March 12, 1940. C. R. ALDEN 2,193,612

PUMP

Original Filed Oct. 8, 1932

Fig. 1

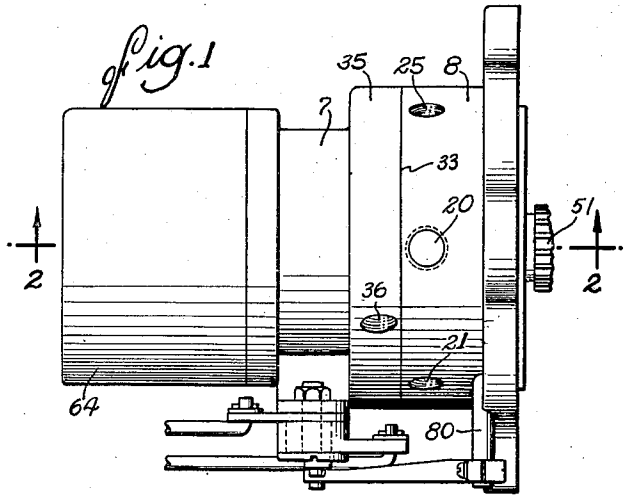


Fig. 3

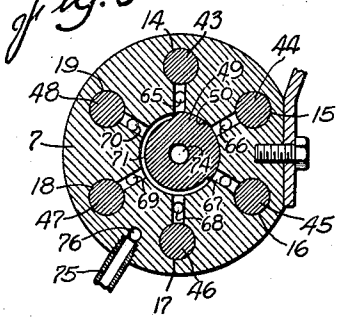


Fig. 2

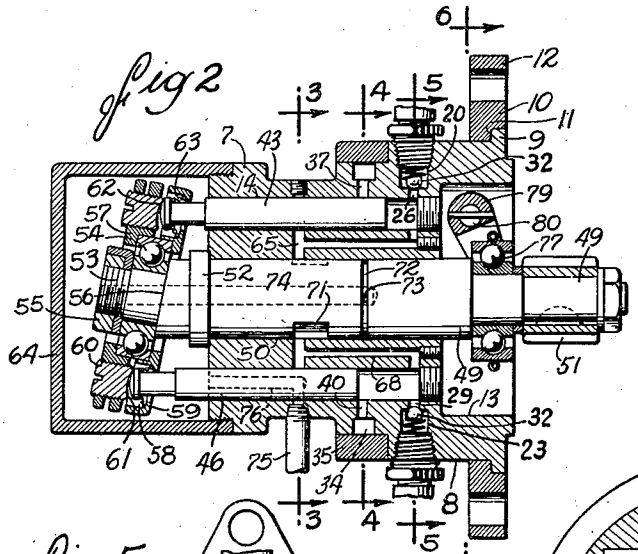


Fig. 4

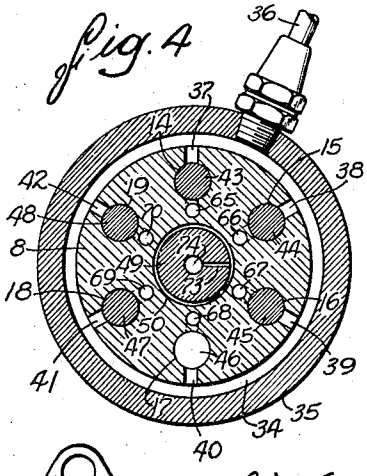


Fig. 5

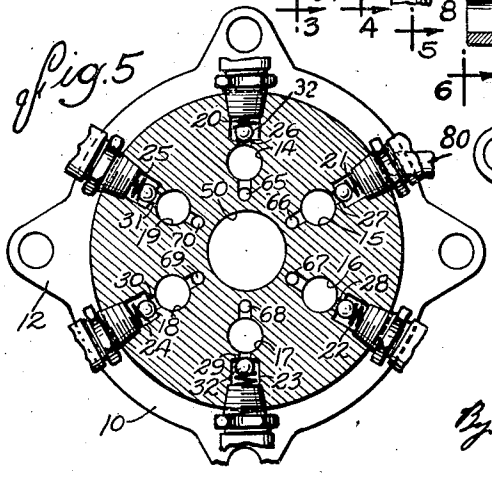
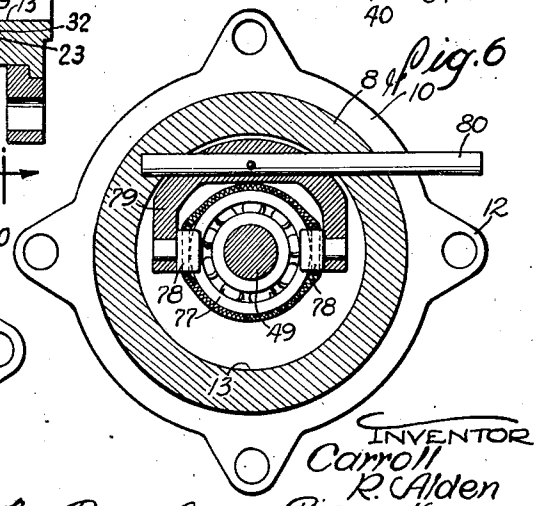


Fig. 6



INVENTOR
Carroll R. Alden

By Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

Patented Mar. 12, 1940 2,193,612

UNITED STATES PATENT OFFICE

2,193,612

PUMP

Carroll R. Alden, Detroit, Mich., assignor to Ex-Cell-O Corporation, a corporation of Michigan

Original application October 8, 1932, Serial No. 636,791. Divided and this application April 9, 1937, Serial No. 135,846

6 Claims. (Cl. 103—173)

The present invention relates generally to improvements in variable-delivery pumps, and has particular reference to pumps especially adapted for use in fuel injection systems and other hydraulic systems.

The present application is a division of my copending application Serial No. 636,791, filed October 8, 1932 (Patent No. 2,087,233).

One object resides in the provision of a novel multiple piston and cylinder pump wherein each cylinder is flooded during the entire suction stroke of the piston, thereby preventing cavitation and the formation of vapor.

Other objects and advantages will become apparent as the description proceeds.

In the accompanying drawing,

Figure 1 is a plan view of a pump embodying the features of my invention.

Fig. 2 is a vertical axial sectional view taken along line 2—2 of Fig. 1.

