

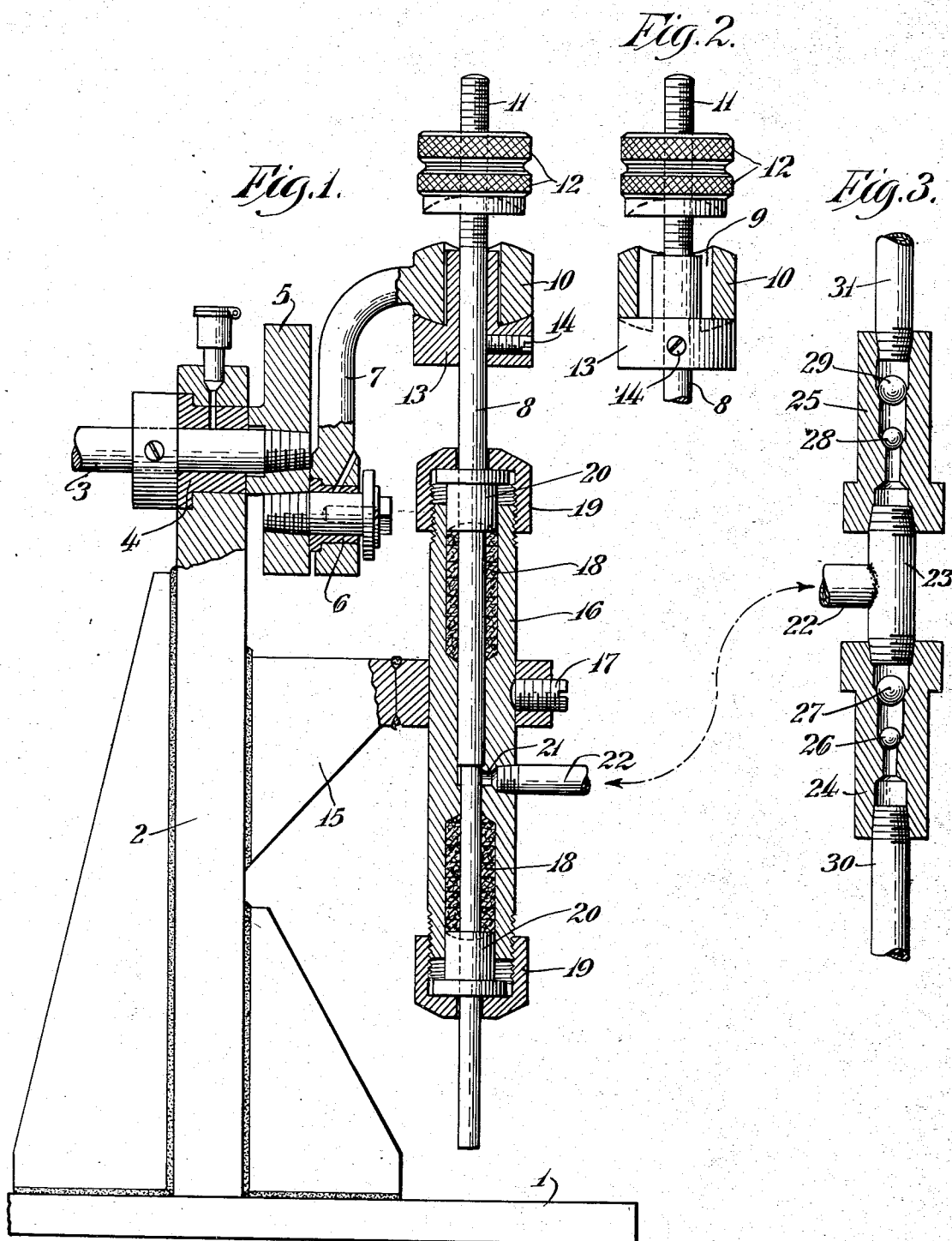
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PUMP

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The invention relates to an improved form of pump, which will be found particularly useful in small scale pilot plant and laboratory work, designed to handle small quantities of liquid at any desired pressure and at a substantially constant discharge rate which is adjustable over a relatively wide range.

In pumping small quantities of liquid, such as is often required in laboratory work and small scale pilot plant operation, a piston or plunger type pump has certain well recognized advantages over pumps of the centrifugal, gear or diaphragm types, particularly when operated against high superatmospheric pressure or when handling hot or corrosive liquids. Since the discharge capacity of piston or plunger type pumps is governed by the piston or plunger area, length of stroke, displacement efficiency and number of strokes per unit time, the minimum discharge capacity is limited by these factors in the following way: The number of strokes per minute should be fairly high, particularly with a single cylinder pump, to maintain a fairly constant flow from the pump discharge. Fewer than 30 strokes per minute is ordinarily unsatisfactory. The displacement efficiency should be high to insure positive action, but with a short stroke the discharge volume will vary considerably due to the elasticity or play of the parts and, with an adjustable stroke, minor variations in the adjustment and any small amount of play in the adjusting mechanism. The size of the piston or plunger is particularly important. With a reciprocating shaft of less than about $\frac{1}{4}$ inch in diameter, the problem of packing to maintain a tight joint is extremely difficult.

