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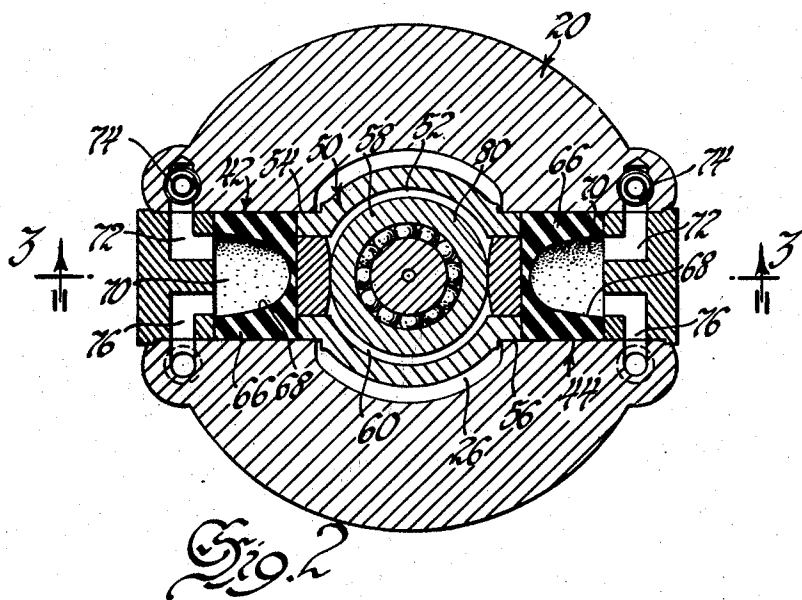
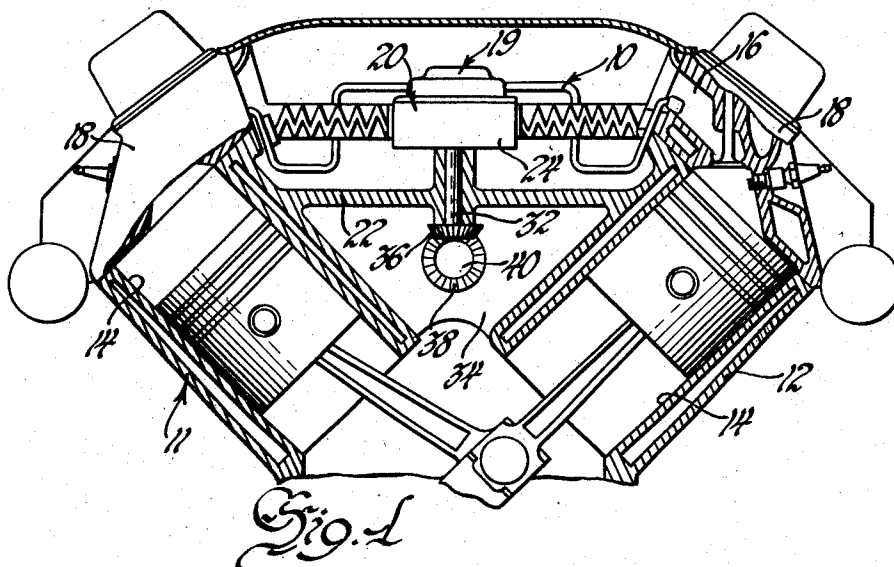
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PUMP