Figs. 3, 4, 5 and 6 are transverse vertical sectional views taken respectively along lines 3—3 to 6—6 inclusive of Fig. 2.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawing and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawing, the pump, constituting the exemplary embodiment of the invention, is of the variable-flow metering and distributing type, and is especially suited for pumping volatile liquids, such as gasoline, naphtha and other similar fuels. In its preferred form, the pump comprises a casing 7 which is generally cylindrical in shape, and peripherally enlarged at one end as indicated at 8. The enlarged portion 8 is formed adjacent its free end with a peripheral flange 9. To mount the casing 7 in position, a ring 10 notched in its inner periphery as indicated at 11 to interfit with the flange 9 is disposed on the enlarged portion 9, and is formed with peripherally spaced ears 12 adapted to be secured to a suitable support (not shown).

The casing 7 is formed in the enlarged end with an axial cylindrical recess 13. Formed in the other end of the casing 7 and extending at their inner ends almost through to the recess 13 are a plurality of parallel longitudinal bores or pump cylinders, six cylinders 14 to 19 in the present instance (see Figs. 2 to 4), uniformly spaced concentrically about the axial center of the casing. A plurality of radial bores 20 to 25 (see Fig. 5) tapped in their outer ends, are formed in the enlarged portion of the casing 7, and open at their inner ends respectively through ports 26 to 31 to the closed inner ends of the cylinders 14 to 19. The bores 20 to 25 are adapted to be connected by means of fittings (shown in Figs. 2 and 5) respectively to the inlet ends of a like number of discharge conduits (not shown). Spring-pressed ball check valves 32 (see Fig. 2 and 5) in the bores 20 to 25 seated against the ports 26 to 31 prevent any back flow of fuel into the cylinders 14 to 19.

