Feb. 22, 1966 G. J. PASKER 3,236,189

VARIABLE DELIVERY PISTON PUMP

Filed Nov. 9, 1962 2 Sheets-Sheet 1

Fig. 1

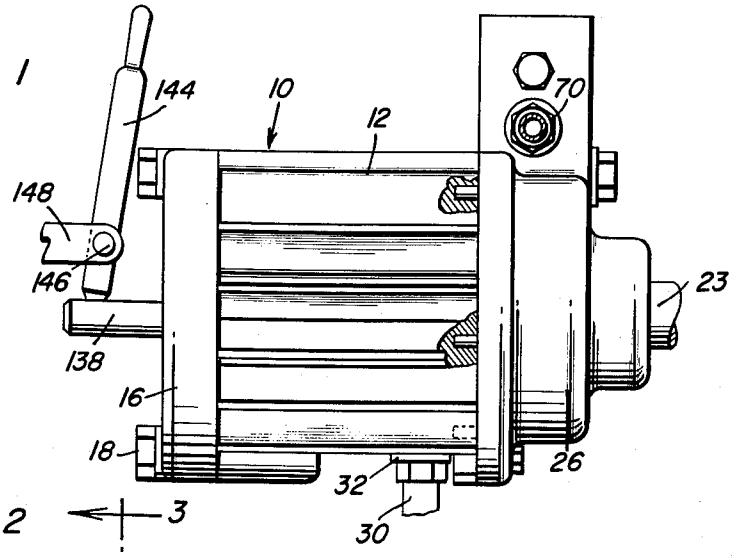


Fig. 2

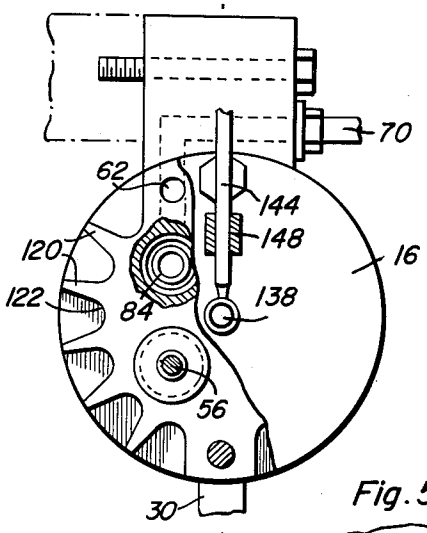


Fig. 4

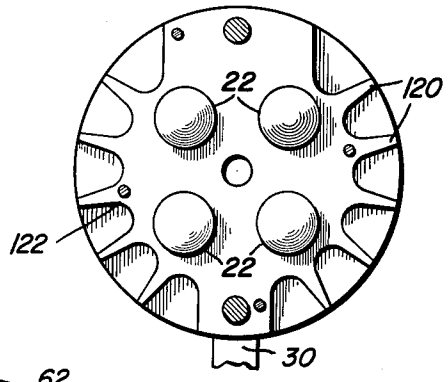
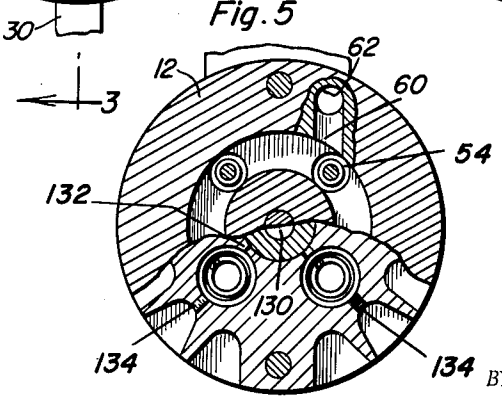


Fig. 5



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VARIABLE DELIVERY PISTON PUMP

