May 15, 1956 R. CAPSEK 2,745,350

INJECTION PUMPS

Filed Jan. 20, 1951 2 Sheets-Sheet 1

Fig. 1

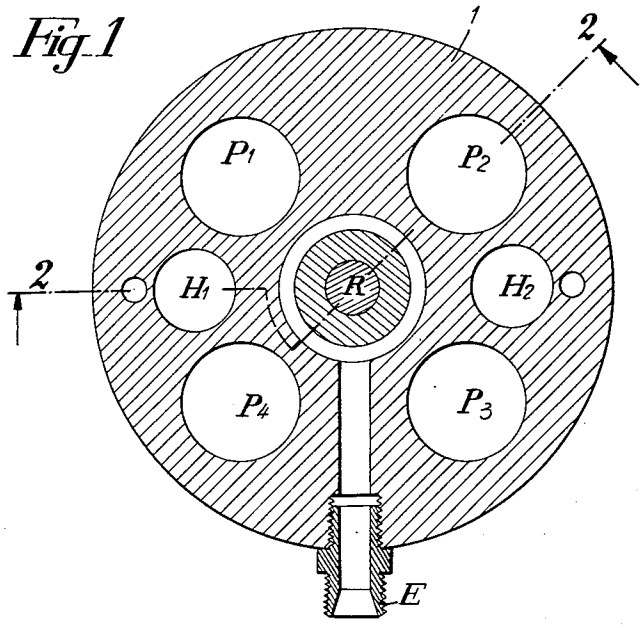


Fig. 3

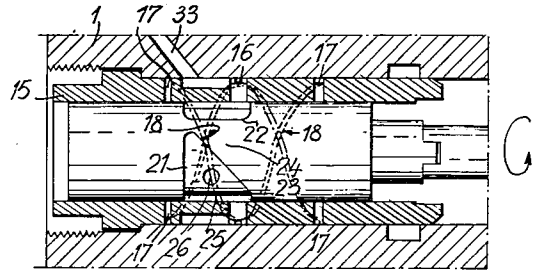
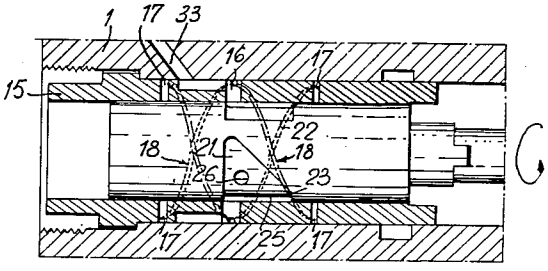


Fig. 4



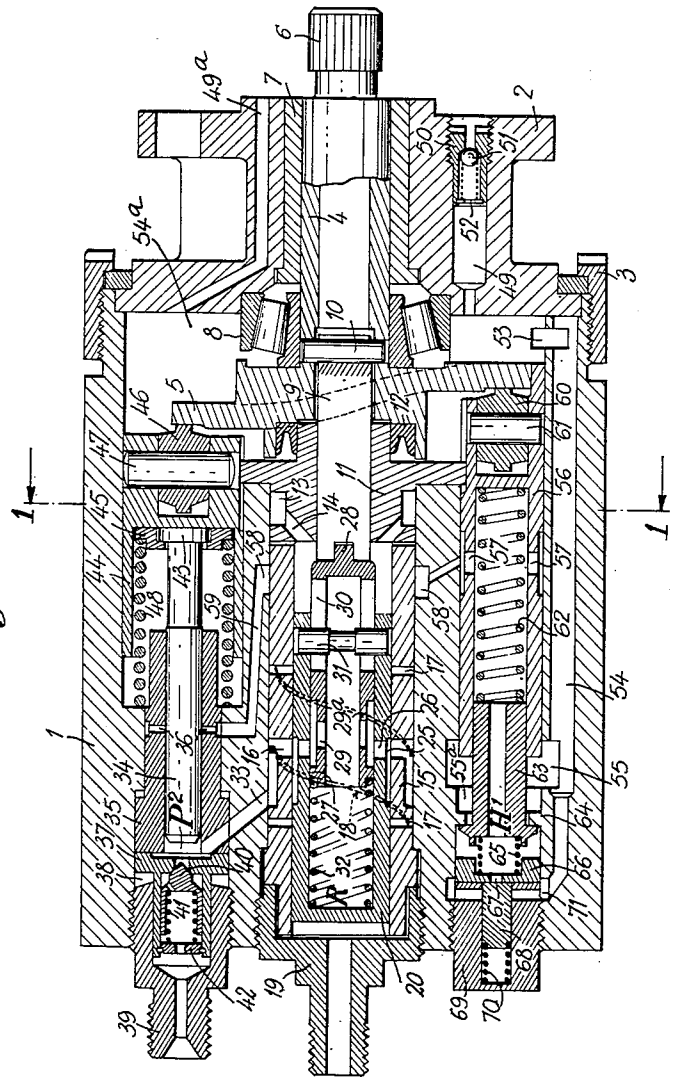
INVENTOR:
ROGER CAPSEK
BY:

May 15, 1956 R. CAPSEK 2,745,350

INJECTION PUMPS

Filed Jan. 20, 1951 2 Sheets-Sheet 2

Fig. 2



INVENTOR:
ROGER CAPSEK
BY:

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2,745,350

INJECTION PUMPS

Roger Capsek, Paris, France, assignor to Bronzavia S. A., Courbevoie, France, a corporation of France

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Claims priority, application France June 23, 1950

14 Claims. (Cl. 103—41)

The present invention relates to fuel injection pumps for explosion or internal combustion engines, of the kind comprising a series of elementary parallel piston pumps arranged circularly about the longitudinal axis of the assembly, in a number equal to the number of engine cylinders to be fed.

An important feature of the pump according to the invention is that the regulation of the output of the elementary pumps is controlled by a single rotary cylindrical piston valve, disposed in the axis of the pump body and adapted to close for a variable period of time the inlet orifices of the elementary pumps.

The following description and the accompanying drawings illustrate an embodiment of the invention:

Fig. 1 is a cross-section taken along the line 1—1 in Fig. 2.

Fig. 2 is an axial section taken along the line 2—2 in Fig. 1.

Figs. 3 and 4 are sectional views on an enlarged scale of the regulator in two different operative positions.

The feed pump comprises a main cylindrical housing or body 1 (Fig. 1), in which are housed several identical elementary fuel pumps corresponding to the number of cylinders to be fed, a number of identical elementary oil pumps and a single regulator or metering valve.

In the particular embodiment illustrated in the drawing there are four elementary fuel pumps P_1, P_2, P_3, P_4, two elementary oil pumps H_1, H_2 and the regulator or metering valve R.

Body 1 is closed at one end by a cover 2 (Fig. 2) secured by a nut 3 screwed on to body 1. Extending axially therethrough is a hollow camshaft 4 having at its inner end a rotative member in the form of a cam 5 and at its outer end flutes 6 for connection with a driving member, this shaft being rotatable in a bushing 7 and a roller bearing 8 housed in cover 2.

A spindle 9 engages hollow shaft 4 and is actuated thereby through a cross-connecting pin 10. Spindle 9 is rotatable in a bearing 11, fitted with a sealing ring 12, which bears at one end against cam 5 and at the other end against bearing 11.

The fuel delivered by a pump (not shown) is supplied through a coupling E (Fig. 1), screwed in the main body, into an annular space 13 around bearing 11 and flows through ducts 14 into the regulator or metering valve R.

Said regulator comprises a cylindrical casing 15 fitting in a bore of the main body and carrying opposite to each pump, such as P_1, an aperture 16 in communication with two further balancing apertures 17, situated on the diametrically opposite generatrix, through a helical groove 18. The casing is held at one end by a connection 19, screwed in the main body.