The inner end of the enlarged portion 8 of the casing 7 is formed externally with a peripheral notch 33, and in the cylindrical surface of the latter is formed a peripheral groove 34. A seal ring 35 fitted in the notch 33 serves to close the groove 34. Opening through the ring 35 is an inlet line or passage 36 leading from a suitable supply (not shown) of the liquid to be pumped. A plurality of inlet ports 37 to 42 (see Fig. 4) formed in the casing 7 open from the groove 34 respectively into the cylinders 14 to 19.

Slidably disposed respectively in the cylinders 14 to 19 are a plurality of pump pistons or plungers 43 to 48. Each pump piston (43 to 48) in its outward or suction stroke is adapted to uncover the associated inlet port (37 to 42), and on its return or pressure stroke to cut-off the inlet port and force the liquid under pressure in a metered quantity through the associated outlet port (26 to 31) past the valve 32 into the discharge line. It will be evident that the extent of movement of each piston on its pressure stroke past its inlet port determines the volume of liquid metered in each discharge.

Any suitable drive may be provided for reciprocating the pistons 43 to 48 in timed sequence and in timed relation to the engine. In the present instance, this means comprises a drive shaft 49 extending through and journaled in an axial bore 50 formed in the casing 7. The end of the shaft 49 outside of the recess 13 has fixed thereon a pinion 51 adapted to be geared to a suitable power means, such as an engine crankshaft (not shown).

The other or inner end of the shaft 49 is formed with a peripheral collar 52 adapted to abut rotatably against the adjacent end of the casing 7, and beyond the collar is reduced in size and bent

at an angle to its axis to provide an eccentric hub 53.

The inner raceway of a ball bearing 54 is secured by means of a nut 55 on the hub 53 against a peripheral transverse shoulder 56. The outer raceway of the bearing 54 is seated in the inner periphery of an annular concentric swash or wobble plate 57.

Formed in the wobble plate 57 in uniformly spaced relation about the bearing 54 are a plurality of recesses 58, each of which has an internal peripheral flange 59 at its outer end. A plurality of bearing plugs 60 are threaded into the wobble plate 57 at the other ends of the recesses 58, and each plug is formed in its inner end with a concave or semi-spherical bearing seat 61. The outer ends of the pistons 43 to 48 extend respectively into the recesses 58 and are formed with rounded heads 62 in bearing engagement with the seats 61. Coiled compression springs 63 seated against the flanges 59 and impinging against the heads 62 serve to hold the latter continuously against the seats 61. A cap 64 secured to the end of the casing 7 encloses the wobble plate 57 and associated parts. It will be evident that each of the pistons 43 to 48 has a universal connection with the wobble plate 57, and that upon rotation of the latter the pistons will be reciprocated in timed sequence.

The volume of delivery may be adjusted by shifting the shaft 49 axially to vary the point of cut-off of the inlet ports 37 to 42 by the pistons 43 to 48. Thus, upon adjusting the shaft 49 into its outermost position, as shown in Fig. 2, the pump will deliver at maximum, and upon adjusting the shaft inwardly the volume of delivery will be progressively reduced.

A pump of the character thus far described is subject to the objection, particularly where a highly volatile fuel such as gasoline is handled, that on the suction stroke of each of the pistons 43 to 48, a substantial vacuum is induced in the associated cylinder, with the result that the liquid in the cylinder tends to vaporize, and that upon uncovering the inlet port the fresh liquid enters with a decided rush. These conditions are not conducive to efficient operation of the pump or of an engine where the liquid is delivered for injection. To prevent same, provision is made to flood each of the cylinders 14 to 19 with fuel during the suction stroke of the associated piston regardless of whether or not the associated inlet port has been uncovered. More particularly, all cylinders whose pistons are on their suction stroke and preferably also those whose pistons are on their pressure stroke but have not cut-off the associated inlet ports are interconnected for the by-pass of liquid. Since some one or more of these cylinders are always in communication with their inlet ports, all of the connected cylinders will be flooded with fuel.