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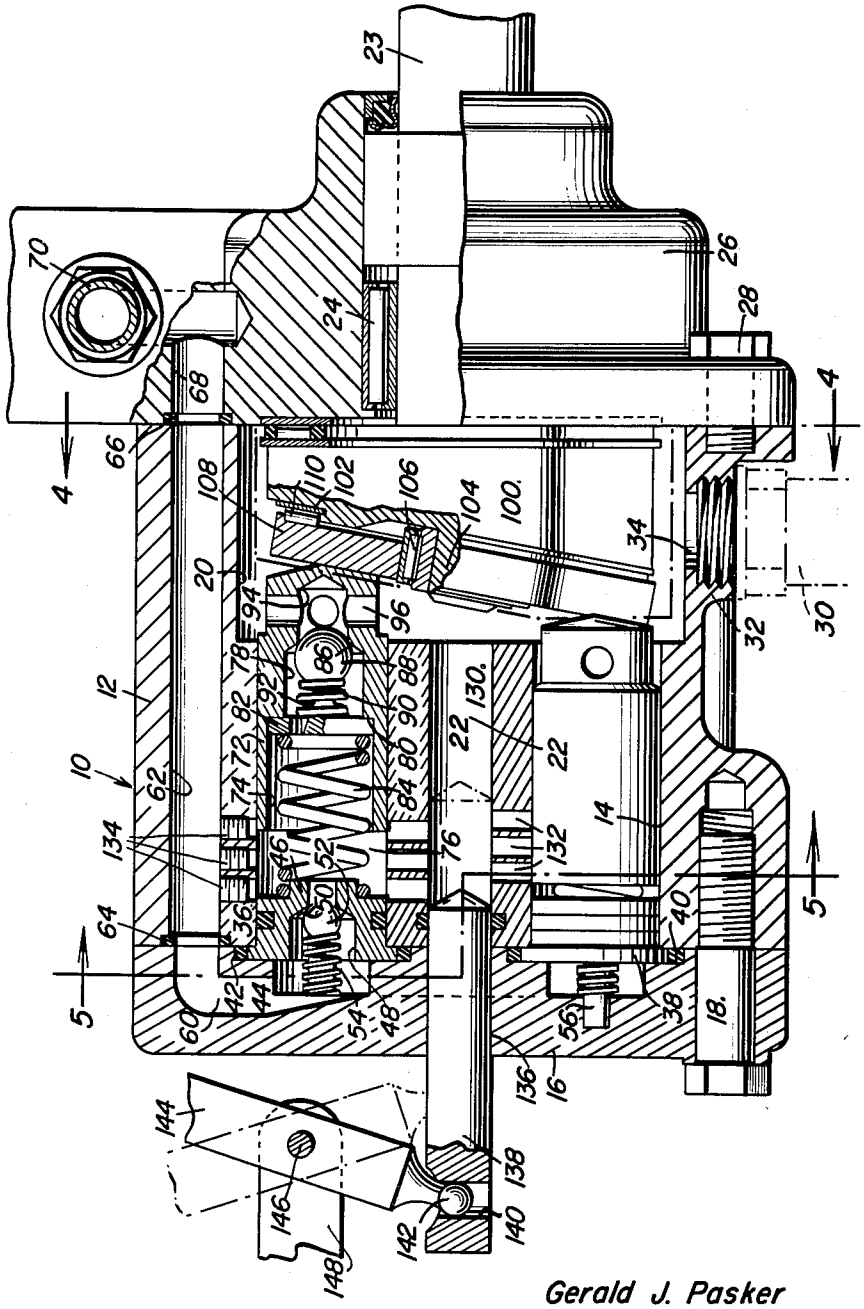


Fig. 3

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VARIABLE DELIVERY PISTON PUMP

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3 Claims. (Cl. 103—173)

This invention comprises a variable delivery piston pump and more particularly pertains to a pump of the reciprocating piston constant stroke type having improved means for feeding fluid into and discharging fluid under compression from the pumping chambers together with means for controllably varying the effective capacity of the pump while maintaining its constant stroke.

A further object of the invention is to provide a device in accordance with the preceding objects wherein a single adjustable means is provided for effectively controlling the effective delivery or capacity of all of the pump cylinders of the device.

Still another object of the invention is to provide a pump having an improved mechnism for effecting reciprocation of the pump pistons with a constant stroke in a compact arrangement together with improved means for providing within the pump casing a reservoir for the fluid to be admitted to the pump and bypass means for effecting rejection of a predetermined and adjustable portion of the inducted pump charge to return a portion of the charge of the pump cylinders to the fluid supply chamber.

A still further object of the invention is to provide a pump construction which may have a constant volmetric capacity and wherein a fuel supply chamber houses the connecting means for imparting reciprocation to the pump pistons and also supplies fluid through the pump positions into the working chambers of the pump.