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2 Sheets-Sheet 1



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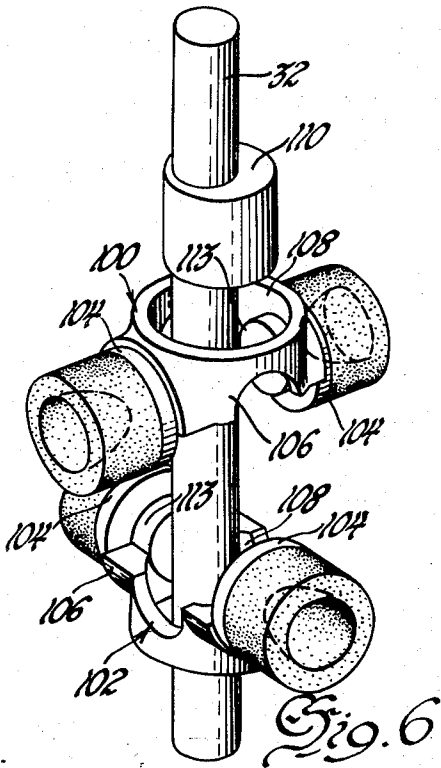
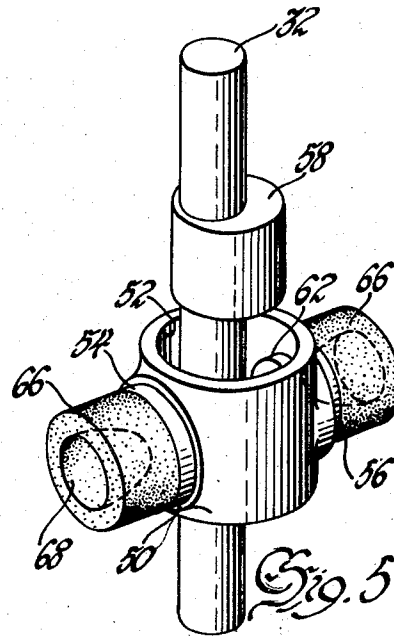
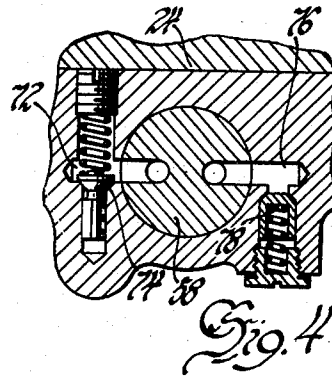
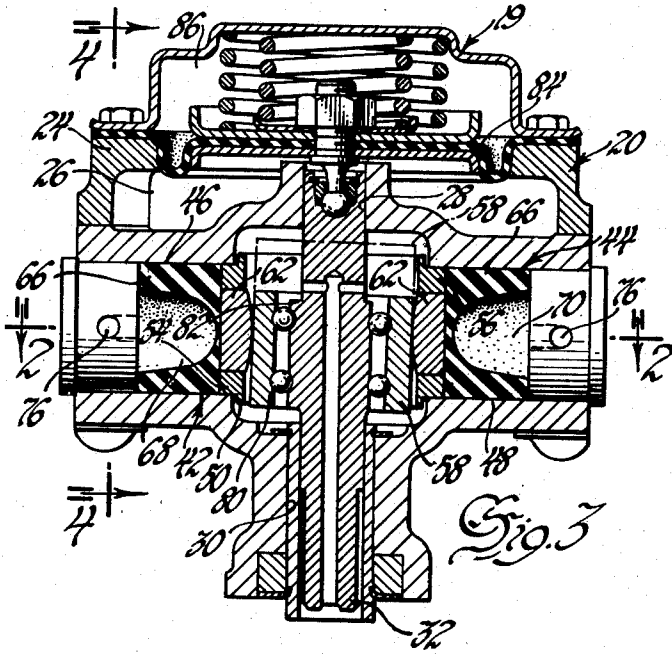
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2 Sheets-Sheet 2



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2 Claims. (Cl. 123—140)

The present invention relates to pumps and more particularly to variable rate, positive displacement pumps.

Under certain conditions it is desirable to employ a positive displacement pump which is very compact but which is economical to manufacture and reliable in operation. As an example, in a fuel injection system for a spark ignited, internal combustion engine, in some types of injection systems, it is desirable to employ a piston type pump to enable a precision metering of the fuel discharged from the pump. However, heretofore, pumps of this nature have been bulky and expensive to manufacture and in addition, they have been difficult to maintain in operation. When a plunger or piston is reciprocally driven within a cylinder by means of a rotating crankshaft, etc., it is difficult to maintain the piston or plunger in axial alignment with the cylinder. This problem is especially acute where an effort is made to decrease the size of the pump by placing the cylinders and the pistons as close as possible to the axis of rotation of the rotating drive member. Such an arrangement normally results in a considerable side thrust on the piston or plunger that in turn results in a strong tendency for the axis of the piston or plunger to become skew to the axis of the cylinder.

