Jan. 9, 1962 H. HORLACHER 3,016,016

RECIPROCATING PUMP

Filed July 2, 1959

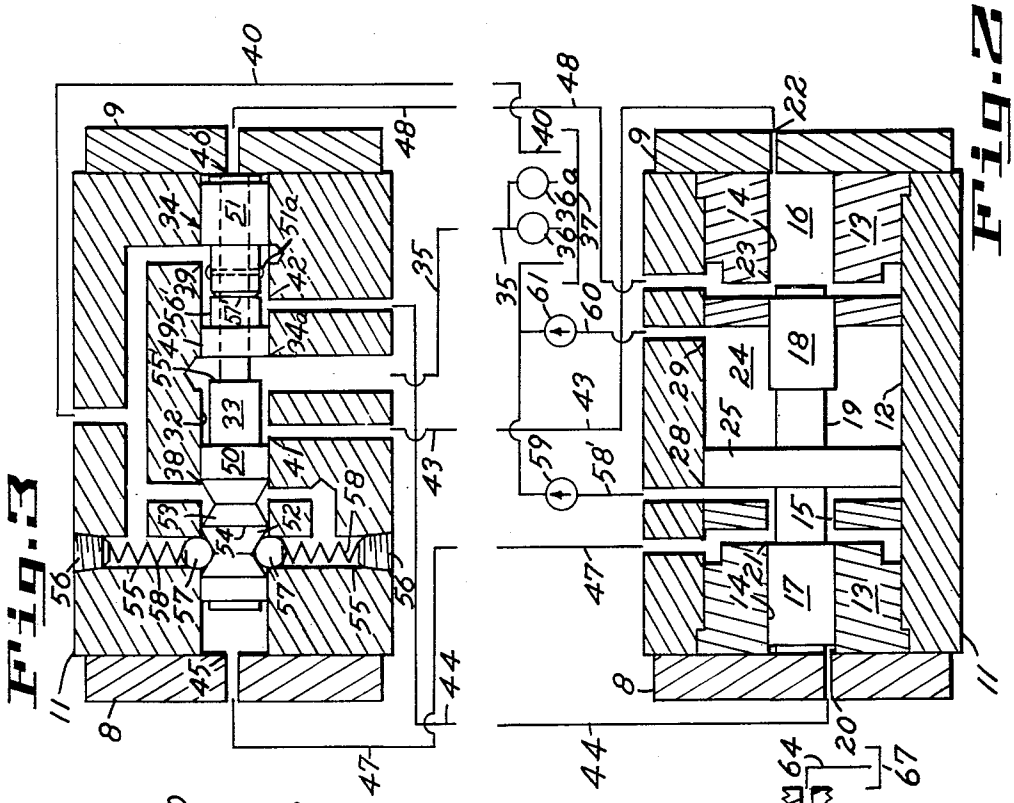


Fig. 2

Fig. 3

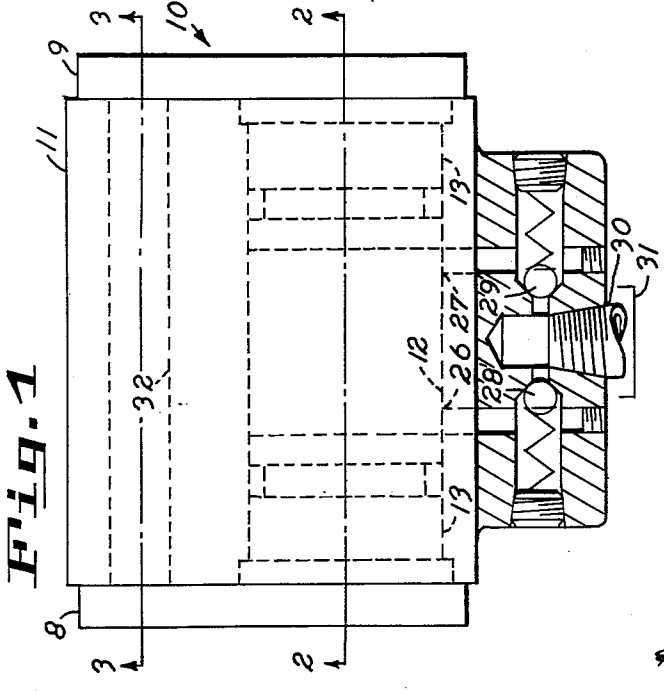


Fig. 1

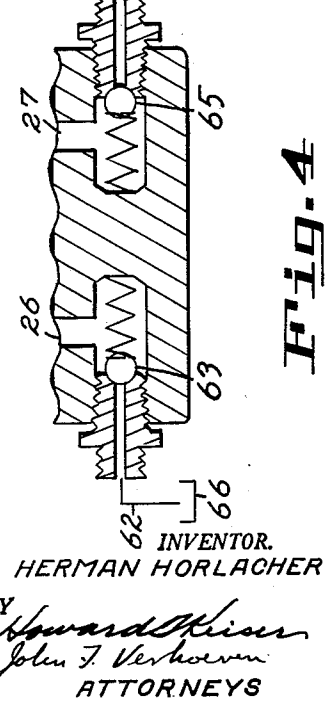


Fig. 4

INVENTOR.
HERMAN HORLACHER

BY Howard A. Kliesen
& John T. Verhoeven
ATTORNEYS

United States Patent Office 3,016,016
Patented Jan. 9, 1962

3,016,016

RECIPROCATING PUMP

Herman Horlacher, Cincinnati, Ohio, assignor to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio

Filed July 2, 1959, Ser. No. 824,593
3 Claims. (Cl. 103—48)

The present invention relates to self-reciprocating pumps such as scavenge pumps.

In the present invention a self-reciprocating piston type pump is provided which is particularly suited for use as a scavenge pump in a hydraulically operated machine tool. In a typical hydraulic system for a machine tool fluid from a sump is delivered under pressure by a pump to a pressure line connected to the hydraulically operated mechanisms of the machine, and is returned to the sump. However, some of the circulating fluid inevitably leaks out of this system, which fluid can generally be collected in reservoirs provided in the machine tool. The pump of the present invention can be connected to the pressure line of the machine hydraulic system and will operate continuously, with minimum tendency to stall, to return escaped fluid from a reservoir to the sump.

It is therefore a general object of the present invention to provide an improved reciprocating pump operable continuous from a source of pressure with minimum tendency to stall.