A hollow piston valve 20, slidable and rotatable within cylindrical casing 15, with a very slight clearance, is formed on its periphery with a recess 21, which is limited by a straight generatrix portion 22 (Figs. 3 and 4), an arc 23 of a helix, and a circular portion in a transverse plane, thus forming a depression in the solid portion 24. Recess

21 and the inner wall of casing 15 define a space 25, which communicates with the apertures 16 in the cylindrical casing 15 and, through orifices 26, with the inner space of piston valve 20.

A sleeve 27, arranged within piston valve 20, has apertures 29 communicating with the apertures 26 in the pis-valve through the medium of a groove 29a, said sleeve also has two longitudinal slots 30, in which is slidable a pin 31, secured to piston valve 20, and sleeve 27 ends in a turnscrew 28, engaging spindle 9, whereby piston valve 20 is rotated bodily by camshaft 9 in sleeve 27.

A spring 32, interposed between sleeve 27 and the closed end of piston valve 20, urges piston valve 20 towards the right.

Ducts 33, provided in the main body, establish communication between space 25 and each elementary fuel pump cylinder.

Each elementary fuel pump P_1 comprises a piston 34 slidable with very little clearance in a cylinder 35, housed within the main body. Said cylinder has two lateral ducts 36 and bears against a hollow valve seat 37, which is held in place, through the medium of a gasket 38, by a connecting nipple 39, screwed in the main body and communicating with an injector (not shown).

A valve 40, cooperating with said seat 37, is urged inwardly by a spring 41, which bears against an abutment ring 42.

Piston 34 has a flange 43, held between the bottom of a hollow plunger 44 and a ring 45. Plunger 44 carries a roller 46, rotatable about a spindle 47 mounted in said plunger. Said roller is biased against cam 5 by a spring 48 interposed between a shoulder of main body 1 and the bottom of plunger 44.

Cover 2 has a bore 49 parallel with the axis of the pump and which is supplied with oil, derived from the lubricating circuit of the engine, through a valve comprising a seat 50, screwed into the main body and a ball 51, held against the seat by a spring, bearing against a ring 52 secured to seat 50. An upper duct 49a enables a circulation of oil to be set up through the pump, for evacuating the air contained in the main body, when the engine is started. An opening 53 and a conduit or duct 54 establish communication between the inner space of the main body, into which opens bore 49, and a circular groove 55 communicating with an inner space 55a of the oil pump body.

Groove 55 feeds the elementary oil pumps H_1, H_2 each comprising a hollow plunger 56 slidable within the main body and provided with lateral orifices 57 establishing communication between the interior of the plunger and an annular chamber or groove 58 surrounding casing 15 and from which conduits or ducts 59 lead to the apertures 36 provided in the fuel pump cylinders.

Plunger 56 is reciprocated by a roller 60, rotatable on a spindle 61 mounted in said plunger and urged against cam 5 by a spring 62, interposed between plunger 56 and the rear portion of a valve 63, which is slidable within the hollow plunger. Said valve 63, which is bored axially, has a flange resting on a shoulder 64 of the main body, under the tension of a spring 65, stronger than spring 62, and bearing against a ring 66 having an axial opening 67 therein. Said opening is closed by an opposite valve 68, slidable in a cap 69, screwed into the main body, a spring 70 being interposed between cap 69 and valve 68. A by-pass channel 71, surrounding valve 68, is connected with the oil inlet passage 54.

The operation is as follows:

The recess 21 in the piston valve being situated opposite the aperture 16 (Fig. 3), fuel, delivered by a pump (not shown) through coupling E, flown successively through: the anular space 13 of bearing 11, ducts 14, slots 30 of sleeve 27, hollow piston valve 20, apertures 29, groove 29a of sleeve 27, apertures 26 in the piston

valve, the space 25 between the casing and the piston valve, apertures 16 in the casing and ducts 33 into the elementary pumps P_1, P_2, P_3, P_4.

