

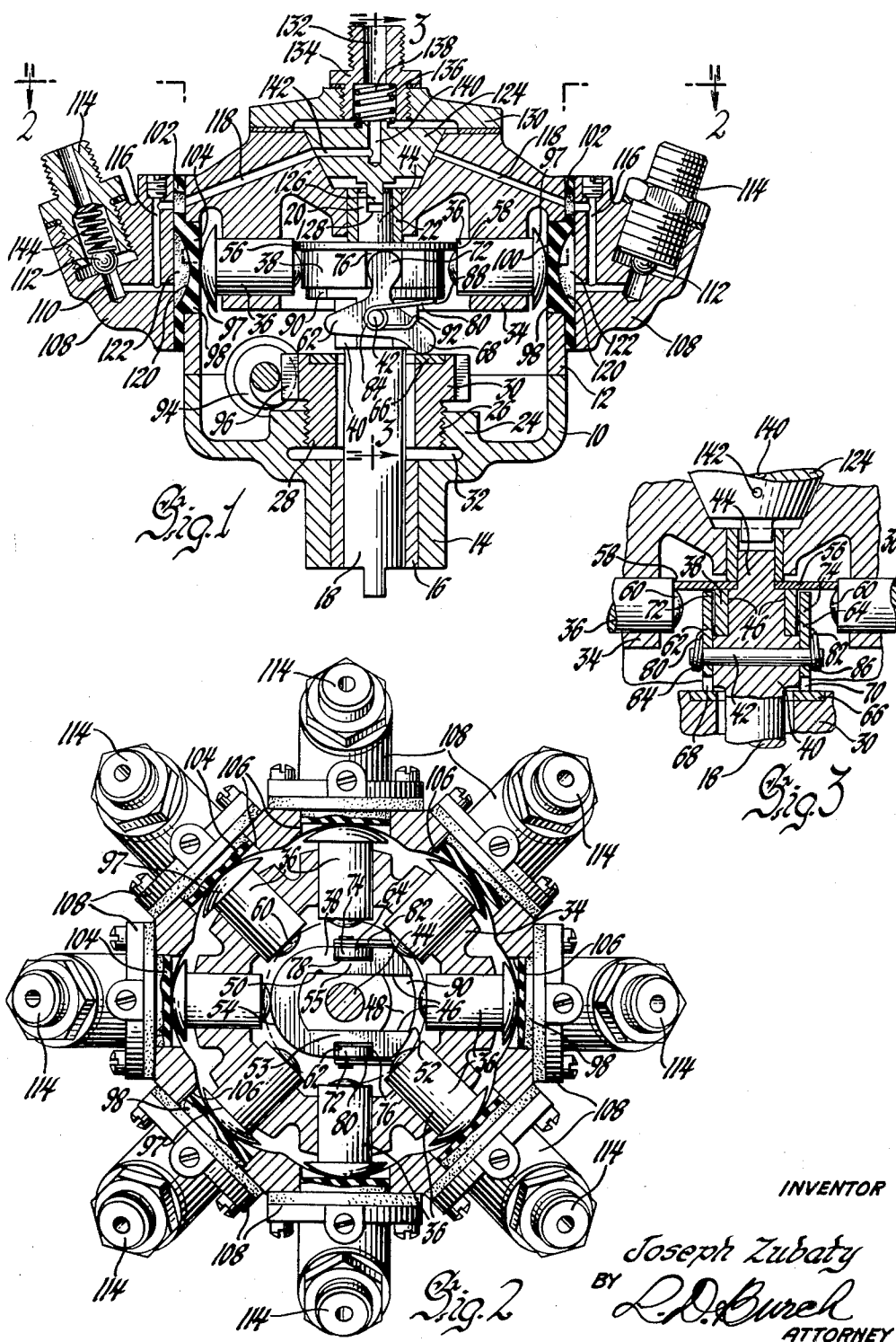
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FLUID PUMP