It is another object of the present invention to provide a piston scavenge pump operable to pump fluid on each stroke.

It is yet another object of the present invention to provide a piston type scavenge pump operable from a pressure source having positive acting means to reverse the valve alternately supplying pressure to the driving pistons.

It is yet another object of the present invention to provide a scavenge pump which can be utilized to pump fluid continuously from one reservoir, or alternately from two reservoirs.

It is still another object to provide a simple, effective, scavenge pump operable to pump a large quantity of fluid in relation to the fluid utilized; and which is self-starting and will operate continuously without stalling.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

In the drawings:

FIG. 1 is an elevational view, partly in cross-section, of the scavange pump of the present invention;

FIG. 2 is a view taken on line 2—2 of FIG. 1;

FIG. 3 is a view taken on line 3—3 of FIG. 1; and

FIG. 4 shows a modification to the pump to permit drawing fluid from two reservoirs.

The scavenge pump **10** has a body **11** having a bore **12** extending therethrough. In each end of the bore **12** there is snugly received a cylindrical core **13** having a central bore **14**. The bores **14** are closed at their outer ends by the end plates **8** and **9** connected to the sides of the body **11**. The bores **14** define spaced motor chambers **15** and **16** and slidably receive pistons **17** and **18**, respectively, therein. The pistons **17** and **18** are connected in spaced relation to a common piston rod **19**.

