DOUBLE-ACTING TANDEM PISTON PUMP

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Related U.S. Application Data

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Field of Search 417/390, 404; 91/275, 313, 91/384

References Cited
UNITED STATES PATENTS
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Primary Examiner—Robert M. Walker
Attorney—Carlton Hill et al.

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
DOUBLE-ACTING TANDEM PISTON PUMP
RELATED APPLICATION

This application is a division of my application enti
ted "Catch Basin and Sewer Pipe Cleaner," U.S. Ser.

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 pres-
surized 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 tan-
dem piston pump of this invention has a central body
portion with cylinders of the same or different diame-
ters extending from both sides thereof. A piston rod ex-
tends 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 slideable in a recess in the piston rod and ex-
tending through the head of the oil cylinder to trip a
switch controlling a valve which controls oil to and
from the opposite sides 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 posi-
tion 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 ap-
proaches the ends of its stroke.

It is then an object of this invention to provide a tan-
dem pump having a driving piston actuated hydrauli-
cally 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 dou-
ble-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 com-
mon 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 dou-
ble-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 ap-
parent 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 lon-
gitudinal 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 con-
vieniently mounted on the catch basin and sewer pipe
cleaning vehicle disclosed in my aforesaid parent appli-
cation, 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 illus-
trated 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 differ-
ent 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 ex-
tends through the central body 61 into both the cylin-
ders 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
gooves in the piston 67 and sealingly engage the
cylinder wall 62. Similar piston rings 70 are carried in
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3 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 end 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 90a 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 90a 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 105a 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 105a 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 90a, 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 90a 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 groove 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 90a 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 150a, 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 90a, 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 sliding 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 slidably 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.

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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. C. MARSHALL DANN
Attesting Officer Commissioner of Patents