These together with other objects and advantages which will become subsequently apparent inside the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is an elevational view, parts being broken away and shown in section of a preferred embodiment of a variable delivery reciprocating piston pump in accordance with this invention;

FIGURE 2 is a view in end elevation taken from the left side of FIGURE 1 with parts being broken away and shown in vertical transverse section and certain concealed parts being shown in dotted line therein;

FIGURE 3 is a vertical central longitudinal sectional view taken upon an enlarged scale substantially upon the plane indicated by the section line 3—3 of FIGURE 2 and showing the internal construction of the pump, with parts broken away and shown in section and with certain concealed parts and alternative positions of parts being shown in dotted lines;

FIGURE 4 is a vertical transverse sectional view taken upon a reduced scale substantially upon the plane indicated by the section line 4—4 of FIGURE 3 and showing in particular a view of the pump housing taken from the right end thereof and with the end cover plate removed therefrom; and

FIGURE 5 is a view taken upon a reduced scale substantially upon the plane indicated by the broken section line 5—5 of FIGURE 3 and showing in vertical transverse section certain further details of the internal construction of the pump.

It should be understood that in its preferred form the principles of this invention are embodied in a reciprocating piston pump having a constant stroke but a variable delivery and in which the variable delivery is effected by

rejecting a predetermined adjustable portion of the chanrge compressed in each pump cylinder and returing this rejection charge to the fluid supply chamber of the pump. Other features of the invention, however, are applicable to pumps of the same general construction but wherein the variable delivery and charge rejecting feature is omitted therefrom.

In the accompanying drawings, the numeral **10** designates generally a multiple cylinder pump in accordance with this invention. This pump includes a generally cylindrical pump body or housing **12** having therein a plurality of pump cylinders or chambers **14** disposed in a parallel side-by-side relation and spaced equidistantly from and about a central axis of the body. The cylinders open at one end of the body which open end is closed by an end plate **16** comprising an end wall of the body and which is removably secured thereto as by fastening bolts **18**. The other end of the body is provided with an enlarged chamber or compartment **20** in which is housed the conecting mechanism by which the individual pump pistons **22**, each reciprocable in one of the cylinders **14**, are operatively connected to a drive shaft **23** which is journaled as by bearings **24** in a removable end wall or closure **26** secured as by bolts **28** to the corresponding end of the pump housing **12**.

It is to be understood that power from any suitable source is applied to the drive shaft **23** and through the connecting means to be herein after set forth, impacts reciprocation to the pump pistons **22**.

The compartment **20** not only serves as a chamber to house the connecting means by which the pump pistons are secured to the drive shaft **23**, but also serves as a fluid supply chamber. Any suitable fluids to be pumped whether a gas or liquid is delivered to the fluid supply chamber as by a supply conduit **30** connected to the tubular boss **32** and which communicates with an inlet port **34** into this chamber.

The open ends of the cylinders **14** are provided with cylinder heads in the form of cylindrical members **36** which have flanges **38** received in recesses **40** in the end plate **16** by which latter member the flanges and thus the cylinder heads are clamped against the end of the associated pump cylinder. Suitable O-ring or other packing means as at **42** may be utilized to establish a fluid tight seal between the cylinder head flanges and the recesses **40** and the end plate **16** as shown in FIGURE 3.

Each cylinder head is likewise provided with a sealing ring such as an O-rig **44** diposed in a peripheral chnnel or groove upon the exterior thereof and engaged against the inside wall of the associated cylinder.

With continuing reference to FIGURE 3 it will be observed that each cylinder head has a tubular axial inwardly extending projection **46** and there is a diametrically enlarged bore or recess as at **48** upon the reverse side of the cylinder head. There is thus provided by this bore a valve seat **50** which is controlled by a non-return outwardly opening check valve **52** which is spring-urged as at **54** to its closed position. The spring **54** in turn may be seated upon an inwardly projecting centering pin **56** carried by the end plate **16**.

Each of the bores **48** in the cylinder heads communicates with an annular delivery chamber **60** formed on the inner face of the plate **16**, and which chamber communicates with an aligned passage **62** formed in the housing. The opposite ends of the passage **62** are sealed as by O-rings **64** and **66** to corresponding ports in the end plates **16** and **26**, the latter end plate having a discharge passage **68** which communicates with a delivery conduit **70** carrying the compressed fluid to any suitable destination.