The improved form of plunger pump provided by the invention overcomes the difficulties normally encountered in the design of pumps of this class for low capacity and high pressure operation. We employ a plunger which passes through the pumping cylinder and is packed at opposite ends thereof. One portion of the plunger within the pumping cylinder is of smaller diameter than the remaining portion. The smallest end of the plunger which passes through the packing gland at one end of the cylinder is of sufficiently large diameter to permit packing without leakage and the effective area of the plunger, in computing the discharge capacity, is, of course, the difference between the area of the large portion of the plunger and the area of the small portion of the plunger. This difference may be as small or as large as desired to give any desired discharge capacity with a sufficiently long

stroke and sufficiently rapid stroke to give good accuracy and fairly constant flow through the discharge valve.

The accompanying diagrammatic drawing illustrates one specific form of pump embodying the features of the invention.

Figure 1 is a side elevation of the pump shown partially in longitudinal section.

Figure 2 is an elevational view of a portion of the stroke adjusting mechanism of the pump, this view being taken at right angles to the view shown in Figure 1.

Figure 3 is an enlarged detail, shown partially in section, illustrating the valve mechanism of the surge block type which may be employed in conjunction with the pumping cylinder shown in Figure 1.

Referring to the drawing, the specific form of pump here illustrated has a bed-plate designated by the reference numeral 1 upon which a pedestal 2 is mounted, the pedestal journaling a rotary drive-shaft 3 in a suitable bearing 4. The drive-shaft may conveniently be operated by a suitable constant speed motivating mechanism, such as, for example, a synchronous motor, not shown, operating through a suitable speed reducing mechanism, not illustrated. Preferably, the motor and speed reducer are also mounted by any well known means, not illustrated, on bed-plate 1.

A suitable crank which, in the particular case here illustrated, comprises a disc shaped member 5 provided with crank-pin 6 is attached to the drive-shaft 3, the center to center distance between crank-pin 6 and drive-shaft 3 corresponding to one-half the desired maximum stroke of the pump plunger.

A suitable connecting rod or pitman 7 is mounted on crank-pin 6 and operatively connects the crank with the reciprocating pump plunger 8. As illustrated in Figure 2, a slotted opening 9 is provided through the upper end member 10 of pitman 7 to accommodate the tilting action imparted to the latter by the crank.

The upper end of plunger 8 is threaded, as indicated at 11, and two knurled thumb nuts 12 are provided on the threaded portion of the plunger. Beneath the threaded portion of the plunger the shaft is enlarged for a short distance or alternately provided with a member 13 which, in the particular case here illustrated, is fixed to the plunger by set screw 14.

To vary the stroke of the plunger 8, thumb nuts 12, one of which serves as a lock nut, are turned to vary the distance between the same and member 13, thereby varying the play of the

upper end of pitman 7 between lock nuts 12 and member 8 and varying the effective throw of the crank since no upward motion of the plunger will occur until member 10 strikes the low thumb nut 12 and no downward motion of the plunger will occur until member 10 on its return stroke strikes member 13. Thus, by turning thumb nuts 12 the stroke of plunger 8 and the displacement of the pump may be adjusted to suit requirement even while the pump is in operation.

A bracket 15 is provided on pedestal 2 which supports the pumping cylinder 16, the latter being secured, in the case here illustrated, to bracket 15 at the desired position by set screw 17.

The plunger 8 passes through the pumping cylinder 16 and is packed adjacent the opposite ends of the latter, as indicated at 18, suitable packing-nuts 19 and followers 20 being provided to compress packing 18.

As illustrated in Figure 1, the lower portion of plunger 8 is of reduced diameter and the bore of the pumping cylinder between the packing glands corresponds approximately or may, when desired, be somewhat greater in diameter than the large portion of the plunger. Thus, the effective area of the plunger for computing the displacement of the pump is the difference between the areas of the large and small diameter portions of the pump.

An inlet and discharge port 21 is provided in the pumping cylinder adjacent the lower end of the large diameter bore, this port communicating with a surge line 22 through which liquid from the valve blocks is intermittently drawn into and discharged from the pumping cylinder as plunger 8 reciprocates.