The by-pass means comprises a plurality of passages 65 to 70 (see Figs. 3 and 5) formed in the body of the casing 7 and communicating respectively with the closed inner ends of the cylinders 14 to 19. The passages 65 to 70 open in uniformly spaced relation in a common transverse plane to the periphery of the bore 50, each passage preferably being located in a common radial plane with its associated pump cylinder.

Formed in the periphery of the drive shaft 49 is a circumferential groove 71 extending through approximately 240°. The lead end of the groove 71 is movable into successive communication with the passages 65 to 70 upon rotation of the shaft 49 in a counterclockwise direction as viewed from the right in Fig. 2. The width of the groove 71 is substantially greater than that of the communicating ends of the passages 65 to 70 so that the rotary valve constituted thereby is unaffected by axial adjustment of the shaft 49. The groove 71 has a phase relation to the pistons 43 to 48 such that all of the cylinders except those in which the pistons at any particular time are in the effective portions of their pressure strokes are intercommunicating. Thus, as a given piston reaches a predetermined point in its inward movement, namely cut-off at full throttle, the associated cylinder is cut out of communication with others of the cylinders.

To prevent fuel from leaking along the shaft 49 out of the casing 7 to the atmosphere, a labyrinth groove 72 is formed in the periphery of the shaft externally of and in spaced relation to the by-pass groove 71. The groove 72 opens through a radial duct 73 and an axial bore 74 in the shaft 49 to the interior of the end cap 64. Fuel leaking along the pistons 43 to 48 also enters the end cap 64. A drain conduit 75 connected to the casing 7 and opening through a passage 76 in the latter to the interior of the cap 64 serves to remove any fuel collecting therein.

The shaft 49 as a rotatable element constitutes the drive for the pump, and as a shiftable element constitutes the fuel throttle. Thus, axial adjustment of the shaft 49 is effective to shift the region of reciprocation of the pistons 43 to 48 collectively relative to the inlet ports 37 to 42, and thereby to vary the amount of the discharge, and incidentally the length of the discharge period and the phase relation of the start of each period to the pump cycle.

To provide means for adjusting the shaft 49 axially, the inner raceway of a ball bearing 77 is rigidly secured thereon within the recess 13. Two shifter shoes 78 pivotally mounted in the arms of a rocking yoke 79 engage the outer raceway of the bearing 77 at diametrically opposed points. The yoke 79 is fixed on a rock shaft 80 journaled in the casing 7 and extending therefrom for external actuation, as for example a reverse self-locking throttle actuator (not shown) disclosed in my aforesaid application.

I claim as my invention:

1. A pump comprising, in combination, a casing, a plurality of pump cylinders formed in said casing in parallel uniformly peripherally spaced rotation, a plurality of pistons respectively reciprocable in said cylinders, a plurality of fuel inlet ports opening respectively to said cylinders in a common transverse plane and adapted to be covered and uncovered in the reciprocation of said pistons, a plurality of fuel outlet ports opening from said cylinders, a valve bore in said casing, a rotary valve in said bore, a plurality of by-pass passages opening respectively from said cylinders to said valve bore, and means for reciprocating said pistons in uniformly timed sequence and for driving said valve in timed relation thereto to interconnect those of said by-pass passages opening to cylinders wherein the pistons are on their suction stroke.

2. A pump comprising, in combination, a casing having a bore, a drive shaft extending slidably and rotatably through said bore, an inclined bearing on said shaft at one end of said casing, a wobble plate rotatably mounted on said bearing, a plurality of pump cylinders formed in said one end of said casing in parallel uniformly

peripherally spaced relation about said shaft, a plurality of pistons respectively reciprocable in said cylinders and extending from said casing, the outer ends of said pistons being operatively related to said wobble plate, a plurality of fuel inlet ports opening respectively to said cylinders in a common transverse plane intermediate the ends of said cylinders and adapted to be covered and uncovered in the reciprocation of said pistons, means for shifting said shaft axially to adjust the range of reciprocation of said pistons relative to said inlet ports, a plurality of outlet ports opening respectively from the inner ends of said cylinders, a plurality of by-pass passages opening respectively from said inner ends of said cylinders to said bore in a common transverse plane, and a valve groove formed in said shaft for rotary movement successively into communication with said by-pass passages in all axial positions of said shaft, said groove extending partially about said shaft and being related in phase to said wobble plate to interconnect all of said cylinders in which said pistons are moving outwardly or said inlet ports are uncovered.