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FLUID PUMP

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The invention relates to a fluid pump and more particularly to a pump in which the delivered fluid volume may be accurately varied over a wide range. Pump delivered volume variations are preferably obtained by adjusting the stroke of diaphragm actuating plungers. The pump plungers may be actuated by a cam mechanism which may be accurately adjusted to vary the plunger strokes. In order to provide additional volume control accuracy, each plunger is provided with an individual diaphragm which forms one wall of a pump chamber. Each diaphragm is flexed a predetermined amount depending upon the plunger stroke. The side of the diaphragm forming the pump chamber is preferably concave and the head of the pump plunger which contacts and flexes the diaphragm is preferably rounded to provide small rate of volume change when a short stroke is used and a proportionally greater rate of volume change as the stroke is increased. Such a construction is especially useful in fuel pumps where it is desirable to obtain a proportionally larger pump output for a slight increase in the stroke of the pump plunger, thereby attaining full power of the engine under load. The curved shape of the plunger head also permits minimum diaphragm stress.

The stroke of the plungers may be adjustable by a worm and pinion mechanism in combination with a spring and stroke adjusting lever. The lever is preferably connected to move a plunger actuating cam from a zero lift position to a position corresponding to the desired plunger stroke.

In the drawing:

FIGURE 1 is a cross section view of a pump embodying the invention;

FIGURE 2 is a view taken in the direction of arrows 2—2 of FIGURE 1, with parts broken away and in section; and

FIGURE 3 is a view of the pump stroke adjusting mechanism and is taken in the directions of arrows 3—3 of FIGURE 1.

The pump may be provided with a lower body 10 and an upper body 12 which are joined to form a pump housing. Lower body 10 may have an external boss 14 with a bearing 16 retained therein. Pump drive shaft 18 may be mounted for rotation in bearing 16 and extend there-through into the housing formed by the upper and lower bodies. The upper end 20 of drive shaft 18 may be journaled within bearing 22 which is supported in the pump upper body 12. Pump lower body 10 is also preferably provided with an inner boss 24 which is axially aligned with boss 14 and is internally threaded at 26 to receive the threaded hub 28 of a stroke adjusting pinion 30. An annular recess 32 may be provided between bosses 14 and 24 to permit pinion hub 28 to be threaded into boss 24 beyond the inner edge thereof.

Pump upper body 12 may be provided with an annular depending plunger support ring 34 which is concentrically located with respect to pump drive shaft 18. Ring 34 has a plurality of radially extending plunger cylinders in which pump plungers 36 may be received and reciprocated.

The length of the reciprocating strokes of plungers 36 is determined by the radially offset position of plunger actuating cam 38. Cam 38 is nonrotatably secured to drive shaft 18 and is permitted to be diametrically displaced to vary the plunger stroke and obtain the desired plunger stroke. Drive shaft 18 has an enlarged section 40

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through which a diametrically extending cam positioning lever pin 42 extends. The upper portion 44 of enlarged section 40 is provided with oppositely disposed flat surfaces 46 which are positioned in planes parallel to and spaced from the axis of the drive shaft. Flat surfaces 46 terminate at their lower sides at radially disposed cam support surface 48. Cam 38 is provided with a center slot 50 which opens at cam end 52 to give cam 38 a generally U-shaped appearance. The closed cam end 54 is preferably exteriorly formed as a semi-circle or other curved shape to provide a cam surface for actuating plungers 36. Cam 38 is received about drive shaft portion 44 and the inner surfaces of the cam legs 53 and 55 which define slot 50 are in sliding engagement with the flat surfaces 46 of the drive shaft. Cam slot 50 extends a sufficient distance toward cam closed end 54 to permit the cam to be positioned to provide zero lift of the plungers 36. A stroke limiting plate 56 is secured around shaft 18 between the cam 38 and bearing 22. Plate 56 is circular and is engageable with the inner ends 58 of plungers 36. No reciprocating motion is obtained when plunger ends 58 engage plate 56 and the plungers are not permitted to reciprocate radially inward beyond that plate. Each of plungers 36 may be provided with a rounded end 60 which is aligned radially with cam 38 and is contacted by that cam when drive shaft 18 is rotated and the cam is not in a zero lift position. As drive shaft 18 rotates, the curved cam end 54 successively engages each of the plungers 36 at a point on round ends 60 and causes radially outward reciprocating movement of each plunger.