It will, of course, be understood that any type of valve mechanism capable of functioning properly at small pumping capacities may be employed within the scope of the invention. In the case here illustrated, a valve arrangement of the surge type is employed, the details of the valve mechanism being illustrated in Figure 3. A surge type valve mechanism is particularly advantageous as applied to pumping hot or corrosive liquids, but no novelty is claimed per se for the specific form of valve mechanism illustrated.

Referring to Figure 3, an inlet valve block 24 and an outlet valve block 25 are provided, the two communicating through member 23 which, in turn, communicates through surge line 22 and port 21 with the pumping cylinder. Ball-checks 26 and 27 are provided in valve block 24 and similar ball-checks 28 and 29 are provided in valve block 25. A suction conduit 30 communicates with the lower end of valve block 24 and a discharge conduit 31 communicates with the upper end of valve block 25.

Upon the upward stroke of plunger 8, liquid from the surge line 22 is drawn into the pumping cylinder and, in turn, draws the liquid to be pumped from conduit 30 past the ball-checks 26 and 27 into member 23, ball-checks 28 and 29 in valve block 25 being closed by suction from the pumping cylinder which draws in against their seats. On the downward stroke of plunger 8, liquid is forced into surge line 22 from the pumping cylinder through port 21 and forces the liquid being pumped from member 23 past ball-checks 28 and 29 to discharge conduit 31, ball-checks 26 and 27 in valve block 24 being closed by pressure from the pumping cylinder which forces them against their seats.

It will be apparent from the above that a

pump embodying the features of the dual size pump provided by the invention may be designed for an extremely small minimum capacity since the effective area of the plunger which, when multiplied by the length of the plunger stroke and the displacement efficiency, determines the displacement, is the difference between the cross-sectional areas of the large and small diameter portions of the plunger. Thus, the minimum displacement obtainable is not limited by the minimum satisfactory plunger diameter and the difficulty of tightly packing plungers of excessively small diameter is obviated. For example, assuming a plunger stroke of 1 inch, a maximum plunger diameter of $\frac{5}{16}$ of an inch and a minimum plunger diameter of $\frac{1}{4}$ inch, the theoretical displacement is 0.0277 cubic inch, which corresponds to the theoretical displacement which would be obtained with a conventional plunger of only $\frac{3}{16}$ of an inch diameter. With the same length of stroke, a maximum plunger diameter of $\frac{5}{16}$ of an inch and a minimum plunger diameter of $\frac{3}{32}$ of an inch, the theoretical displacement is approximately 0.015 cubic inch which corresponds to the theoretical displacement which would be obtained with a conventional plunger only slightly more than $\frac{1}{4}$ of an inch in diameter.

Since at the small capacities for which pumps of the type provided by the invention may be employed to particular advantage, it is difficult, if not possible, to accurately vary the discharge capacity by means of a by-pass or a throttling valve, we have, in the preferred embodiment of the invention, provided means for varying the stroke of the plunger in order that the capacity may be thus regulated to suit requirements. The relatively simple form of stroke adjusting mechanism illustrated in the drawing is only one of many specific forms which may be employed within the scope of the invention in conjunction with its other features, but we preferably employ a stroke adjusting mechanism which can conveniently be manipulated while the pump is in operation.

We claim as our invention:

1. In a pump, a pump cylinder having an opening therein, a plunger adapted to operate within said cylinder, a surge valve operatively associated with said opening, means for driving the plunger including a pitman, said pitman having an arm provided with a slotted aperture and means for varying the stroke of said plunger comprising upper and lower adjustable members mounted at one end of said plunger, said lower adjustable member being provided with a projection adapted to slidably engage said slotted aperture.

2. In a pump, a pump cylinder having an opening therein, a plunger adapted to operate within said pump cylinder, one portion of said plunger being smaller in cross sectional area than another portion thereof, guide means at opposite ends of said cylinder adapted to receive said respective portions of said plunger, means for driving said plunger including a pitman, said pitman having an arm provided with a slotted aperture and means for varying the stroke of said plunger comprising upper and lower adjustable members mounted at one end of said plunger, said lower adjustable member being provided with a projection adapted to slidably engage said slotted aperture.

3. In a pump, a pump cylinder having an opening therein, a plunger adapted to operate within

said pump cylinder, and means for driving said plunger including a pitman, said pitman being provided with a slotted projection adapted to engage said plunger, the upper and lower sides of said projection being substantially convex in shape, and means for varying the stroke of said plunger comprising upper and lower adjustable

members mounted on said plunger, the inner sides of said members being substantially concave, the convex sides of said projection being adapted to engage the concave inner sides of said adjustable members.

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