During the rotation of camshaft 4, which through spindle 9 and turnscrew 28, rotates piston valve 20, communication between recess 21 and apertures 16 is periodically stopped as the solid portion 24 of the piston valve comes opposite apertures 16.

The piston 34 of elementary pump P_1, through roller 46 biased toward the cam 5 by spring 48 is reciprocated and compresses the fuel in cylinder 35, duct 33, apertures 16, helical groove 18 and the diametrically opposed apertures 17 which balance the stresses upon piston valve 20.

As the pressure of the fuel compressed in the cylinder attains the adjusted pressure of the spring urging valve 40, this latter opens, and the fuel is injected under pressure into the engine cylinder through valve seat 37, ring 42 and nipple 39.

As the shaft continues its rotation, apertures 16 are uncovered and the fuel remaining within cylinder 35 is now forced through duct 33 and aperture 16 into the interior of the main body, until piston 34 has reached its upper dead centre. Therefore, the duration of the injection corresponds to the period during which the apertures 16 in the casing are covered by the solid portion 24 of the piston valve 20, the arrangement being such that this corresponds to the movement of piston 34 towards its upper dead centre. According to the direction of rotation herein illustrated, the edge 23 (Fig. 3) corresponds to the beginning of the injection and the edge 22 to the completion thereof. It will be seen, therefore, that the period of injection varies in accordance with the circumferential distance between these two edges along solid portion 42 in a transverse plane passing through aperture 16. Owing to the helical shape of edge 23, this distance decreases as piston valve moves from the left towards the right.

Fig. 3 shows the piston valve in a position in which the circumferential distance between the edges 22 and 23 is a maximum opposite aperture 16. The period of injection and hence the amount of fuel injected per stroke of the piston is also a maximum.

Fig. 4 illustrates the piston valve in a position in which the circumferential distance between the edges 22, 23 opposite the aperture 16 is a minimum. The time of injection and the amount of injection per piston stroke are then also minimum.

The longitudinal position of piston valve 20 in relation to casing 15 may be adjusted through the hollow nipple 19 by any suitable means, for example by a hydraulic servo-motor; in such case, said piston valve would be at each instant in a state of equilibrium under the opposing action of the pressure of the fluid used by the servo-motor on the one hand and the tension of spring 32 and the pressure of the fuel prevailing within the piston valve on the other hand.

A high-pressure oil circulating circuit ensures the lubrication and sealing of pistons 34. Through valve 50, which is adapted to prevent the pump from emptying at rest, the oil successively flows through: bore 49 in cover 2, opening 53, duct 54 and groove 55.

Roller 60, urged toward cam 5 by spring 62, imparts a reciprocatory motion to plunger 56, and in the extreme position of said plunger towards the right, groove 55 is in communication with the cylinder of the main body where plunger 56 operates. Upon return of plunger 56 towards the left, communication between groove 55 and said cylinder is cut off, and the oil thus admitted behind the plunger is compressed in the space 55*a* and lifts hollow valve 63; through said hollow valve, it enters hollow plunger 56, and escapes through orifices 57, circular groove 58, duct 59 and ducts 36 into cylinder 35, to secure sealing of piston 34.

When the oil pressure exceeds a predetermined amount

valve 68 is lifted and the oil circuit is by-passed through orifice 71 back to the oil feed duct 54.

The housings for plungers 44 and 56 communicate with the interior of the main body.