The motor chamber **15** has at its left (as viewed in FIG. 2), or outer, end an inlet port **20** and spaced from its right, or inner, end an inlet port **21**. The other motor chamber **16** also has an inlet port **22** at its outer end and

an outlet port **23** spaced from its inner end. It will be noted that the ports of motor chamber **16** are in opposed relation to the ports of chamber **15** wth the inlet port **22** at the right end of the chamber instead of the left end, and the outlet port **23** spaced from the left end thereof instead of the right end. The piston rod **19** and the pistons **17** and **18** thereon reciprocate between an extreme left hand position (as shown in FIG. 2) where the outlet port **23** of chamber **16** is uncovered by piston **18** and therefore is connected to inlet port **22** through chamber **16**, and an extreme right hand position where outlet port **21** of chamber **15** is uncovered by piston **17** and thereby connected to inlet port **20**.

The bore **12** and the inner ends of cores **13** define a vacuum, or pump, chamber **24** between the motor chambers. Piston **25**, connected to piston rod **19** and reciprocated thereby, is slidably received in the vacuum chamber. The vacuum chamber **24** has an inlet port, **26** and **27**, at each end (see FIG. 1), and has an outlet port, **28** and **29**, at each end. As shown in FIG. 1, both inlet ports **26** and **27** are connected through check valves **28'** and **29'**, respectively, to an inlet pipe **30** which leads to a reservoir for scavenge fluid represented schematically at **31**.

Another bore **32** extends through the body **11**, the ends of which are also closed by end plates **8** and **9**, which slidably receives therein the valve plunger **33** to define a valve **34**. The valve **34** has a pressure port **34***a* connected to pressure line **35**. Motor driven pump **36** takes hydraulic fluid from the sump **37** of the hydraulic system of the machine and delivers it to pressure line **35** at a pressure established by relief valve **36***a* connected to line **35** and discharging into sump **37**. The valve **34** has a pair of discharge ports **38** and **39**, one on each side of pressure port **34***a*, which are connected to a return line **40** by which fluid is returned to the sump **37**. The valve **34** has a pair of motor ports **41** and **42**, each between the pressure port and one of the discharge ports, connected, respectively, through lines **43** and **44** to inlet ports **22** and **20** of the motor chambers. The valve **34** also has a pair of terminal ports **45** and **46** in communication with the respective ends of valve plunger **33** and connected, respectively, through lines **47** and **48** to the outlet ports **21** and **23** of the motor chambers.

The valve plunger **33** reciprocates in response to pressure supplied alternately at terminal ports **45** and **46**. The plunger has a spool **49** which moves from one side of the pressure port **34** to the other as the plunger moves from one extreme position to the other. The plunger **33** also has a pair of end spools **50** and **51** which alternately open and close discharge ports **38** and **39** as the plunger reciprocates. The spool **50** is integral with plunger **33**, and the spool **51** has an integral sleeve pinned to plunger **33** at **51***a*. When the plunger **33** is in the right hand position, shown in FIG. 3, the pressure port **34***a* is connected through the valve to motor port **41** and is blocked, or disconnected, from motor port **42**, which at that time is connected to discharge port **39**. Conversely, when the valve plunger **33** is in the extreme left hand position the pressure port is connected to motor port **42** and disconnected from motor port **41**, which is then connected to discharge port **38**. As the spool **49** passes over and blocks the pressure port **34***a* a dead center position is reached where the pressure is blocked from the motor ports. Therefore, pressure is blocked from the terminal port at which pressure was previously supplied to move the valve. Unless the valve plunger is kept moving past this dead center position by some other force the reciprocating pistons in the motor chambers **15** and **16** will stall, and the valve plunger will remain at the dead center position. Rather than rely on the momentum of the

valve plunger to carry it past this position it is preferable to provide a positive acting actuator to prevent stalling.

To this end the valve plunger 33 has a pair of oppositely beveled surfaces 52 and 53 which are joined at an apex 54. Bores 55 in communication with bore 32 have plugs 56 at their outer end and balls 57 at their inner ends, the balls defining actuators urged into engagement with the valve plunger 33 by springs 58. When the balls engage surface 52 the plunger is urged to the right; when the balls engage surface 53 the plunger is urged to the left. It will be noted that the bores 55 are connected to the discharge line 40 to prevent trapped fluid which leaks past the balls from blocking the yielding movement of the balls.