It is now proposed to provide a compact pump which will employ a piston reciprocally driven in a cylinder by a rotating member and still have a large capacity for its size. This pump may employ a pair of cylinders disposed in axial alignment with each other on diametrically opposite sides of a driving eccentric or cam. A yoke may surround the eccentric or cam and be driven thereby with the opposite ends of the yoke forming pistons or plungers that are reciprocally disposed inside the cylinders in axial alignment therewith. Since the opposite ends of the yoke are widely spaced from each other and they always will be substantially concentric in the cylinders, axial alignment of the pistons will be assured. Thus the pistons may be located very close to the axis of rotation of the eccentric without resulting in any side thrust or misalignment. In fact, each of the pistons may be relatively short members in direct driving engagement with the eccentric or cam at all times. In order to further improve the effectiveness of the pump and reduce the cost thereof, a plug of resilient material such as rubber may be disposed in the cylinder and engaged by the piston. One end of the plug may have a cavity therein that forms a pumping chamber. Thus the reciprocating movement of the piston will result in the plug being periodically compressed. This periodic compression of the plug will result in the capacity of the cavity increasing and decreasing thereby producing a pumping action. The resilient plug will engage the walls of the cylinder very tightly and provide a liquid tight seal irrespective of any minor irregularities in the surfaces of the piston and/or cylinder walls.

It is also proposed to provide a variable lift cam for driving the yoke. This will make it possible to control the stroke of the piston, thereby making it possible to

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readily vary the output of the pump. In the present instance this cam comprises a cylindrical sleeve mounted for rotation about an axis that intersects the axis of the cylinder but is oblique thereto. Thus by moving the cylindrical surface in an axial direction, the amount of life or eccentricity thereof may be varied from zero to any desired amount, and as a consequence, the stroke of the pistons can be readily adjusted.

In the drawings:

Figure 1 is a vertical cross sectional view of an engine employing a fuel injection pump embodying the present invention.

Figure 2 is a horizontal cross sectional view of a pump adapted to be embodied in the fuel injection system employed in Figure 1.

Figure 3 is a longitudinal cross sectional view of the pump taken substantially along the plane of line 3—3 in Figure 2.

Figure 4 is a cross sectional view taken substantially along the plane of line 4—4 in Figure 3.

Figure 5 is an exploded perspective view diagrammatically illustrating one form of the embodiment of the present invention.

Figure 6 is an exploded perspective view diagrammatically illustrating another form of the present invention.

Referring to the drawings in more detail, the present invention may be embodied in a pump suitable for use in a fuel injection system 10 for an internal combustion engine 11. This engine 11 may be of any desired type such as a so-called V type having a cylinder block 12 with a pair of angularly disposed banks of cylinders 14. These cylinders 14 are charged through intake passages 16 extending through the cylinder heads 18 secured to the banks of cylinders. The fuel injection system 10 may include a fuel metering and/or distributing unit 19 for drawing fuel from a source such as a fuel tank and for metering and/or distributing the fuel to the various intake passages 16 to mix with the induction air therein to form a combustible charge for the cylinders 14.

The metering and/or distributing system 19 may include a pump 20 adapted for mounting on a web 22 that extends between the two banks of cylinders 14. The present pump 20 includes a housing 24 having a chamber 26 with an upper bearing 28 and a lower bearing 30 disposed on the opposite sides thereof for rotatably supporting a vertical driveshaft 32. The driveshaft 32 may project downwardly into the camshaft gallery 34 and have a gear 36 on the lower end thereof driven by a similar gear 38 on the camshaft 40. Thus the pump 20 will be driven at some fixed ratio to the engine speed.

Although the pump 20 may employ any number of pumping cells 42 and 44, in the present instance it includes a pair of axially aligned cylinders 46 and 48 disposed on diametrically opposite sides of the driveshaft 32. In other words the cylinders 46 and 48 will be symmetrically disposed about the driveshaft 32 with their axes in a plane normal thereto.