It will be understood that the invention is not limited to the form of embodiment described, which is given merely by way of example.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. A fuel injection pump including a pump body, a plurality of parallel fuel pumps arranged on a circle in said pump body and comprising each a cylinder and a piston reciprocatable therein, a rotative member rotatively mounted in said pump body and operatively connected to each of said pistons for reciprocating the latter in succession in their conjugate cylinders, parallel lubricating oil pumps arranged on a circle in said pump body and each comprising a cylinder and a reciprocative plunger therein and oil inlet and outlet ports provided in said oil pump cylinder, each plunger being operatively connected to said rotative member for reciprocation in their conjugate cylinders by the latter, first conduits connecting said lubricating oil inlet ports to a source of lubricating oil, second conduits connecting the outlet ports of said lubricating oil pumps to an oil chamber, third conduits radially connected to the respective cylinders of said fuel pumps and to said oil chamber thereby putting the oil chamber in communication with said fuel pump cylinders, and pressure relief means provided in said pump body and in communication with said outlet ports for controlling the pressure of the oil pumped by the lubricating oil pumps through said outlet ports, whereby a supply of lubricating oil may be pumped between the piston and cylinder of said fuel pumps at a high pressure controlled by said pressure relief means and thoroughly lubricate the contacting surfaces of piston and cylinder and create an effective fuel-tight seal between the latter.

2. A fuel injection pump including a pump body, a plurality of parallel fuel pumps arranged on a circle in said pump body and comprising each a cylinder and a piston reciprocatable therein, a rotative member rotatively mounted in said pump body and operatively connected to each of said pistons for reciprocating the latter in succession in their conjugate cylinders, parallel lubricating oil pumps arranged on a circle in said pump body and each comprising a cylinder and a reciprocative plunger therein and oil inlet and outlet ports, each plunger being operatively connected to rotative member for reciprocation in their conjugate cylinders by the latter, a first oil chamber which is contained in said pump body and surrounds said rotative member and is connected to a source of lubricating oil, conduits connecting the lubricating oil pump inlet ports to said oil chamber, a second oil chamber in said pump body, second conduits connecting the outlet ports of said lubricating oil pumps to said second oil chamber, third conduits radially connected to the respective cylinders of said fuel pumps and to said second oil chamber thereby putting the second oil chamber in communication with said fuel pump cylinders, at least one pressure relief valve in said pump body and in communication with said outlet ports for controlling the pressure of the oil pumped by the lubrication oil pumps, whereby a supply of lubricating oil may be pumped between the piston and cylinder of said fuel pumps at a high pressure controlled by the pressure relief valve and thoroughly lubricate the contacting surfaces of piston and cylinder and create an effective fuel-tight seal between the latter.

3. A fuel injection pump including a pump body, a plurality of parallel fuel pumps arranged on a circle in said pump body and comprising each a cylinder and a piston reciprocatable therein, a rotative member rotatively mounted in said pump body and operatively connected to each of said pistons for reciprocating the lat-

tures, a rotary valve movable in said sleeve in controlling relationship to said first apertures and connected to said rotative member so as to cyclically close said first apertures in timed relation to the reciprocation of the fuel pump pistons by said rotative member, at least two lubricating oil pumps in said pump body substantially diametrically opposed on either side of said cylindrical aperture, said lubricating oil pumps comprising each a cylinder and a reciprocative plunger in the latter and oil inlet ports and oil outlet ports in said cylinder, said plungers being operatively connected to said rotative member so as to be reciprocated thereby in their respective cylinders, first conduits connecting the oil inlet ports of said lubricating oil pumps with a source of lubricating oil, an oil chamber in said pump body, second conduits connecting said oil chamber to the oil outlet ports of said lubricating oil pumps, third conduits radially connected to the cylinders of said fuel pumps and to said oil chamber, and pressure relief means provided in said pump body and in communication with said oil outlet ports for controlling the pressure of the oil pumped by said lubricating oil pumps through said oil outlet ports.