Cam 38 is preferably adjusted by means of a spring and lever linkage system including crank arm levers 62 and 64 which are oppositely disposed about drive shaft enlarged section 40 and pivotally mounted on either end of pin 42. Cam adjusting pinion 30 may be provided with a thrust ring 66 on its upper end which is engageable with crank arm lever following ends or arms 68 and 70. The cam positioning ends or arms 72 and 74 of levers 62 and 64 may be rounded and received within cam slots 76 and 78 formed on the outer side of each cam leg 53 and 55. Crank arm levers 62 and 64 are biased into engagement with thrust ring 66 and cam 38 by torsion springs 80 and 82. Springs 80 and 82 are provided with center loops 84 and 86 which respectively encircle the ends of pin 42. The upper ends 88 of the springs are in engagement with the lower surface of enlarged drive shaft section 90 on which cam 32 is supported along surface 48. The lower ends 92 of the springs are hooked about lever following ends 68 and 70 to bias those ends away from enlarged drive shaft section 90. The crank arm levers are therefore biased to rotate in a clockwise direction as viewed in FIGURE 1 thereby keeping follower ends 68 and 70 in constant engagement with thrust ring 66 and biasing cam 38 toward a zero lift position.

In order to adjust the position of levers 62 and 64, pinion 30 is moved axially relative to drive shaft 18. This movement may be accurately controlled by turning worm gear 94, which is in driving engagement with the teeth 96 of pinion 30. When worm gear 94 is rotated, pinion 30 is also rotated and the pinion hub 28 is screwed inwardly or outwardly relative to boss 24, thereby moving the pinion 30 and thrust ring 66 axially. The axial movement of pinion 30 and thrust ring 66 pivots crank arm lever follower ends 68 and 70 arcuately about pin 42. Lever cam positioning ends 72 and 74 are also moved arcuately about pin 42 and have a component of motion parallel to cam 38. This component of motion causes cam 38 to move radially inward or outward to adjust the stroke of plungers 36. When pinion 30 is moved upward, the plunger stroke is increased and when it is moved downward the plunger stroke is decreased until it reaches zero.

The outer ends 97 of plungers 36 are preferably rounded and formed as mushroom heads. Each of the plungers is in axial alignment with a pump diaphragm 98 and is engaged with the flat surface 100 of these diaphragms over an area which is substantially centered about the axis of each plunger 36. Each diaphragm 98 is preferably formed with a diaphragm mounting rib 102 which also acts as a gasket. A cylindrical boss 104 extends inwardly from diaphragm rib 102 and terminates at the diaphragm surface 100. The pump upper body 12 is provided with a plurality of diaphragm receiving openings 106 through which diaphragm bosses 104 extend. The diaphragms are held tightly in place by caps 108 which contain discharge passages 110 and ball check valves 112. Outlet lines, not shown, are attached to each of the caps 108 through bushings 114. Caps 108 also include intake passages 116 which are aligned with passages 118 formed in the end of pump upper body 12. Diaphragms 98 are provided with concave center sections 120 which are axially positioned within bosses 104 and cooperate with caps 108 to form pumping chambers 122. The pumping chambers 122 are thus each provided with a spherical wall which has a curvature opposite to the curvature of the rounded ends 97 of plungers 38. Due to the rounded form of the plunger ends 97 and the concave shape of the pumping cylinders 122, the plunger stroke required for a given volume of fluid pumped is larger at a lower volume output than at higher volume delivery conditions. The stroke-volume ratio is therefore a non-linear variation which is a useful result in fuel pumps where it is desirable to obtain a proportionally larger pump output for a slight increase in the stroke of the pump plunger.

Distribution passages 118 are connected with discharge passages 110 adjacent pumping chambers 122. Passages 118 are intermittently provided with fluid under intake pressure conditions by rotary distributor valve 124. Valve 124 may be frusto-conical in cross section and is preferably provided with a drive tang 126 which is received within a slot 128 formed in the upper end of drive shaft 18. An upper body pump cap 130 may be secured over valve 124 and have an inlet passage 132 formed therein. If desired, an adapter 134 may be provided in order that various inlet connections may be made. Adapter 134 may be recessed at 136 to receive distributor valve spring 138. Spring 138 is held in compression between valve 124 and adapter 134 to bias the valve against its conical seat in the pump upper body 12. Inlet passage 132 connects with valve passage 140 which extends axially into valve 124. Valve distributing passage 142 extends radially outward from passage 140, and, when valve 124 is properly seated, may be successively aligned with each of the distributing passages 118.