A yoke 50 may be provided which has an opening 52 in the center thereof to straddle the driveshaft 32 while the opposite ends 54 and 56 of the yoke 50 are disposed in the cylinders 46 and 48. These ends of the yoke 50 are preferably a sliding fit in the cylinders 46 and 48 so that they may function as pistons. Since each end 54 and 56 of the yoke 50 will be disposed concentric with the cylinders 46 and 48, the wide spacing of the ends 54 and 56 will result in the yoke 50 being retained in exact axial alignment at all times. Thus if the ends 54 and 56 of the yoke 50 form the pistons or plungers that reciprocate in the cylinders 46 and 48, the cylinders may be disposed very close to the cam or eccentric 58. In fact, the working surfaces of the pistons may be only the thick-

ness of the end portion away from the cam 58 without impairing the alignment of the pistons. It will thus be seen that the pump 20 may have a very small diameter.

In order to provide a reciprocating movement of the opposite ends of the yoke 50, an eccentric or cam 58 may be mounted on the driveshaft 32 and rotatably disposed in the central opening 52 through the middle of the yoke 50. The surface of the diametrically opposite sides of this opening may engage the opposite sides of the eccentric 58 in alignment with the axis of the cylinders 46 and 48. This will provide a positive force in both directions of movement of the yoke 50 without producing any lateral thrust that would tend to force the pistons against the sides of the cylinders 46 and 48. It should be noted that a clearance space 60 on the opposite sides of the opening 52 eliminates any interference between the yoke 50 and eccentric 58. Inserts 62 may be press fitted in a passage through the ends 54 and 56 of the yoke 50 so that a spherical surface 64 thereon will ride on the eccentric 58. This will provide a point contact between the yoke 50 and eccentric 58.

It may thus be seen that as the engine camshaft 40 rotates, the gear 38 thereon will rotatably drive the vertical driveshaft 32 of the pump 20. As the driveshaft 32 and the eccentric 58 thereon rotates, the yoke 50 will reciprocate between the two cylinders 46 and 48 and produce a pumping action.

In order to increase the effectiveness of this pumping action, a resilient plug 66 of some suitable material such as a rubber may be provided in each of the cylinders 46 and 48. One end of each plug 66 may be flat to engage the end of the yoke 50 while the opposite end of the plug 66 has a cavity 68 formed therein. These cavities 68 cooperate with the inner ends of the cylinders 46 and 48 to form pumping chambers 70. Inlet passages 72 extend through the housing 24 so that an inlet valve 74 may be provided for each of the cylinders 46 and 48. The inlet passages 72 are adapted to draw fuel from suitable sources such as a storage tank. An outlet passage 76 may be provided for each cylinder 46 and 48 for allowing the fuel to be pumped into the fuel distributing system 19 for discharging the fuel into the various intake passages 16. It is preferable that the inlet passages 72 intersect the bottom of the pumping chamber 70 and that the outlet passages 76 draw fuel from the top of the chamber 70. Thus if there are any vapors in the chamber 70, they will collect adjacent the outlet valve and be vented during every pumping cycle. By maintaining the plugs 66 under compression at all times, an effective sealing action will be provided that will prevent the loss of fluid from the pumping chamber 70 without undue machining of the mating surfaces. Also wearing of the cylinder surfaces etc. by abrasion from foreign particles in the fluid will not destroy the effectiveness of the pump.

When the yoke 50 moves to one side, one of the resilient plugs 66 will expand and the other plug 66 will be compressed. This will result in, respectively, an increase and a decrease in the capacities of the chambers 70. Thus fuel will be drawn inwardly through the inlet 72 for the chamber 70 on one side of the housing and outwardly through the outlet valve 78 in outlet passage 76 for the chamber 70 on the other side of the housing 24. When the movement of the yoke 50 reverses, the flow will then be in through the other inlet and out through the other outlet. Thus a positive pumping action will result that will have an output substantially equal to the total swept volume of the pistons or ends of the yoke 50, i. e., the area times the stroke. The outputs from each of the cells may be combined to produce a unitary flow of fluid or the outputs may be kept separate.