8. In a fuel injection pump comprising a pump body, a series of fuel pumps each including a cylinder, fuel inlet and outlet passageways and a piston reciprocatable in said cylinder, and a rotary valve rotative in a rotary valve cylinder provided in said pump body for closing in succession fuel inlet apertures which communicate with said fuel inlet passageways in timed relation to the reciprocation of the pistons, the provision of two balancing apertures in the wall of said rotary valve cylinder opposite each inlet aperture and passages in said pump body connecting each pair of balancing apertures to their corresponding inlet aperture, each pair of balancing apertures being located in a diametral plane containing said inlet aperture and the axis of the rotary valve cylinder and having a total cross-sectional area which is substantially equal to that of the corresponding inlet aperture, whereby the lateral thrust exerted on the rotary valve by the fuel pressure from the fuel pumps acting through the inlet apertures is substantially compensated by a thrust exerted by this fuel pressure on the rotary valve through their corresponding balancing apertures.

9. In a fuel injection pump comprising a pump body, a series of fuel pumps each including a cylinder, fuel inlet and outlet passageways and a piston reciprocative in said cylinder, and a rotary valve in said body for closing in succession said fuel inlet passageways in timed relation to the reciprocation of said pistons, the provision of a sleeve interposed between said rotary valve and said body and held fast in the latter, first apertures in said sleeve each one of which is connected to one of said fuel inlet passageways, two balancing apertures for each first aperture also in said sleeve and located on the opposite side of the axis of the sleeve relative to the first aperture in a diametral plane which contains said first aperture and the axis of said sleeve, the total cross-sectional area of the pairs of balancing apertures being substantially equal to that of their corresponding first aperture, and passageways connecting the first apertures to their corresponding balancing apertures, whereby the lateral thrust exerted on the rotary valve by the fuel pressure from the fuel pumps acting through the first apertures is substantially compensated by a thrust exerted by this fuel pressure on the rotary valve through their corresponding balancing apertures.

10. In a fuel injection pump comprising a pump body, a series of fuel pumps each including a cylinder, fuel inlet and outlet passageways and a piston reciprocative in said cylinder, and a rotary valve in said body for closing in succession said fuel inlet passageways in timed relation to the reciprocation of said pistons, the provision of a sleeve interposed between said rotary valve and said body and held fast in the latter, first apertures in said sleeve each one of which is conncted to one of said fuel inlet passageways,

two balancing apertures for each first aperture also in said sleeve and located on the opposite side of the axis of the sleeve relative to the first aperture in a diametral plane which contains said first aperture and the axis of said sleeve, the total cross-sectional area of the pairs of balancing apertures being substantially equal to that of their corresponding first aperture, and helical passageways provided between said sleeve and said pump body, each helical passageway connecting each first aperture to its corresponding balancing apertures, whereby the lateral thrust exerted on the rotary valve by the fuel pressure from the fuel pumps acting through the first apertures is substantially compensated by a thrust exerted by this fuel pressure on the rotary valve through their corresponding balancing apertures.

11. A fuel injection pump as claimed in claim 10, wherein said helical passageways comprise helical grooves provided on the outer cylindrical wall of said sleeve.

12. In a fuel injection pump comprising a pump body, a series of fuel pumps each including a cylinder, fuel inlet and outlet passageways and a reciprocative piston in said cylinder, said pistons being reciprocated by a rotative member, the combination with said pump body of a sleeve held in a fluid-tight manner in the latter, first apertures in said sleeve each one of which is connected to one of said fuel inlet passageways, a rotary valve rotative in said sleeve and adapted to close in succession said first apertures in timed relation to the reciprocation of said pistons, two balancing apertures for each first aperture also in said sleeve and located on the opposite side of the axis of the sleeve relative to the first aperture in a diametral plane which contains said first aperture and the axis of said sleeve, the total cross-sectional area of these balancing apertures being substantially equal to that of their corresponding first apertures, and passageways connecting the first apertures to their corresponding balancing apertures, whereby the lateral thrust exerted on the rotary valve by the fuel pressure from the fuel pumps acting through the first apertures is substantially compensated by a thrust exerted by this fuel pressure on the rotary valve through the corresponding balancing apertures.