If the spool 49 were fixed on the plunger 33 and spaced from apex 54 an amount equal to the distance between the center of the actuators 57 and the center of pressure port 34*a*, the balls 57 would be engaged with the apex 54 as the spool 49 reaches the dead center position and the actutators might not be effective to carry the spool past dead center. In order to assure that the balls are engaged with the beveled surface behind the apex (relative to the direction of movement) as the spool 49 passes the pressure port, regardless of the direction of movement of the plunger, the spool 49 is loosely received on the plunger and shiftable thereon between a position where the spool 49 abuts against fixed shoulder 55′ and a position where the sleeve 56′ integral with spool 49, abuts against fixed shoulder 57′.

It will be noted that when the valve plunger is in its right hand position (as shown in FIG. 3) the left side of the shiftable spool 49 is exposed to pressure and the right side thereof is exposed to exhaust so the spool sleeve 56′ is held against shoulder 57′. Shortly after the spool 49 passes over pressure port 34*a* during movement of the valve plunger 33 to the left, discharge port 38 opens and discharge port 39 is closed so that the right side of spool 49 is exposed to pressure and the left side thereof is exposed to exhaust. This fires the spool 49 to the left on valve plunger 33 against the fixed shoulder 55′ thereof. When the valve plunger 33 is moved to the right, the spool 49 is initially in its left hand position on plunger 33 but, after passing the pressure port, is fired to its right hand position where sleeve 56 engages shoulder 57′

The extreme positions of the spool 49 on the valve plunger 33 are spaced from the apex 54 a lesser and greater amount, respectively, than the distance between the pressure port and the actuators. Therefore, when the plunger begins movement to the left, the spool 49, which is in its right hand position on the plunger at that time, is spaced further from the apex than the distance between the pressure port and the actuators so that the apex passes the actuators before the spool 49 passes the pressure port. Thus, when the spool reaches the dead center position the actutators are engaged with the beveled surface 53 and the plunger is kept moving past the dead center position by the actuators. The actuators, aided by the hydraulic firing of the spool 49 against the fixed shoulder 55′ on the valve plunger, keep the valve plunger moving to its extreme left hand position. When the plunger begins return movement to the right, the spool 49 at that time is in its left hand position on the plunger and is spaced from the apex 54 an amount less than the distance between the actuators and the pressure port so that the apex passes the actuators before the spool passes the pressure port. Thus, when the spool reaches dead center the actuators are engaged with the beveled surface 52 and the plunger is kept moving to its extreme right hand position. The actuators are aided by the firing of the spool 49 and sleeve 56′ against the fixed shoulder 57′ on the valve plunger after the spool passes the dead center position. It will be noted that as the plunger moves initially from its extreme positions the balls are urged outwardly, and thereby loaded, by their contact with the beveled surface in front of the apex 54 (relative to the direction of movement).

In operation, with the valve 34 in the position shown, pressure is supplied through the valve to motor port 41, line 43, and inlet port 22 of motor chamber 16 to shift the piston rod 19 to the left. Fluid in motor chamber 15 is discharged through inlet port 20, line 44, motor port 42 of valve 34, discharge port 39, and line 40 to sump 37. In chamber 24 scavenge fluid previously drawn into the left side of the chamber is discharged through outlet port 28. Port 28 has a line 58′, containing check valve 59, connected thereto which leads to sump 37. At the same time, fluid is drawn into the right side of chamber 24 from the reservoir 31 through pipe 30, check valve 29′, and inlet port 27. As piston rod 19 approaches its extreme left hand position outlet port 23 of motor chamber 16 is uncovered and ports 23 and 22 are thereby connected to supply pressure through line 48 to terminal port 46 of valve 34. This shifts valve plunger 33 to the left, spool 49 shifting to its left hand position on the plunger 33 after it passes the pressure port 34*a*. Fluid from the left hand side of valve bore 32 is discharged through terminal port 45, line 47, port 21 of motor chamber 15, chamber 24 and port 28 thereof, into line 58′ and thence to sump 37.