In order to vary the rate or quantity of fuel discharged from the pump 20, the eccentric or cam 58 may have a variable lift which is effective for varying the travel of the yoke 50 and thus the stroke of the pump 20. The

present eccentric 58 is a hollow cylindrical sleeve 80 mounted on a cylindrical spindle 82 that rotates with the driveshaft 32. The axis of the spindle 82 is oblique to the axis of rotation so that either one or both ends of the spindle 82 are displaced from the axis while some intermediate portion is concentric with the axis of rotation. Thus the amount of eccentricity of the sleeve 80 will vary in an axial direction. Accordingly, by moving the sleeve 80 and spindle 82 the eccentricity thereof will vary, thus varying the stroke of the piston and consequently, the output from the pump 20.

Although any suitable control means may be provided for moving the sleeve 80 in an axial direction, in the present instance a pneumatic system including a spring biased diaphragm 84 is provided. The balance between the spring and the pressure in the plenum chamber 86 will determine the axial position of the cam 58 and its surface. As a consequence, the rate of output of the pump 20 may be determined by the plenum chamber pressure which is characteristic of the engine fuel requirements.

Under some circumstances, it may be desirable to provide more pumping cells to allow a separate cell for each engine cylinder, produce a more continuous output, and/or increase the capacity of the pump, etc. Accordingly, the pump 20 may be equipped with additional cells. One means of accomplishing this is to provide another pair of cells that are disposed in the same plane as the first pair of cells but at right angles thereto. A separate yoke 100 and 102 is provided for each pair of aligned cylinders so that the opposite ends 104 of the yokes 100 and 102 will be disposed in the cylinders. These cylinders are preferably substantially identical to each other and similar in all respects to the first described embodiment.

Each of the yokes 100 and 102, as best seen in Figure 6, has an offset center portion 106 with a central opening 108 therein for the cam or eccentric 110 and a pair of cylindrical ends 104 that are adapted to fit into the cylinders. The offset center portions 106 will allow the two yokes 100 and 102 to intermesh with each other with the cylindrical ends 104 being disposed in a common plane. Each end of the yokes 100 and 102 may have an insert 113 with spherical surfaces thereon that will engage the surface of the cam 110. It may thus be seen that all of the spherical surfaces will engage the cam 110 along a common plane normal to the axis of rotation. This insures all of the cells having identical strokes at all times even when the cam's lift varies in an axial direction.

It will thus be seen that a plurality of cells may be provided while still employing a compact structure wherein the plungers will always be maintained in axial alignment.

It is to be understood that, although the invention has been described with specific reference to particular embodiments thereof, it is not to be so limited since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. A pump structure comprising a housing having a chamber in the center thereof, a driveshaft extending longitudinally of said housing and through said chamber, a cam mounted on said driveshaft and disposed inside of said chamber, a pair of axially aligned cylinders disposed substantially normal to the axis of said driveshaft with the inner ends thereof opening into diametrically opposite sides of said chamber adjacent said cam, a plug of resilient material disposed in the outer ends of said cylinders to thereby form pumping chambers, a yoke disposed in said chamber and having an opening in the center thereof for encompassing said cam, said yoke including plunger portions on diametrically opposite ends thereof disposed in the inner ends of said cylinders for engaging, said

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resilient plugs, said plunger portions being a sufficiently close fit in said cylinders for maintaining said yoke in axial alignment therewith, said yoke engaging said cam at points in substantial alignment with the axis of said cylinders for reciprocating said yoke to alternately compress said resilient plugs and thereby produce a pumping action in said pumping chambers.

2. In a fuel injection system for an internal combustion engine, the combination of a pump housing having a chamber therein, a rotatable drive shaft extending through said housing and said chamber, a cam rotatably driven by said driveshaft and disposed in said chamber, said cam being axially movable with the amount of lift thereof varying in an axial direction, aligned cylinders in said housing opening into diametrically opposite sides of said chamber adjacent said cam, a yoke disposed in said chamber and having plunger portions on diametrically opposite ends thereof reciprocally disposed in said cylinders to maintain said yoke in axial alignment therewith, plugs of resilient material disposed in said cylinders to be engaged by said plunger portions to form pumping

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chambers, the center portion of said yoke having an opening adapted to straddle said cam and be reciprocally driven thereby in said cylinders, an outlet communicating with each of said cylinders for distributing metered fuel therefrom to the engine cylinders, and means responsive to the fuel demands of said engine for moving said cam in an axial direction to thereby vary the stroke of said yoke and consequently the amount of fuel pumped to said engine.

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