13. In a fuel injection pump comprising a pump body, a series of fuel pumps each including a cylinder, fuel inlet and outlet passageways and a reciprocative piston in said cylinder, said pistons being reciprocated by a rotative member, the combination with said pump body of a sleeve held in a fluid-tight manner in the latter, first apertures in said sleeve each one of which is connected to one of said fuel inlet passageways, a rotary valve rotative in said sleeve and adapted to close in succession said first apertures in timed relation to the reciprocation of said pistons, two balancing apertures for each first aperture also in said sleeve and located on the opposite side of the axis of the sleeve relative to the first aperture in a diametral plane which contains said first aperture and the axis of said sleeve, the total cross-sectional area of these balancing apertures being substantially equal to that of their corresponding first apertures, and helical passageways provided between said sleeve and said pump body, each helical passageway connecting each first aperture to its corresponding balancing apertures, whereby the lateral thrust exerted on the rotary valve by the fuel pressure from the fuel pumps acting through the first apertures is substantially compensated by a thrust exerted by this fuel pressure on the rotary valve through their corresponding balancing apertures.

14. A fuel injection pump as claimed in claim 13, wherein said helical passageways comprise helical grooves provided on the outer cylindrical wall of said sleeve.

(References on following page)

ter in succession in their conjugate cylinders, parallel lubricating oil pumps arranged on a circle in said pump body and each including a cylinder and a plunger reciprocatable therein and an oil inlet port and an oil outlet port in said cylinder, means for holding said plungers in operative connection with said rotative member, means associated with said plungers for obturating said oil inlet port during a part of the pressure stroke of said plunger, first conduits connecting the oil inlet ports of said lubricating oil pumps to a source of lubricating oil, second conduits connecting the oil outlet ports to an oil chamber, third conduits radially connected to the respective cylinders of said fuel pumps and to said oil chamber thereby putting the oil chamber in communicating with said fuel pump cylinders, and pressure relief means provided in said pump body and in communication with said outlet ports for controlling the pressure of the oil pumped by the lubricating oil pumps through said outlet ports, whereby a supply of lubricating oil may be pumped between the piston and cylinder of said fuel pumps at a high pressure controlled by said pressure relief means and thoroughly lubricate the connecting surfaces of piston and cylinder and create an effective fuel-tight seal between the latter.

4. In a fuel injection pump including a pump body, a series of fuel pumps arranged about an axis in the latter and comprising each a cylinder and a piston reciprocatable therein, in combination, a rotative member in said pump body and mounted to rotate about said axis, said pistons being operatively connected to said rotative member for their reciprocation in their conjugate cylinders by said rotative member, lubricating oil pumps arranged about said axis in said pump body and each including a cylinder and a reciprocative plunger therein and oil inlet and outlet ports in said cylinder, first conduits connecting the respective oil inlet ports to a source of lubricating oil, an oil chamber in said pump body, second conduits connecting the respective oil outlet ports to said oil chamber, third conduits radially connected to the cylinders of said fuel pumps and to said oil chamber, pressure relief means in said pump body and in communication with said oil outlet ports for controlling the pressure of the lubricating oil pumped by the lubricating oil pumps, and means for maintaining said plungers in operative connection with said rotative member so that the latter reciprocates said plungers in their conjugate cylinders.

