof through the ports **71** and **72**, which act both as inlet and outlet ports.

As shown in FIG. **1**, oil from a tank **83** on the vehicle is fed through an intake tube **84** to the inlet side of an engine-driven oil pump **85**. This pump discharges through a tube **86** into a four-port spring-centered spool valve diagrammatically illustrated at **87**. This valve **87** is hydraulically actuated from a solenoid operated pilot valve **88**. The solenoid valve **88** is controlled from a master switch **89** supplying actuating current to a reversing micro-switch **90** having one pole **91** actuating a solenoid **92** on one side of the valve spool in the pilot valve **88** and a second pole **93** actuating a second solenoid **94** on the opposite side of the spool valve.

Oil from the tube **86** passes through the valve **87** to a tube **95**, discharging to a pressure regulating valve **96** which dumps into a return tube **97** back to the tank **83**. The valve **96** maintains a predetermined pressure differential between the tubes **95** and **97**.

The spool in the valve **87** is shifted by oil under pressure from chambers **98** and **99** at opposite ends of the spool. These chambers selectively receive oil at the pressure maintained by the valve **96** under the control of the pilot valve **88**. This pilot valve **88** has an inlet oil tube **100** in the oil line **95** ahead of the valve **96** and an outlet oil tube **101** downstream of the valve **96** so that the pilot valve only receives oil under the pressure maintained by the valve **96**. This oil is selectively fed under control of the pilot valve **88** through a tube **102** to the chamber **98** and through a tube **103** to the chamber **99**. With the leaf **90***a* of the microswitch in the position shown in FIG. **1**, current flows through the wire **91** to energize the solenoid **92**, thus shifting the spool in the valve **88** so that oil from the tube **100** will flow to the tube **102** and chamber **98** for forcing the spool in the valve **87** to the right. At the same time oil in the chamber **99** will be drained back through the tube **103**, through the valve **88** to the return line **101** back to the tank through the tube **97**.

The valve **87**, when shifted by oil under pressure from the chamber **98**, will communicate the pump pressure tube **86** to the port **72**, while at the same time opening the port **71** to the tube **95** and through the pressure valve **96** back to the tank **83**. Oil under the full pressure of the pump **85** will thereby be introduced to the left-hand side of the cylinder **62**, forcing the piston **67** to the right. When the piston reaches the right-hand end of its stroke, as shown in FIG. **3**, the leaf **90***a* of the micro-switch **90** returns to its opposite pole and energizes the line **93**, which activates the solenoid **94** and reverses the pilot valve **88** so that oil from the pressure line **100** will flow to the line **103** and to the chamber **99**, while oil from the chamber **98** will flow through the tube **102** into the line **101** back to the tank. The valve **87** will thereupon be shifted so that oil is fed under pressure to the port **71** and drained from the port **72**.

The micro-switch activating means is shown in FIGS. **2** and **3**, and includes a control rod **104** freely mounted in an axial recess **105** in the left-hand end of the piston rod **66**. The rod **104** slides freely through a cap **106** which is threaded in the end of the piston rod **66** and is adapted to allow high pressure oil from the port **72** to flow into the recess **105**. The rod **104** has a head **107** on its inner end adapted to bottom at opposite ends of the piston rod stroke respectively on the cap **106** and on the end wall **105***a* of the recess **105**. A reduced diameter integral rod portion **108** slides through a gland **109** in the end head **64** and provides a shoulder **110** in which port **72**. The gland **109** has a recess **111** exposed to the port **72** and confronting the shoulder **110**.

The reduced diameter portion **108** of the control rod **104** projects beyond the end head **64** and has an enlarged head **112** thereon slidably mounted in an open-ended cylinder **113** which is secured to the outer face of the end head **64**. In the position illustrated in FIG. **2** the end wall **105***a* of the recess has just pushed the control rod **104** to move this head **112** to its extended posi-

tion projecting beyond the cylinder **113**. In this extended position the head **112** has tripped the switch leaf **90***a*, admitting oil to the port **72**, thus starting the piston on its stroke to the right. Since the head end **107** of the rod **104** is exposed to the high pressure in this port **72** while the other head end **112** of the rod **104** is exposed to the atmosphere, the rod **104** is driven further outwardly, moving the shoulder **110** into the recess **111**, where trapped oil in this recess will prevent the shoulder from impacting against the gland **109**. The rod will remain in its extended position, with its head **112** against the switch leaf **90***a* until the cap **106** engages the head **107** at the inboard end of the piston stroke, as shown in FIG. **3**. Then the head **112** of the control rod **104** will be pulled into the cylinder **113** to a position where a peripheral grove **114** in the head is aligned with spring-loaded ball-bearings **115** carried by the cylinder. These spring-loaded ball bearings or detents will snap into this groove **114** for holding the control rod **104** in a retracted inward position, as shown in FIG. **3**.