Each of the pistons **22** comprises a hollow shell having a cylindrical skirt **72** slidably received in the corresponding cylinder **14**. This skirt defines a bore or chamber **74** opening from its inward extremity into a compression chamber or working chamber **76** in the cylinder. The bore **74** communicates with a diametrically reduced bore **78** by means of an annular shoulder **80** upon which is received a spider or other bridging means **82** against which abuts one end of a compression spring **84** whose other extremity is seated upon and surrounds the tubular projection **46** of the cylinder head as previously mentioned. The spring thus yieldingly urges the piston away from the cylinder head.

At the inward extremity of the diametrically reduced bore **78** there is provided a valve seat **86** with which a ball check valve **88** cooperates, the valve being urged as by a spring **90** to its valve closing position. This spring is seated upon an axially projecting extension **92** of the spider or spring-retaining member **82**.

The reduced bore **78** terminates at its inner end in a further diametrically reduced bore **94** which is closed, this bore having a plurality of laterally extending ports **96** establishing communication with the interior of the fluid inlet storage chamber **20**. The chamber **20** is thus at all times in communication with the interior of the bore **94** so that fluid may pass by the check valves **88** into the skirt of the piston and thus into the working or compression chamber **76**, and after compression therein, may be discharged past the delivery check valve **52** and into the delivery conduit **62**.

In order to effect reciprocation of the pistons in their cylinders, a connecting means is provided which operatively connects the inner faces of the pistons with the drive shaft **23**. For this purpose, the drive shaft is provided with a wobbler or swash plate **100** having an annular face **102** which is inclined to the axis of rotation of this plate and of the drive shaft **23**. The plate is further provided with a correspondingly inclined inwardly projecting stub shaft **104** upon which is rotatably mounted by a bearing assembly **106** a wobbler or swash plate **108** which bears against the inclined cam surface **102** as by a bearing assembly **110**. The plate **108** in turn abuts against the corresponding extremities of the pistons, which latter are held against the plate by the action of the springs **84**.

The arrangement is such that in accordance with a conventional wobbler or swash plate mechanism, rotation of the shaft **23** through the inclination of the plate **108** will produce a reciprocation of the pistons in their cylinders and thus generate the pumping or working stroke of the pistons.

As will be seen by reference particularly to FIGURES 2–4, the exterior surface of the housing **12** may be provided with a plurality of circumferentially spaced and axially extending fins **120** defining grooves or channels **122** therebetween. These fins facilitate the cooling of the pump by dissipating any heat generated by the compression therein.

As so far described the pump is effective for providing a constant stroke and constant delivery of fluid. This fluid is supplied into the chamber **20** which serves as a reservoir to provide a constant supply of fluid for the pumping chambers and also serves to cool and if the fluid is of a liquid nature may serve to lubricate the connecting mechanism by which the pump pistons are connected to the drive shaft **23**. There is thus provided a uni-flow action or passage of the fluid from the chamber **20**, through the pistons, through the pumping chambers and through the outlet ports to the delivery chamber **60** and from thence to the conduit **62** and to the final discharge conduit **70**. This produces a very compact device which can be readily serviced by merely removing the corresponding end plates whereby access can be had to the fluid inlet compartment and the connecting mechanism at one end of the device or to the cylinder heads and the discharge valves at the other end thereof. In some instances this construction may be found to be satisfactory and the device may be so employed.

In general, however, it is preferred to provide a means for effecting a controlled variable delivery of the pump cylinders while maintaining their constant stroke. For this purpose, the particular construction shown in the drawings is employed.

This feature of the invention utilizes a fluid rejection mechanism whereby any desired portion of the charge compressed by the pump cylinders may be returned directly to the fluid supply compartment **20** thereby reducing correspondingly the fluid which is discharged from the pump into the delivery line thereof.

For this purpose, there is provided an axial passage or bore **130** disposed centrally of the housing **12** and communicating with the compartment **20**. This bore is provided with a plurality of longitudinally spaced radially extending rejection ports **132**, one set of each such ports communicating with each of the working cylinders of the pump. As will be noted from FIGURE 3, the rejection ports of one cylinder are staggered with respect to those of the other cylinders although in other instances they may be aligned therewith if desired. Blind bores aligned with these ports may be drilled in the wall of the housing and closed by plugs **134** to prevent the passage of the drills which make the ports **132**.