When valve 34 shifts to the left, motor port 41 is disconnected from pressure port 34*a* and motor port 42 is connected to port 34*a*. Thus, pressure is supplied to inlet port 20 through line 44, and piston rod 19 is shifted to the right. Fluid from chamber 16 is discharged through port 22, line 43, port 41 of valve 34, discharge port 38, and line 40 to sump 37. At the same time fluid in the right hand end of chamber 24, which was drawn in on the previous stroke, is discharged through port 29. Line 60, having check valve 61, is connected to port 29 and leads to sump 37. Simultaneously, scavenge fluid is drawn in to the left hand side of chamber 24 from reservoir 31 through pipe 30, check valve 28′, and inlet port 26. At the end of the stroke the port 21 of motor chamber 15 is uncovered by piston 17, connecting that port to inlet port 20, and pressure is supplied through line 47 to terminal port 45, shifting the valve plunger 33, once again, to the right hand position. Fluid from the right end of bore 32 is discharged through line 48, port 23, chamber 24, port 29, line 60 and check valve 61 thereof, to sump 37. It will be noted, that with the construction of the present invention the chamber 24 can be of substantially greater diameter than chambers 15 and 16 and fluid can be pumped from reservoir 31 to sump 37 on each stroke so that substantially more fluid can be returned to the system than is utilized. In the embodiment above described fluid is continuously pumped from a single reservoir 31.

With the embodiment shown in FIG. 4, fluid can be pumped from two separate reservoirs, fluid being drawn from each on alternate strokes. To accomplish this the vacuum chamber inlet port 26 is connected to line 62 through check valve 63 while the inlet port 27 is connected to line 64 through check valve 65. Line 62 leads from reservoir 66 in which scavenge fluid has been trapped, while line 64 leads from the separate reservoir 67 also containing scavenge fluid.

Although the connecting lines between the valve 34 and the motor chambers have been shown schematically these lines may be drilled passages in the body 11 and the end plates 8 and 9.

What is claimed is:

1. A scavenge pump comprising: means defining a pair of motor chambers each having an inlet port at one end and an outlet port spaced from the opposite end and each having a motor piston movable a predetermined distance in one direction in response to pressure at the inlet port to uncover the outlet port and connect said inlet and outlet ports, said motor pistons operatively connected to reciprocate in unison in response to pres-

sure alternately supplied to said inlet ports; means defining a vacuum chamber having an inlet port and an outlet port, said vacuum chamber having a piston operatively connected to the motor pistons and reciprocated thereby to draw scavenge fluid in the vacuum chamber inlet port and to discharge fluid through the vacuum chamber outlet port; and a valve having a pressure port, a pair of motor ports in communication with the inlet ports of the motor chambers, respectively, and a pair of terminal ports in communication with the outlet ports of the motor chambers, respectively, said valve having a valve plunger slidably received therein having ends in communication with the terminal ports, said valve plunger having a pair of oppositely beveled surfaces thereon joined at an apex and having a spool shiftable thereon, the valve plunger shiftable in one direction in response to pressure at one terminal port from the outlet port of one motor chamber to connect the motor port in communication with the inlet of other motor chamber to the pressure port as the spool passes the pressure port and shiftable in the other direction in response to pressure at the other terminal port from the outlet port of said other motor chamber to connect the motor port in communication with the inlet port of said one motor chamber to the pressure port as the spool passes the pressure port, the spool shifting on the plunger in the direction of plunger movement when the spool passes the pressure port, said valve having a spring urged actuator adapted to engage the beveled surfaces of the valve plunger to assist movement of the valve plunger after the apex thereon has passed the actuator.