In the position of FIG. **3** the head **112** has been withdrawn into the cylinder **113** sufficiently to allow the spring-loaded leaf **90***a* of the micro-switch to move to the right and change the pole position of the switch. The control rod will remain in the position of FIG. **3**, held by the detents **115** until it is again pushed by the recessed end wall **150***a*, returning the rod to the position of FIG. **2** for the next stroke.

In the position of FIG. **8**, fluid is just beginning to enter the port **71** to start the piston on its stroke to the left.

In the position of the leaf **90***a*, shown in FIGS. **1** and **2**, the solenoid-actuated pilot valve **88** feeds oil under the differential pressure maintained across the valve **96** to position the main valve **87** so that oil will flow into the port **72** and out of the port **71**. This, of course, will drive the piston **67** to the right-hand end of the cylinder **62**, whereupon, as shown in FIG. **3**, the cap **106** will engage the control rod head **107**, retracting the head **112** into the cylinder **113** to a position where it is retained by the spring pressed detents **115**. Of course, upon reversal of the pole position of the micro-switch to the position of FIG. **3**, the pilot valve **88** will again be energized to reverse the main valve **87** and introduce pressurized oil into the port **71** and out of the port **72**, thereby moving the piston **67** to the left.

It will be appreciated that while the stroke of the piston rod **66** may be quite long, the control rod **104** is only shifted a short distance, just sufficient to throw the leaf **90a** of the micro-switch **90** between its poles. Thus, when the piston rod **66** moves to the right from the position of FIG. **2**, the rod **104** will remain stationary, being retained in its extended position by oil pressure in the port **72**. Then when the piston rod **66** moves to the inboard end of its stroke, as shown in FIG. **3**, the head **107** will be engaged by the cap **106**, pulling the rod **104** therewith only until the head **112** is moved into the cylinder **113** sufficiently to align the groove **114** with the spring-pressed detents **115**. For example, the control rod **104** may only be shifted 1 inch or so in installations where the piston rod **66** is shifted 15 inches or more.

As illustrated, the cylinders **62** and **63** are of the same diameter, but if it is desired to increase the flow capacity of the water pump, the cylinder **63** and piston **68** can be of a larger diameter than the cylinder **62** and piston **67**. Conversely, if it is desired to obtain a higher maximum water pressure, the cylinder **62** and piston **67** can be larger than the cylinder **63** and piston **68**.

From the above descriptions of the pump **60** it will be understood that the engine-driven oil pump **85** operates through a pilot valve and a main valve to alternately deliver pressurized oil into the opposite ends of the cylinder **62**. When oil is delivered into one end of the cylinder **62**, it is simultaneously drained from the other end of the cylinder **62**. This, of course, reciprocates the piston **67** which, in turn, drives the piston **68**. Water is supplied from the tank **12** alternately to opposite sides of the piston **68**, and when one side of the piston is on the intake stroke, the other side is on the pressure stroke, and the water is delivered under pressure to the hose **28**. Very high pressures may be developed in the chamber of the oil cylinder **62** to deliver water under very high pressures. These high pressures will be maintained, although there is a momentary lull or dwell in the water flow as the pistons reverse their stroke. As a result, the water is delivered to the hose at a high pressure, but at a flow rate which drops rapidly at the end of the stroke and then picks up very rapidly. This causes the hose **28** to jump, and effects the jack-hammer driving of the nozzle **29**.

I claim as my invention:

1. A tandem pump which comprises a central body, a cylinder of selected diameter mounted on and extending axially from each side of said body, a piston head in each cylinder in sealed relation therewith, a piston rod slidably mounted in said body having its ends secured to the pistons in said cylinders, inlet ports at both ends of one cylinder, separate outlet ports at both ends of said one cylinder, valves in said inlet and outlet ports admitting fluid to the cylinder on the suction stroke of the piston and discharging said fluid on the opposite side of the piston, combination inlet and outlet ports on the opposite ends of the other cylinder, means for selectively introducing fluid under pressure into one of said combination ports to reciprocate the piston in the cylinder between the ports, a control rod means controlled from the piston rod for controlling the flow of the pressured fluid to and from the combination ports whereby reciprocation of the piston by the pressurized fluid will reciprocate the piston in said one cylinder to alternately surge fluid through one and then the other of said outlet ports, mechanical means holding said control rod in a retracted fixed position during one stroke of the piston between the combination ports, and fluid pressure actuated means holding the control rod in an extended fixed position during the opposite stroke of said piston.