The stroke and consequent delivery volume of the pump may be adjusted either prior to operation of the pump or during pump operation. Worm gear 94 may be provided with an extension shaft, not shown, passing through the side of the pump housing for this purpose.

When drive shaft 18 is rotated, distributor valve 124 is also rotated to successively permit inlet fluid flow through the passages 132, 140, 118, and 116 to pressure chamber 122. The pressure chambers and the passages connected thereto are thus filled with fluid. Distributor valve 124 is so timed relative to the angular position of cam 38 that passage 142 is no longer aligned with passage 118 when the plunger 36 actuating the pressure chamber to which that particular distributing passage connects is outwardly reciprocated. When plunger 36 is moved radially outward under action of cam 38, its rounded head 96 flexes diaphragm 98. Plunger head 97 contacts diaphragm surface 100 over an increasing area as the stroke is increased. Pressure chamber 122 is correspondingly

decreased in volume and the pressure built up in that chamber and passages 110, 116, and 118 is sufficient to open ball check valve 112 and permit flow of fluid under pressure to the pump outlet line connected to bushing 114.

The same operation is carried out in each of the pumping units as the cam distributor valve 124 and cam 38 are rotated by drive shaft 18. Ball check valve 112 may be biased to a closed position by a spring 144 which will determine the minimum pressure which may be delivered through the pump outlet lines. The volume pumped by the various plungers and diaphragms is thus accurately controlled by controlling the stroke of the plungers 36. The volume of fluid pumped may be varied from zero to a maximum determined by the maximum stroke of cam 38 by providing a simple and reliable external adjustment. This adjustment may be made as part of a control system to obtain a desired volume at all times or may be manually controlled.

What is claimed is:

1. In a fluid pump having a housing and drive shaft, means for varying the volume of fluid pumped comprising a reciprocable plunger having a curved head at one end, a diaphragm of substantially rectangular cross section mounted in said housing and including a section having a continuously concave surface defining one wall of a pumping chamber and a flat surface engaging said plunger curved head, said plunger curved head having substantially the same projected area as said diaphragm concave surface, and stroke varying means drivably engageable with said plunger and driven by said drive shaft for reciprocating said plunger whereby said plunger is caused to flex said diaphragm, the stroke varying means thereby cooperating with said diaphragm and said plunger head during the pump operation to provide a non-linear stroke-volume ratio.

2. In a pump, a non-linear volume delivery control comprising a pump housing, a diaphragm of substantially rectangular cross section received within said housing, a cap for said diaphragm, said cap and said diaphragm cooperating to define a pumping chamber, said diaphragm having a spherically and continuously concave wall defining one side of said pumping chamber and a substantially flat wall opposite said concave wall, a diaphragm flexing plunger having a spherically convex end of substantially the same area as said diaphragm and engageable with said flat wall opposite said concave wall and driven means engageable with said plunger for adjustably reciprocating said plunger and thereby varying the plunger end-to-diaphragm engageable area to non-linearly control pump volume delivery in relation to plunger reciprocating stroke.

References Cited in the file of this patent

UNITED STATES PATENTS

285,477	Garsed	Sept. 25, 1883
2,078,835	Brisson	Apr. 27, 1937
2,267,280	Kuhnel	Dec. 23, 1941
2,311,939	Goode et al.	Feb. 23, 1943
2,393,175	Laskey	Jan. 15, 1946
2,491,230	Theis	Dec. 13, 1949
2,569,900	Nevin et al.	Oct. 2, 1951
2,632,339	Lane	Mar. 24, 1953
2,690,295	Rand	Sept. 28, 1954
2,710,629	Price	June 14, 1955
2,730,131	Asp et al.	Jan. 10, 1956
2,871,846	Zimmerman	Feb. 3, 1959
2,890,656	Kohtaki	June 16, 1959
2,928,426	Taylor	Mar. 15, 1960

FOREIGN PATENTS

659,791	France	Feb. 11, 1929
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