5. In a fuel injection pump including a pump body, a series of fuel pumps arranged about an axis in the latter and comprising each a cylinder and a piston reciprocatable therein, in combination, a rotative member in said pump body and mounted to rotate about said axis, said pistons being operatively connected to said rotative member for their reciprocation in their conjugate cylinders by said rotative member, lubricating oil pumps arranged about said axis in said pump body and comprising each a cylinder and a reciprocating plunger therein and oil inlet and outlet ports in said cylinder, a first oil chamber contained within said pump body and surrounding said rotative member, said first oil chamber being connected to a source of lubricating oil, first conduits connecting the oil inlet ports to said first oil chamber, a second oil chamber in said pump body, second conduits connecting the oil outlet ports to said second oil chamber, third conduits radially connected to the cylinders of said fuel pumps and to said second oil chamber thereby putting the second oil chamber in communication with the contacting surfaces of piston and cylinder in said fuel pumps, pressure relief means provided in said pump body and in communication with said oil outlet ports for controlling the pressure of the lubricating oil pumped by the lubricating oil pumps and means for maintaining said plungers in operative connection with said rotative member so that rotation of the latter causes said plungers to reciprocate in their conjugate cylinders.

6. In a fuel injection pump including a pump body, a series of fuel pumps arranged about an axis in the latter and comprising each a cylinder and a piston reciprocatable therein, a rotative member in said pump body and mounted to rotate about said axis, said pistons being operatively connected to said rotative member for their reciprocation in their conjugate cylinders by said rotative member, at least two parallel lubricating oil pumps positioned in said pump body substantially diametrically opposite on either side of said axis, each lubricating oil pump unit comprising, a cylinder having a closed end and an open end, an oil inlet port and an oil outlet port in said cylinder, a hollow plunger having a closed end and an open end and reciprocatable in said cylinder, an oil outlet aperture provided in said plunger at such position therein and having such length in the direction of reciprocation of said hollow plunger that the interior of the plunger is in constant communication therethrough with said oil outlet port, a valve piece having an aperture throughout its length, a portion of this valve piece being slidably mounted in the open end of the hollow plunger, a flange portion constituting a seating surface included in said valve piece at the end thereof remote from the closed end of the hollow plunger, the major diameter of said flange being less than the diameter of said cylinder, an annular shoulder constituting a seating surface provided in said cylinder and having a minor diameter which is greater than the outside diameter of the portion of said valve piece which is slidable in said hollow plunger, said annular shoulder having a position between the open end of the hollow plunger and the flange portion of the valve piece and facing this flange portion so that said seating surfaces are capable of engaging one another, a spring interposed between the closed end of the cylinder and the valve piece for urging said flange portion against said annular shoulder and thereby cause said seating surfaces to engage one another, means for maintaining the closed end of the hollow plunger in constant operative connection with said rotative member, and said inlet port having such position between said annular shoulder and the open end of the hollow plunger when the latter is at the beginning of its pressure stroke that said inlet port is obturated by the hollow plunger for a part of its pressure stroke and the hollow plunger exerts a pressure on the oil thereby trapped in the annular space between the cylinder the valve piece and the end of the plunger, and raises the flange portion of the valve piece off the annular shoulder against the restraint of said spring and urges the oil past the flange portion of the valve piece, through the aperture in the latter, into the hollow plunger and thence through the oil outlet aperture and the oil outlet port without occasioning at any time any loss of oil pressure through said inlet port, pressure relief means being provided in said pump body and in communication with said oil outlet ports for controlling the pressure of the lubricating oil pumped by the lubricating oil pumps.

7. A fuel injection pump comprising, in combination, a pump body having a cylindrical aperture therein, a series of fuel pumps disposed in said pump body about said aperture, said fuel pumps comprising each a cylinder and a piston reciprocatable therein and fuel inlet and outlet passages in said cylinder, a rotative member coaxial with said cylindrical aperture and operatively connected to said pistons to reciprocate the latter in their conjugate cylinders, a cylindrical sleeve immovably held in said cylindrical aperture in a fluid-tight manner, first apertures in said sleeve each one of which is connected to one of said fuel inlet passages, at least two second apertures also provided in said sleeve for each first aperture and having such position as to lie substantially in the diametral plane passing through said first aperture and the axis of said sleeve, the total cross-sectional area of these second apertures being substantially equal to that of their respective first apertures, passageways connecting said first apertures to their respective second aper-

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