Slidably received in the fluid rejection bore **130** and also extending through a corresponding aligned bore **136** in the end plate **16** is a control valve **138** in the form of a plunger. The control valve is provided with a recess **140** in which is received the extremity **142** of a control lever **144** journaled as at **146** upon any suitable support such as that indicated at **148**. The arrangement is such that by manipulating the lever or handle **144**, the plunger may be adjustably positioned axially of the bore **130** so that it will selectively control one or more of the sets of ports **132** therein.

Obviously, when the piston uncovers all of the ports, the entire volume delivered by the reciprocating pump pistons will be discharged through the series of rejection ports and into the rejection bore **130** and thus bypassed back to the fluid storage compartment or chamber **20**. Consequently, there will be no fluid delivered past the delivery valves **52** into the delivery passage **60**, **62** of the pump. On the other hand, when the plunger is moved all of the way inward so that it covers and closes all of the ports **132**, none of the charge compressed in the pump or working chambers will be bypassed or rejected and sent back to the compartment **20**. Consequently, the entire stroke of the pump is effective to compress and deliver fluid. The plunger may however be adjusted to a number of intermediate positions covering one or more of the ports **132**. Under this condition, varying proportions of the charge will be rejected inasmuch as the charge continues to be rejected until such time as the outermost port which remains uncovered by the control valve **138** is covered by the skirt of the piston. Thereafter, the remainder of the stroke of the piston is effective to compress a fluid charge and deliver it past the valve **52**.

It will thus be observed that in this embodiment a single centrally located control valve is effective to simultaneously control and regulate a variable delivery of the pistons of the pump.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A variable delivery reciprocating pump comprising a hollow elongated housing open at opposite ends and

having a compartment therein opening at one end, a plurality of open-ended pump cylinders in said housing disposed in circumferentially spaced side-by-side relation about the central axis of said housing, said compartment comprising a crankcase into which one end of each cylinder communicates, the other end of each cylinder opening at the other end of said housing, closure plates for said housing opposite ends comprising a cylinder head cover and a crankcase cover, a drive shaft journaled entirely in said crankcase cover and extending into said compartment, pistons each reciprocable in one of said cylinders and operatively connected to said drive shaft in said compartment, a cylinder head disposed in and closing said other end of each cylinder and forming therewith a pump chamber, means supplying a fluid into said pump chambers, fluid outlet means receiving fluid under pressure from said pump chambers, fluid rejecting means communicating with each pump chamber and receiving fluid therefrom whereby to control the proportion of the delivery of fluid from said pump chambers to said fluid outlet means, and means associated with said fluid rejection means and regulating the delivery of fluid from said pump chambers to said fluid rejection means and thereby adjustably controlling the delivery of said pump chambers, said fluid supplying means and said fluid rejecting means each communicating with said crankcase, a supply passage extending through each piston and connecting the crankcase with the associated pump chamber.

2. The combination of claim **1** wherein said fluid rejecting means includes a passage in said housing disposed between said cylinders and having one end continuously opening into said fluid supply means and having series of longitudinally spaced ports, each series of ports communicating with one of said pump chambers, a control valve movably mounted in said passage and selectively controlling the ports of said series.

3. A variable delivery reciprocating pump comprising a hollow elongated housing open at opposite ends and having a compartment therein opening at one end, a plurality of open-ended pump cylinders in said housing disposed in circumferentially spaced side-by-side relation about the central axis of said housing, said compartment comprising a crankcase into which one end of each cylinder communicates, the other end of each cylinder opening at the other end of said housing, closure plates for said housing opposite ends comprising a cylinder head cover and a crankcase cover, a drive shaft journaled entirely in said crankcase cover and extending into said compartment, pistons each reciprocable in one of said cylinders and operatively connected to said drive shaft in said compartment, a cylinder head disposed in and closing said other end of each cylinder and forming therewith a pump chamber, means supplying afluid into said pump chambers, fluid means receiving fluid under pressure from said pump chambers, fluid rejecting means communicating with each pump chamber and receiving fluid therefrom whereby to control the proportion of the delivery of fluid from said pump chambers to said fluid outlet means, and means associated with said fluid rejection means and regulating the delivery of fluid from said pump chambers to said fluid rejection means and thereby adjustably controlling the delivery of said pump chambers, said fluid rejecting means comprising a bore in said housing disposed between said pump chambers, a series of longitudinally spaced ports connecting each pump chamber with said bore and positioned to be successively overrun and blocked by the associated pump piston, a control valve movably mounted in said bore and adjustably movable to positions selectively blocking flow through said ports into said bore.

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