2. The pump of claim **1** wherein said means reversing flow through the combination inlet and outlet ports includes a solenoid actuated pilot valve tripped at the ends of the stroke of the piston rod and a high pressure oil valve actuated by the solenoid valve for controlling flow to and from said combination ports.

3. A tandem piston pump effective to surge water through a hose and self-propelling nozzle on the leading end of the hose to cause the hose and nozzle to jump at periodic intervals which comprises a central body, first and second cylinders of selected diameters

each secured to an opposite side of said central body and extending coaxially therefrom, end heads on the outer ends of said cylinders, a piston rod slidably mounted in the central body and extending into both cylinders, pistons slidably mounted in the cylinders secured on the ends of the piston rod, a water inlet port in said body communicating with the inner end of the first cylinder, a water inlet port in the end head of said first cylinder communicating with the outer end of said first cylinder, a water outlet port in said body communicating with the inner end of said first cylinder, a water outlet port in said end head of said first cylinder communicating with the outer end of said first cylinder, valves in each of said inlet ports opening on the suction stroke of the piston in said first cylinder, valves in said outlet ports opening on the pressure stroke of the piston in said first cylinder, a combination inlet and outlet port in said central body communicating with the inner end of said second cylinder, a combination inlet and outlet port in the end head on said second cylinder communicating with the outer end of said second cylinder, a pump delivering oil under pressure to and receiving oil from said combination ports, a control rod controlled by said piston rod reversing oil flow through said combination ports to opposite sides of the piston in said second cylinder for reciprocating the piston to drive the piston in said first cylinder for surging water alternately through said outlet ports, mechanical means holding said control rod in one fixed position during one stroke of the piston in the second cylinder, and oil pressure actuated means holding said control rod in a second fixed position during the opposite stroke of said piston in the second cylinder.

4. The pump of claim 3 wherein the means for reversing flow through the combination ports includes an oil actuated spool control valve selectively venting oil to said combination ports and a solenoid actuated pilot valve tripped by the piston rod controlling the oil actuated spool valve.

5. A pump having a pair of opposed cylinders, a piston rod projecting into both cylinders, piston heads on the ends of said rod, means for introducing fluid under pressure alternately into the opposite ends of one cylinder for reciprocating the piston therein to drive the piston rod for reciprocating the piston in the other cylinder, said means including an axial recess extending inwardly from the end of the piston rod in the cylinder receiving the fluid under pressure, a cap on said recess, a control rod in said recess having a first head engaged by the piston rod at one end of its stroke and by the cap at the other end of its stroke, an end head on the cylinder receiving the fluid under pressure, a reduced diameter portion on said control rod sliding through said end head in sealed relation therewith, a second head on the reduced diameter control rod portion beyond the end head of the cylinder, a supplemental cylinder receiving said second end head in slidable relation, a groove in said second head, spring-pressed detents in said supplemental cylinder engaging in said groove to hold the control rod in retracted position, a switch engaged by the control rod in the extended position thereof, and said control rod being reciprocated at the ends of the stroke of the piston rod to trip said switch whereby the detents will hold the control rod in stationary position between the ends of the piston rod stroke.

6. The pump of claim 5 wherein the seal for the control rod in the cylinder end head has a fluid trapping recess and the control rod has a shoulder bottoming against fluid trapped in said recess to cushion the outward driving of the rod through the end head.

7. In combination with a cylinder having an end head on one end thereof, a body at the opposite end thereof, a piston rod slidable through said body, and a piston on the piston rod in said cylinder, the improvement of a control device for regulating flow of oil under pressure into opposite ends of the cylinder for reciprocating the piston which comprises said piston rod having an axial recess communicating with the end head end of the cylinder, a control rod having one end freely movable in said recess and the other end slidable through said end head in sealed relation therewith, said control rod having opposed shoulders respectively outside of said end head and inside of said end head limiting sliding movement of the control rod through the end head, said control rod being pushed by fluid under pressure in the end head end of the cylinder to an extended position, means on the piston rod pulling the control rod to a retracted position, means on the end head holding the control rod in said retracted position whereby the rod is locked in fixed position except at the very ends of the stroke of the piston, and switch means tripped by the end of the control rod each time it is shifted by the piston rod.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,700,360 Dated October 24, 1972

Inventor(s) Roland E. Shaddock

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

Column 4, line 55. cancel "which" and insert --the--.

Column 5, line 16, cancel "grove" and insert --groove--;

line 28, cancel "150a" and insert --105a--.

Signed and sealed this 16th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334