3. A pump comprising, in combination, a casing having a plurality of parallel pump cylinders, pistons reciprocable respectively in said cylinders, means for reciprocating said pistons in timed sequence, each reciprocation comprising a suction stroke and a return pressure stroke, inlet ports opening respectively to said cylinders and adapted to be uncovered by said pistons in the course of said suction strokes, a plurality of discharge ports opening respectively from said cylinders, means for simultaneously adjusting the region of reciprocation of said pistons in said cylinders relative to said inlet ports, and a rotary by-pass valve automatically operable to connect each cylinder during the suction stroke of the associated piston with some other of said cylinders which is in communication at the time with its associated inlet port.

4. A pump comprising, in combination, a casing having a plurality of pump cylinders, pistons reciprocable respectively in said cylinders, means for reciprocating said pistons in timed sequence, each reciprocation comprising a suction stroke and a return pressure stroke, inlet ports opening respectively to said cylinders and adapted to be uncovered by said pistons in the course of said suction strokes, a plurality of discharge ports opening respectively from said cylinders, and means automatically operable to connect each cylinder independently of said inlet ports during the entire suction stroke of the associated piston with some other of said pump cylinders which is in communication at the time with its associated inlet port.

5. A pump comprising, in combination, a casing having a bore, a drive shaft extending rotatably through said bore, an inclined bearing on said shaft at one end of said casing, a wobble plate rotatably mounted on said bearing, a plurality of pump cylinders formed in said one end of said casing in parallel uniformly peripherally spaced relation about said shaft, a plurality of pistons respectively reciprocable in said cylinders and extending from said casing, the outer ends of said pistons being operatively related to said wobble plate, a plurality of fluid inlet ports opening respectively to said cylinders in a common transverse plane intermediate the ends of said cylinders and adapted to be covered and uncovered in the reciprocation of said pistons, a plurality of outlet ports opening respectively from the inner ends of said cylinders, a plurality of by-pass passages opening respectively from said inner ends of said cylinders to said bore in a common transverse plane, and a valve groove formed in said shaft for rotary movement successively into communication with said by-pass passages, said groove extending partially about said shaft and being related in phase to said wobble plate to interconnect the cylinders in which said pistons are moving outwardly.

6. A pump comprising, in combination, a casing having a bore, a plurality of pump cylinders formed in said casing in parallel uniformly peripherally spaced relation about said bore, a plurality of pistons respectively reciprocable in said cylinders, a plurality of inlet ports opening respectively to said cylinders in a common transverse plane intermediate the ends of said cylinders and adapted to be covered and uncovered in the reciprocation of said pistons, a plurality of outlet ports opening respectively from the inner ends of said cylinders, a plurality of by-pass passages opening respectively from said inner ends of said cylinders to said bore in a common transverse plane, a valve rotatable in said bore, and means for reciprocating said pistons in timed sequence and rotating said valve in timed relation thereto, said valve having a recess movable successively into communication with said by-pass passages and being so related in phase to the reciprocation of said pistons as to interconnect the cylinders in which said pistons are moving outwardly.

CARROLL R. ALDEN.

CERTIFICATE OF CORRECTION.

Patent No. 2,193,612. March 12, 1940.

CARROLL R. ALDEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 14, for "Fig." read --Figs.--; page 2, second column, line 54, claim 1, for the word "rotation" read --relation--; page 3, first column, line 40, claim 3, before "cylinders" insert --pump--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of May, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)