2. A scavenge pump comprising in combination: a valve having a pressure port and having a motor port and discharge port on each side of the pressure port, said valve having a pair of terminal ports and having a spring urged actuator therein; a valve plunger having a pair of oppositely beveled surfaces joined at an apex slidably received in the valve for reciprocation in response to a pressure differential at the valve terminal ports, said beveled surfaces adapted to engage the actuator for continued movement of the valve plunger by the actuator after the apex has passed the actuator, said valve plunger having a shiftable spool thereon and having spaced fixed shoulders defining two extreme positions of the shiftable spool on the valve plunger, the spool in one extreme position opening the pressure port to the motor port on one side of the pressure port when the apex is at the actuator and in the other extreme position opening the pressure port to the motor port on the other side of the pressure port when the apex is at the actuator, the spool shifted on each stroke of the valve plunger from one extreme position to the other by pressure at the pressure port as the spool passes the pressure port for positioning thereof in the extreme position to pass the pressure port on the next stroke after the apex has passed the actuator, said valve plunger connecting one motor port to the pressure port and the other motor port to a discharge port when the valve plunger is at one end of a stroke and connecting said other motor port to the pressure port and said one motor port to the other discharge port when the valve plunger is at the opposite end of a stroke; a pump body having a central pump chamber and two motor chambers one on each side of the pump chamber and in communication therewith, the pump chamber having an inlet port and an outlet port at each end, the motor chambers each having an outer end port connected, respectively, to the motor ports in the valve, the motor chambers each having an inner port spaced from the inner end of the motor chamber and connected, respectively to the valve terminal ports; a piston rod received in the body for reciprocation therein and having a piston slidably received in the pump chamber to draw in fluid alternately through the inlet ports at the ends of the pump chamber and simultaneously to discharge fluid alternately through the outlet ports as the piston rod is reciprocated, the piston rod having a piston slidably received in each motor chamber for reciprocation between predetermined extreme inner and outer positions in response to the pressure alternately supplied to the respective outer end ports of the motor chambers through the valve motor ports, the piston in each motor chamber uncovering the inner motor chamber port at both extreme positions, the inner ports communicating through the motor chambers respectively with the outer end ports thereof when the respective pistons are alternately in their inner positions to apply pressure alternately to the ends of the valve plunger, said inner ports communicating with an outlet port of the central pump chamber when the pistons are alternately in their extreme outer positions.

3. In a pump of the type having a pump piston with a reciprocating motor connected thereto, and having a valve with a pressure port connectable to a continuous source of fluid under pressure, said valve having a valve plunger operable on reciprocation to alternately supply pressure from the pressure port to the respective sides of the pump motor for reciprocation thereof, said valve plunger reciprocated in response to reciprocation of the pump motor, mechanism to minimize stalling of the valve plunger as pressure from the pressure port is diverted from one side of the motor to the other comprising in combination; a pair of oppositely beveled surfaces on the valve plunger joining at an apex, an actuator in the valve and a spring to urge the actuator toward the valve plunger, the actuator adapted to engage the beveled surfaces of the valve plunger for compression of the spring as the apex approaches the actuator and expansion of the spring after the apex passes the actuator to assist movement of the valve plunger in the direction of travel after the apex has passed the actuator, a spool slidably received on the valve plunger for shifting thereon, a pair of spaced stops straddling the shiftable spool to define two extreme limits of movement of the spool on the plunger, one of said stops located on the plunger to define one extreme position of movement of the spool on the plunger on one side of the pressure port when the apex is at the actuator and the other of said stops located on the plunger to define the other extreme position of movement of the spool on the plunger on the other side of the pressure port when the apex is at the actuator whereby the spool is shifted by pressure at the pressure port in the direction of valve plunger movement on each stroke as the spool passes the pressure port and is therefore positioned to pass the pressure port after the apex has passed the actuator on the next reverse stroke.

References Cited in the file of this patent

UNITED STATES PATENTS

2,826,149	Wrigley	Mar. 11, 1958
2,864,342	Ziegelmeyer	Dec. 16, 1958

FOREIGN PATENTS

12,990	Great Britain	of 1892
30,273	France	Mar. 31, 1926

(2nd addition to No. 567,394)

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,016,016 January 9, 1962

Herman Horlacher

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 71, for "inlet" read -- outlet --.

Signed and sealed this 8th day of May 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents