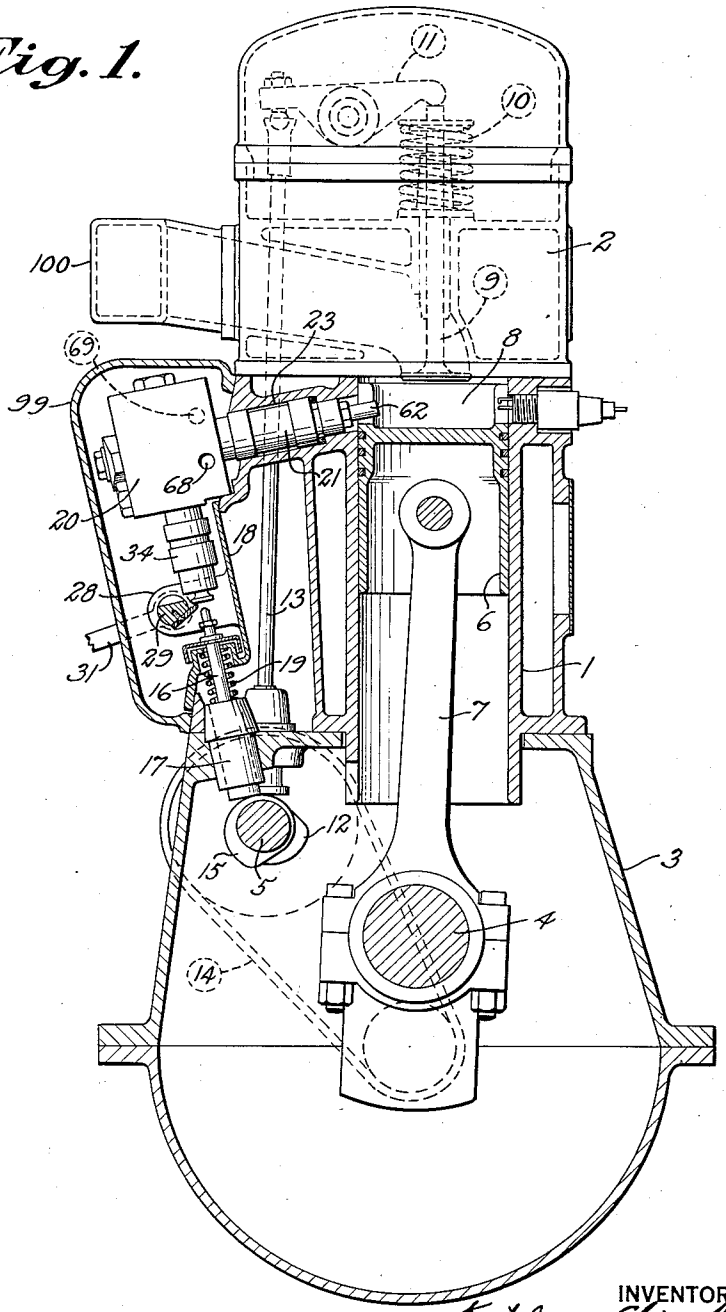
May 19, 1936. K. J. E. HESSELMAN 2,040,847

FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Original Filed May 20, 1931 2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

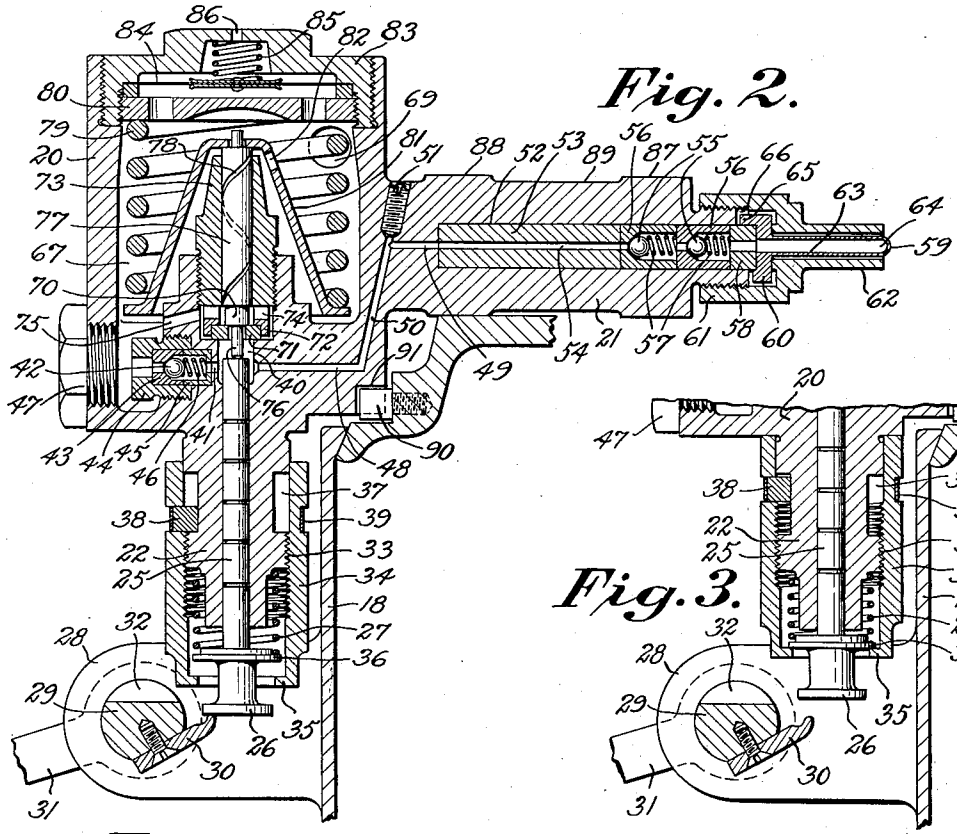


Fig. 3.

Fig. 4.

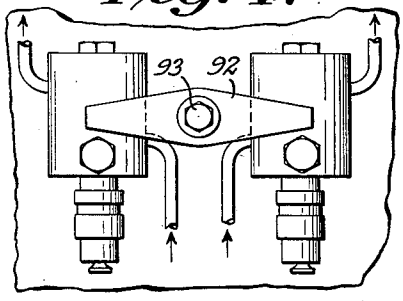


Fig. 5.

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FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

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Application May 20, 1931, Serial No. 538,756. Renewed September 24, 1935. In Sweden November 7, 1927

40 Claims. (Cl. 123—139)

This application is a continuing application in respect to my co-pending applications Serial Nos. 315,957 filed October 30, 1928 (Patent No. 1,912,367 granted June 6, 1933); 473,332 filed August 8, 1930 (Patent No. 1,835,490 granted December 8, 1931); and 483,833 filed September 23, 1930 (Patent No. 1,949,470 granted March 6, 1934); and is to be considered as relating back so far as herein continued, to the aforesaid applications for all dates and rights incident to the filing thereof.

The present invention relates to fuel pumps for internal combustion engines of the type driven by liquid fuel and has particular reference to pumps for engines of such type which are provided with cylinder valves operated through the medium of an engine driven cam shaft.

A major object of the present invention is to provide an improved form of pump construction in which one or more fuel pumps are driven from the engine cam shaft and in which the casing of each pump is provided with a projecting journaled part adapted to be seated in the cylinder casting in such a way as to absorb the torque resulting from the pressure due to actuation of the pump plunger. Other objects of the invention, together with its more specific nature and the advantages to be derived from its use will best be understood from the following detailed description of a preferred embodiment which is illustrated in the accompanying drawings forming a part of this specification.

In the drawings,

Fig. 1 is a side elevation of a pump embodying the invention mounted in an engine which is shown partly in end elevation and partly in transverse vertical cross section;

Fig. 2 is a central longitudinal section on an enlarged scale of the pump shown in Fig. 1;

Fig. 3 is a section of a part of the pump shown in Fig. 2 with the parts illustrated in a different position;

Fig. 4 is a front elevation illustrating mounting of a plurality of pumps in a multi-cylinder engine; and,

Fig. 5 is a diagrammatic illustration showing the manner of connecting a plurality of pumps in a multi-cylinder engine.

Turning now to Fig. 1 reference numeral 1 indicates the engine cylinder and 2 the cylinder head in an internal combustion engine having a crank case 3 in which is mounted the main crank shaft 4 and the usual cam shaft 5. Piston 6 connected to crank shaft 4 by means of connecting rod 7 is located in cylinder 1 and air for combustion is admitted to the combustion chamber 8 and exhaust gases are expelled therefrom through the medium of inlet and exhaust valves located in the cylinder head 2. These valves are ordinarily alined axially of the motor and in the figure one of the valves is indicated at 9.

Inlet and exhaust valves for the cylinder are closed by means of springs 10 and are opened by rocker arms 11 which are actuated by cams 12 on shaft 5 through the medium of vertical push rods 13.

Cam shaft 5 is driven from crank shaft 4 by any suitable means such for example, as the usual cam shaft gear or chain drive indicated in dotted lines at 14.

The cam shaft 5 is utilized to actuate the fuel pumps as well as to operate the engine valves. In engines requiring a plurality of pumps the construction and arrangement of the several pumps with respect to the cam shaft is the same and I will, therefore describe only the construction of one such pump.

For the purpose of actuating the pump the cam shaft 5 is provided with a cam 15 acting on a tappet 16 which extends upwardly and outwardly through a stuffing box 17 in the upper wall of the crank case 3 and through a plate 18 secured to the side of the cylinder casting and providing a partition extending substantially parallel to the axis of the cam shaft and enclosing the space alongside the cylinder through which the tappets 16 extend. A spring 19 seated between suitable shoulders on the plate 18 and the tappet 16 operates to keep the tappet in constant contact with the face of cam 15. As will be explained more in detail later, the construction of the pump is such that the tappet 16 operates to actuate the pump on its delivery stroke, the suction stroke of the pump being effected by spring action.

Referring to Fig. 2, the pump is shown therein in detail. It comprises a casing 20 having two projecting arms 21 and 22, these arms being preferably at right angles to each other. Arm 21 provides a cylindrical journal adapted to seat in a cooperating bore 23 in the side of the cylinder casting, and arm 22 provides a bore 24 for the reception of the pump plunger 25. The end of plunger 25 extending beyond arm 22 is provided with a head 26, the lower face of which is adapted to be directly contacted by the upper end of the tappet 16. The upper face of head 26 acts as a retainer for a spring 27, this spring operating to actuate the pump plunger on the suction stroke.

The partition plate 18 is provided with out-

wardly extending ears 28 carrying the rotatably mounted shaft 29, this shaft being situated outside of the arm 22 of the pump casing. Shaft 29 is provided with an arm 30 adapted to contact the lower face of the plunger head 26 to limit the length of the suction stroke of the pump. In order to vary the length of the suction stroke of the pump, shaft 29 is rotated by means of a lever 31 or the like which may be controlled either by hand or by means of a suitable speed governor. Opposite the head 26 the shaft 29 is grooved as at 32 for a purpose which will be explained later.

Arm 22 is threaded at 33 and over this threaded portion there is screwed a sleeve 34 having an inwardly turned flange 35 at its lower end, the inner diameter of this flange being somewhat less than the diameter of the collar 36 forming the upper portion of head 26. Above the threaded portion 33 the arm 22 is provided with a cylindrical recess 37 into which projects a key 38. Key 38 is removably seated in an opening in the sleeve 35 and is retained in position by a spring steel clip 39 seating in a suitable external groove in sleeve 34. The bore 24 communicates at its upper end with the pump chamber 40 which, it is to be noted, is considerably below the level of the center line of the arm 21.

Opening laterally into the pump chamber 40 is the inlet passage 41 controlled by the pump inlet valve 42. Valve 42 seats against a hardened seat in a sleeve 43 which is seated in the bore of a threaded plug 44 screwed into a suitable recess in the main body portion of the casing. A second sleeve 45 having an inturned flange at its inner end, acts as a retaining member for the valve spring 46. Sleeves 44 and 45 are preferably a tight fit in plug 44 so that upon removal of this plug the entire valve assembly will be removable as a unit. A removable plug 47 screwed in the outer wall of the casing provides means for inserting and removing the inlet valve assembly.

The delivery channel leading from the pump chamber 40 is in the form of a small diameter bore 48 preferably in alinement with the inlet passage 41. Bore 48 is connected with bore 49 at the axis of arm 21 by means of a substantially vertically extending bore 50 closed at its upper end by means of plug 51. Because of the difficulty of making a small diameter bore of sufficient length to extend to the end of the arm 21, the outer end of this arm is bored to a relatively large diameter as at 52 and a plug 53 is inserted in this bore, this plug having a bore 54 therethrough of the same diameter as and registering with the bore 49.

In the outer end of bore 52 are two discharge or delivery valve assemblies 55, each of these assemblies comprising a ball valve seated against a suitable tubular seat-forming member 56 by means of a spring 57.

Outside of the outermost delivery valve assembly is an annular plug 58 which provides an abutment for the outer valve spring 57 to bear against and which also serves to center the injection nozzle 59 carried at the end of the arm 21. The plug 58 serves as a centering means by engaging a recess in the face of the plate-like base 60 of nozzle 59. Nozzle 59 is secured to the end of arm 21 by means of a cap 61 screwed over the externally threaded end of arm 21 and engaging the base 60 of the nozzle. Cap 61 is provided with a tubular extension 62 which serves to protect the relatively delicate tubular portion 63 of the nozzle from damage when the pump and nozzle assembly is removed from the engine.

Nozzle 59 is provided with one or more fuel delivering orifices 64 and in order to prevent rotation of the nozzle when cap 61 is screwed into position (which rotation might throw the delivery orifice or orifices out of their proper position) the base of the nozzle is provided with a projection or lug 65 adapted to engage a suitable notch 66 in the end wall of the arm 21.

The pump casing 20 provides an oil inlet chamber 67 having an oil inlet at 68 and an oil outlet at 69.

The casing also carries a pump release valve 70 arranged to interrupt the effective delivery or discharge stroke of the pump plunger and to return the oil displaced by the plunger after the release valve is opened to the suction side of the pump. The valve seat for the release valve 70 is preferably formed by a separate plate 71 of hardened steel or other suitable material held in place within the pump casing by a distance piece 72 against which the inner end of a retaining sleeve 73 which is screwed into the casing abuts. The distance piece 72 is provided with a plurality of ports or openings 74 affording communication with a channel 75 in the pump casing which leads to the inlet chamber 67. Valve 70 has a downwardly projecting stem 76 adapted to be contacted by the inner end of plunger 25 before the latter reaches the end of its discharge stroke for the purpose of lifting the valve determining the effective discharge stroke of the plunger. It will be noted that clearance is provided between the stem 76 and the valve seat member 71 so that oil may flow freely from the pump chamber 40 to the inlet chamber 67 upon opening of valve 70. Valve 70 is provided with an upwardly extending stem in the form of a plunger 77 slidably mounted in the sleeve 73 which serves as a guide. An external spiral groove 78 is provided on the plunger 77, this groove operating to permit the escape of air from the pump chamber when valve 70 is opened.

The release valve is closed by means of a spring 79 compressed between a spring retaining ring 80 and the lower flange of a cup shaped spring retaining member 81 resting on a suitable shoulder at the upper end of the plunger 77. The spring retainer 81 is provided with one or more perforations 82 adjacent to its upper end.

The perforated spring retaining member 80 is screwed into the removable cover plate 83 the latter being recessed above the member 80 and having a flexible oil proof diaphragm 84 extending across the recess. This diaphragm is preferably backed up by a light spring 85 and the portion of the recess above the diaphragm is vented to the atmosphere through the opening 86.

The manner in which the pump is held in position in the cylinder will be largely obvious from Fig. 1. In order to facilitate insertion and removal of the arm 21 in the cylinder bore 23, this arm is preferably provided with two spaced cylindrical journals 87 and 88, the latter being of slightly larger diameter than the former. These journals are made a close sliding fit within corresponding portions of the bore 23 and between these journals the diameter of the arm 21 may be made somewhat smaller as at 89.

In order to prevent rotational displacement of the pump after it is mounted, the cylinder casting carries a projecting pin 90 adapted to seat in a corresponding recess 91 in the pump casing.

In multi-cylinder engines when two or more

pumps are employed they may advantageously be held in position in pairs (as shown in Fig. 4) by means of clamps 92 through which anchoring studs 93 secured to the cylinder block pass. Other suitable means may, however be employed for removably securing the pumps in position.

I prefer to supply the pumps with oil by means of a circulating system and have illustrated such a circulating supply system in Fig. 5. The arrangement shown in the figure comprises a feed conduit 94 supplied by means of any suitable form of engine driven pump 95 and a return conduit 96 for returning excess fuel to the supply tank. The engine illustrated is of the conventional six cylinder type and it will be observed that the several pumps are connected in parallel between the conduits 94 and 96 by means of branch inlet conduits 97 and branch discharge conduits 98. It will also be observed that oil is supplied through conduit 94 at one end of the motor and is returned by way of conduit 96 from the opposite end of the motor, this arrangement affording the most even distribution of flow through the several pumps.

The operation of the pump will be largely evident from the foregoing description. Oil is drawn into the pump chamber 40 on the suction stroke of the plunger from the supply chamber 67 and on the discharge stroke is delivered through the injection nozzle 59 until the upper end of the plunger contacts the stem 76 on the releasing valve to lift the valve and terminate the effective discharge stroke. The length of stem 76 is such that valve 70 is opened by the pump plunger while the latter is still traveling at a relatively high velocity and the consequent sudden release in pressure provides for sudden cessation of flow through the injection nozzle at a time when the oil is flowing therethrough at high velocity. This prevents poor atomization due to deceleration of flow at the end of the injection period.

It will be apparent that when the release valve 70 is opened by the pump plunger, the oil thereafter returned from the pump chamber to the inlet chamber 67 during the remainder of the upward stroke of the pump plunger will tend to produce pressure pulsations within chamber 67. In order to eliminate such pulsations the diaphragm 84 is provided. A circulating oil supply system such as is shown in Fig. 5 will tend to keep the inlet chamber 67 under a slight pressure and a spring such as spring 85 is preferably employed in conjunction with such a system for the purpose of balancing the normal constant pressure maintained in chamber 67 by the circulating pump 95.

The removal of air from the oil is highly important and in the form of pump herein illustrated any air carried into the pump is effectively removed from the pump chamber. As will be observed from Fig. 2, the release valve 70 is at the upper end of the pump chamber where any air carried into the chamber will automatically tend to collect. The upper end of this chamber is opened upon each discharge stroke of the pump so that air has no opportunity to remain within the pump chamber. Whenever the release valve is opened a free passage for flow of air is provided through the groove 78 and openings 82 to the upper part of chamber 67 from which the air is carried together with the excess oil through the outlet 69 communicating with the branch outlet pipe 98.

Regulation of the amount of oil delivered for each stroke of the pump plunger is governed by varying the length of the intake stroke through movement of the control shaft 29.

It is highly important that the accuracy of the adjustment governing the stroke of the pump be not disturbed and one of the objects of the present invention is to provide a pump which may be readily removed for inspection or repair and then replaced without disturbing any adjustment governing the quantity of fuel delivered by the pump. As will be evident from the drawings the position of the pump is fixed by the seating of arm 21 in the cylinder bore 23. This fixes the position of the release valve 70 governing the termination of the delivery stroke. Shaft 29 is rotatably fixed with respect to the cylinder and since the position of this shaft governs the length of the suction stroke, it is important that it be maintained in accurate alinement.

When it is desired to remove the pump, the sleeve 34 on the arm 22 is screwed upwardly from the position shown in Fig. 2 to the position shown in Fig. 3. This lifts the head 26 on the pump plunger above the level of the bottom of the groove 32 in shaft 29 and upon release of the clamping means securing the pump to the cylinder block permits the pump to be withdrawn from the cylinder without necessitating removal of shaft 29. The sleeve 34 may also be screwed into the position shown in Fig. 3 in case it is desired to render the pump inoperative because of breakage of some part thereof or because of failure of the cylinder with which the pump is associated to function properly for any other cause.

The key 38 prevents the sleeve 34 from being inadvertently screwed off of the stem 22 and provides a positive lock preventing the plunger from falling out of the pump with consequent damage, when the pump is removed from its operating position. If it is desired to remove the pump plunger for any reason this may readily be done by removing the retaining clip 39 and key 38 after which the sleeve 34 may be screwed off and the plunger removed.

It is not necessary to remove the pump if it is desired to remove the inlet valve assembly. Removal of this assembly may readily be accomplished merely by removing the cover plate 99 and unscrewing the plugs 47 and 44.

The release valve assembly may readily be removed upon unscrewing the cover plate 83.

It will be evident that the discharge valve and injection nozzle assembly may be readily disassembled by unscrewing the cap member 61, it being of course obviously necessary to remove the pump before this can be accomplished.

As will be evident from Fig. 1 the pump arrangement is extremely compact, the pump or pumps being so positioned as to not interfere with other auxiliary equipment necessary for the engine. By placing the pump chamber at a level below that of the arm 21, the entire pump may be kept below the level of the top of the cylinder and in a position where it does not interfere with the usual intake or exhaust manifolding 100, at the side of the cylinder head.

Due to the manner in which the arm 21 is mounted in the cylinder, it will be evident that this arm is capable of readily absorbing the torque or bending movements due to pressure created by the pump plunger, thus eliminating the difficulty arising from any part of the mechanism bending or springing out of position due to forces encountered in operation.

It will be apparent that many changes and modifications may be made within the scope of the present invention, which is defined in the appended claims.

What I claim is:

1. A fuel injecting unit for internal combustion engines comprising a casing providing a pump chamber, an arm providing a journal adapted to seat in an engine cylinder to fix the position of the pump, a discharge passage leading from the pump chamber to the end of said arm, an injection nozzle removably secured to the end of said arm and in communication with said passage, a second arm having a bore communicating with the pump chamber, a pump plunger in said bore, said plunger having a portion projecting from said arm, and a sleeve adjustably mounted on the second mentioned arm and adapted to engage the projecting portion of the plunger to hold the same in retracted position.

2. A fuel pump of the plunger type for internal combustion engines comprising a casing providing a pump chamber and a fuel inlet chamber, an inlet valve and a release valve for providing communication between the pump chamber and the inlet chamber, a pump plunger adapted to contact said release valve to open the same during the discharge stroke of the plunger, a laterally projecting arm on said casing providing a journal adapted to seat in an engine cylinder to fix the position of the pump, and a pump discharge passage leading from the pump chamber to the end of said arm.

3. A fuel pump for airless injection of fuel into internal combustion engines comprising a pump casing having a pump chamber, a laterally extending arm providing a journal adapted to seat in an engine cylinder to fix the position of the pump, said arm having an axial bore of relatively large diameter extending inwardly from the outer end thereof, a pump discharge passage of relatively small diameter in said casing providing communication between the pump chamber and said bore, and a sleeve within said bore, said sleeve having a small diameter bore registering with one end of said discharge passage and providing a continuation thereof to a point adjacent to the outer end of the arm.

4. A fuel pump of the character described comprising a casing having a laterally projecting arm adapted to seat in an engine cylinder to fix the position of the pump, said arm having two spaced cylindrical bearing surfaces, the outer of said surfaces being of smaller diameter than the inner surface and the diameter of the arm between said surfaces being less than that of either of said surfaces, and means for preventing said cylindrical bearing surfaces from turning with respect to the cylinder in which they are seated.

5. A fuel pump of the plunger type for internal combustion engines comprising a casing providing a pump chamber and an inlet chamber, inlet and discharge passages communicating with the pump chamber, a release valve above said pump chamber providing communication between places in the pump chamber and in the inlet chamber above said passages, and a pump plunger extending into the pump chamber, said release valve having a part extending into said pump chamber and positioned so as to be opened by the plunger on each discharge stroke thereof whereby to provide a passage for escape of air from the pump chamber to the inlet chamber upon opening of said release valve.

6. A fuel pump of the plunger type for internal combustion engines comprising a casing providing a pump chamber and an inlet chamber, inlet and discharge passages communicating with the pump chamber, a release valve providing communication between said inlet chamber and a point in the pump chamber above said passages, said release valve comprising an upwardly extending stem and groove means providing a channel for escape of air from the pump chamber past said stem when the release valve is opened.

7. A liquid fuel pump of the plunger type for internal combustion engines comprising a pump casing providing a pump chamber and an inlet chamber, a release valve adapted to be opened by the pump plunger on each discharge stroke thereof, said release valve comprising a stem extending into said inlet chamber, a spring located in said inlet chamber and a cup-shaped spring retaining member engaging said stem for causing said spring to close the release valve.

8. A liquid fuel pump for internal combustion engines comprising a casing providing a pump chamber and having inlet and outlet passages communicating with said chamber, a release valve for closing the upper end of said chamber above the level of said passages, a pump plunger, means for reciprocating said plunger to cause it to directly open said release valve at a fixed point in the discharge stroke of the plunger, and means for stopping the plunger at selected points during the suction stroke of the plunger to meter the quantity of fuel drawn into the pump.

9. A fuel pump for internal combustion engines comprising a casing providing a pump chamber and an inlet chamber, a valved inlet passage for flow of fuel from the inlet chamber to the pump chamber, a passage for flow of excess fuel and of air from the pump chamber to the inlet chamber, said passage being arranged above the pump chamber so as to automatically free it of air when the passage is opened, a release valve adapted to be opened by the pump plunger for controlling said last named passage, and means for circulating fuel through said inlet chamber.

10. A fuel pump of the plunger type for internal combustion engines comprising a casing providing a pump chamber and an inlet chamber, means providing for flow of fuel from the inlet chamber to the pump chamber, means for discharging excess fuel from the pump chamber to the inlet chamber during the discharge stroke of the pump plunger, and flexible means for momentarily enlarging the capacity of the inlet chamber to prevent pressure pulsations therein upon return thereto of the excess fuel from the pump chamber.

11. A fuel pump of the plunger type for internal combustion engines comprising a casing providing a pump chamber and an inlet chamber, means providing for flow of fuel from the inlet chamber to the pump chamber, means for discharging excess fuel from the pump chamber to the inlet chamber during the discharge stroke of the pump plunger, said inlet chamber being defined in part by a flexible diaphragm for absorbing pressure pulsations in the chamber due to return thereto of fuel from the pump chamber.

12. A fuel pumping system for internal combustion engines comprising a pump of the plunger type having a pump chamber and a fuel inlet chamber, a pump release valve adapted to return excess fuel from the pump chamber to the inlet chamber on each discharge stroke of the pump, and a flexible diaphragm movable to enlarge the volume of said inlet chamber upon return of fuel thereto from the pump chamber, means for circulating fuel through said inlet chamber, and

spring means acting on said diaphragm to balance the pressure exerted thereon by the pressure required to circulate fuel through the inlet chamber.

13. A fuel supply system for a multi-cylinder internal combustion engine comprising a fuel pump for each cylinder, each of said pumps having a laterally extending arm journaled in a cylinder to fix the operative position of the pump with respect to the cylinder, and common clamping means for removably securing a plurality of pumps in operative position.

14. In an internal combustion engine having a cylinder, a fuel pump having a casing providing a pump chamber and having an extension removably secured to the wall of said cylinder to fix the position of the pump casing with respect to the cylinder, a pump plunger projecting from said casing, engine driven means for actuating said plunger, a rotatable shaft having an arm adapted to contact the end of said plunger to regulate the length of the suction stroke of the plunger, the axis of said plunger passing between said shaft and said cylinder, and said plunger being retractable to permit removal of the pump laterally from the cylinder past said shaft.

15. In an internal combustion engine, a cylinder having inlet and discharge valves, a cam shaft for operating said valves, a fuel pump having an arm journaled in the cylinder to fix the position of the pump with respect to the cylinder, said pump comprising a plunger projecting from the pump casing, a tappet adapted to actuate said plunger by contacting the projecting end thereof, a cam on said cam shaft for actuating said tappet, a control shaft located outside the axis of the tappet and the pump plunger, means associated with said shaft for controlling the length of the suction stroke of the plunger and means for holding said plunger in retracted position to permit removal of the pump past said shaft.

16. In an internal combustion engine, a cylinder having a counterbored opening through the wall thereof, a fuel pump comprising an integral body having a bore forming a pump chamber and an arm having a shoulder adapted to seat against the bottom of the counterbore and bearing surface adapted to engage the side wall of the opening to center the arm, there being a fuel discharge passage through said arm communicating with said chamber, means for clamping said body in position with the arm seated in said opening, a plunger in said bore, and means in said body for relieving pressure in said chamber at a fixed point in the discharge stroke of the plunger.

17. In an internal combustion engine, a cylinder block forming a plurality of cylinders, each having a counterbored opening through the wall thereof, a fuel pump for each cylinder comprising an integral body having a bore forming a pump chamber and an arm having a shoulder adapted to seat against the bottom of the counterbore and bearing surface adapted to engage the side wall of said opening to center the pump with respect to the opening, there being a fuel discharge passage through said arm communicating with said chamber, common clamping means for removably securing a plurality of pumps to said block, a plunger reciprocable in each of said bores, means for reciprocating said plungers, and control means operated by a common member for stopping the suction stroke of each of said plungers at a selected point.

18. In an internal combustion engine, a plurality of cylinders, each having an opening through the wall thereof, a fuel pump for each cylinder, each pump comprising a body having a bore forming a pump chamber and an arm adapted to seat in one of said openings to fix the position of the pump with respect to the cylinder, a plunger in each of said bores, means for removably securing said pumps in position with said arms seating in said openings, means for causing reciprocation of the pump plungers, and control means operated by a common member for stopping each of said plungers at like selected points in their respective suction strokes.

19. In an internal combustion engine having a combustion chamber, the combination with a cylinder having an opening through the wall thereof communicating with the combustion chamber, of a fuel pump comprising a body having a bore forming a pump chamber and an arm having a fuel discharge passage therethrough communicating with the pump chamber, said body having bearing surface for fixing the position of the pump with the arm in said opening, a valve seating in said body for relieving pressure in the pump chamber and having a part extending into said chamber, a plunger in said bore having an inner end adapted to contact the valve part in said chamber to open said valve at a fixed point in the discharge stroke of the plunger, means for actuating the plunger by contacting the outer end thereof, means for removably securing said pump in position with said arm in said opening, and control means for stopping the suction stroke of said plunger at selected points.

20. In an internal combustion engine having a combustion chamber, the combination with a cylinder having an opening through the wall thereof communicating with the combustion chamber, of a fuel pump comprising a body having a bore forming a pump chamber and an arm having a fuel discharge passage therethrough communicating with the pump chamber, said arm having bearing surface adapted to fix the position of the pump with respect to the cylinder by seating against the side wall of said opening, a valve seating in said body for relieving the pressure in the pump chamber and having a part extending into said chamber, a plunger in said bore having an inner end adapted to contact the valve part in said chamber to open said valve at a fixed point in the discharge stroke of the plunger, means for actuating the plunger by contacting the outer end thereof, means for removably securing said pump in position with said arm in said opening, and control means for stopping the suction stroke of said plunger at selected points.

21. In an internal combustion engine having a combustion chamber, the combination with a cylinder having an opening through the wall thereof communicating with the combustion chamber, of a fuel pump comprising a body having a bore forming a pump chamber and an arm having a fuel discharge passage therethrough communicating with the pump chamber, said body having bearing surface for fixing the position of the pump with the arm in said opening, an injection nozzle removably secured to the end of said arm and adapted to project into said chamber when the pump is in fixed position, a valve seating in said body for relieving pressure in the pump chamber and having a part extending into said chamber, a plunger in said bore having an inner end adapted to contact the valve part in said chamber to open said valve at a

fixed point in the discharge stroke of the plunger, means for actuating the plunger by contacting the outer end thereof, means for removably securing said pump in position with said arm in said opening, and control means for stopping the suction stroke of said plunger at selected points.

22. In an internal combustion engine having a combustion chamber, a cylinder having a cylindrical opening through the wall thereof communicating with the combustion chamber, a fuel pump comprising a body having a bore forming a pump chamber and a cylindrical arm having a fuel discharge passage therethrough communicating with the pump chamber, said arm having bearing surface adapted to fix the position of the pump body with respect to the axis of said opening by seating against the wall thereof, means for removably securing said pump in position with said arm in said opening, means for preventing turning movement of the pump body with respect to the opening, a fuel injection nozzle removably secured to the end of said arm and having an orifice for projecting fuel from the nozzle at an angle to the axis of said opening, means for holding said nozzle in a predetermined position of rotation with respect to said arm, a plunger in said bore, and means for actuating said plunger by contacting the outer end thereof.

23. In a fuel injecting unit for internal combustion engines, a body portion adapted to seat in an engine cylinder having a passage therethrough for discharge of fuel, an injection nozzle, means for removably clamping the injection nozzle to the end of said body portion, means for centering the nozzle with respect to said passage, means for insuring the positioning of said nozzle in a given fixed position of rotation with respect to said body portion, and means for insuring the positioning of said body portion in a given fixed position of rotation with respect to the cylinder.

24. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and an end portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, an injection nozzle, means for removably clamping said nozzle to the end of said body portion and means for centering the nozzle with respect to said bore comprising an annular element extending into said end portion of the bore and extending into a suitable cooperating recess in the nozzle.

25. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and an end portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, an injection nozzle, an annular element in threaded engagement with said body portion for removably clamping said nozzle to the end of the body portion and means for centering the nozzle with respect to said bore comprising an annular element extending into said end portion of the bore and extending into a suitable cooperating recess in the nozzle.

26. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and an end portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, an injection nozzle, means for removably clamping said nozzle to the end of the body portion, and means for centering the nozzle with respect to said bore comprising an annular element extending into said end portion of the bore and extending into a suitable cooperating recess in the nozzle, said nozzle and said body portion having cooperating surfaces for insuring the positioning of said nozzle in a given fixed position of rotation with respect to said body portion.

27. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and an end portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, an injection nozzle, an annular element in threaded engagement with said body portion for removably clamping said nozzle to the end of said portion, and means for centering the nozzle with respect to said bore comprising an annular element extending into said end of the bore and extending into a suitable cooperating recess in the nozzle, said nozzle and said body portion having cooperating surfaces for insuring the positioning of said nozzle in a given fixed position of rotation with respect to said body portion.

28. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and the major portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, a plurality of tubular inserts in said bore including an end insert projecting from the end of said body portion, an injection nozzle having a recess and means for removably clamping said injection nozzle to the end of said body portion, said end insert extending into said recess to center the nozzle.

29. In a fuel injecting unit for internal combustion engines, a body portion adapted to extend through the wall of an engine cylinder, said body portion having a bore for discharge of fuel and the major portion of said bore being of substantially larger diameter than necessary for the discharge of fuel, a plurality of tubular inserts in said bore including an insert having discharge valve means therein and an end insert projecting from the end of said body portion, an injection nozzle having a recess, and means for removably clamping said injection nozzle to the end of said body portion, said end insert extending into said recess to center the nozzle.

30. In a fuel pump of the plunger type for internal combustion engines, a casing providing a pump chamber and an inlet chamber above the pump chamber, inlet and release valves providing communication between said chambers, a pump plunger, said release valve being located above the pump chamber and being adapted to be opened by said plunger, said inlet valve being located laterally of the pump chamber, said casing having an opening in the side wall thereof for removal of said inlet valve and a removable closure for said opening.

31. In a fuel pump of the plunger type for internal combustion engines, a pump casing providing a pump chamber and an inlet chamber adjacent to said pump chamber, inlet and release valves providing communication between said chambers, a guide extending into said inlet chamber, said release valve having a stem extending through said guide, a cup shaped spring retainer

engaging said stem, a spring in said inlet chamber engaging said retainer to seat the release valve, and a pump plunger adapted to unseat the release valve to return excess fuel from the pump chamber to the inlet chamber.

32. In a fuel pump of the plunger type for internal combustion engines, a pump casing providing a pump chamber and an inlet chamber adjacent to said pump chamber, inlet and release valves providing communication between said chambers, a removable element providing a seat for the release valve, a guide removably secured in said casing, said guide extending into said inlet chamber and serving to clamp said removable element in position, said release valve having a stem extending through said guide, a cup shaped spring retainer engaging said stem, a spring in said inlet chamber engaging said retainer to seat the release valve, and a pump plunger adapted to unseat the release valve to return excess fuel from the pump chamber to the inlet chamber.

33. In a fuel pump of the plunger type for internal combustion engines, a pump casing providing a pump chamber and an inlet chamber adjacent to said pump chamber, inlet and release valves providing communication between said chambers, an annular element at the end of the pump chamber providing a seat for the release valve, a guide threaded into the casing, said guide extending into said inlet chamber and serving to clamp said annular element in position, said release valve comprising a shouldered plunger having a pin portion projecting through said annular element into the pump chamber and a plunger portion extending through said guide, a spring retainer engaging said plunger portion, a spring in the inlet chamber engaging said retainer to seat the release valve, and a pump plunger adapted to contact said pin portion to unseat the release valve whereby to return excess fuel from the pump chamber to the inlet chamber.

34. In a fuel pump for internal combustion engines, a casing providing a pump chamber and having an arm providing a cylinder for a pump plunger, a plunger in said cylinder having a portion projecting from the casing, a spring engaging the projecting portion of the plunger to move it outwardly of the casing on its suction stroke, and an adjustable sleeve engaging said casing and the plunger for limiting outward movement of the plunger.

35. In a fuel pump for internal combustion engines, a casing providing a pump chamber and having an arm providing a cylinder for a pump plunger, a plunger in said cylinder having a portion projecting from the casing, a spring engaging the projecting portion of the plunger to move it outwardly of the casing on its suction stroke, and an adjustable sleeve threaded over said arm and engaging the plunger for holding the plunger inwardly of the outer end of its stroke against the action of said spring.

36. In a fuel pump for internal combustion engines, a casing providing a pump chamber and having an arm providing a cylinder for a pump plunger, a plunger in said cylinder having a portion projecting from the casing, a spring engaging the projecting portion of the plunger to move it outwardly of the casing on its suction stroke, a sleeve threaded over said arm and engaging the plunger for holding the plunger inwardly of the outer end of its stroke against the action of said spring, and means providing a stop for limiting the outward travel of said sleeve.

37. In a fuel pump for internal combustion engines, a casing providing a pump chamber and having an arm providing a cylinder for a pump plunger, a plunger in said cylinder having a portion projecting from the casing, a spring engaging the projecting portion of the plunger to move it outwardly of the casing on its suction stroke, a sleeve threaded over said arm and engaging the plunger for holding the plunger inwardly of the outer end of its stroke against the action of said spring, and means providing a stop for limiting the outward travel of said sleeve comprising an annular recess in said arm and a part on said sleeve projecting into said recess.

38. In a fuel pump for internal combustion engines, a casing providing a pump chamber and having an arm providing a cylinder for a pump plunger, a plunger in said cylinder having a portion projecting from the casing, a spring engaging the projecting portion of the plunger to move it outwardly of the casing on its suction stroke, a sleeve threaded over said arm and engaging the plunger for holding the plunger inwardly of the outer end of its stroke against the action of said spring, and means providing a stop for limiting the outward travel of said sleeve comprising an annular recess in said arm and a part on said sleeve projecting into said recess, said part being removable from the sleeve to permit the sleeve to be screwed off the arm, whereby to permit removal of the plunger from the casing.

39. In an internal combustion engine, a cylinder having a bore through the side wall thereof, a fuel pump comprising a casing having a laterally projecting arm providing a journal engaging the wall of said bore, a pump plunger projecting from said casing substantially at right angles to said arm, engine driven means for forcing said plunger inwardly of the casing on its discharge stroke, means separate from the pump adapted to contact said plunger to control the length of the suction stroke thereof, the axis of said plunger passing between the last mentioned means and the cylinder, and means associated with the pump casing for holding the pump plunger in retracted position to permit removal of said pump laterally of the cylinder.

40. In apparatus of the character described, a cylinder block having a plurality of cylinders, a bore through the side wall of each of two adjacent cylinders, a fuel pump for each cylinder, each pump comprising a casing having a laterally projecting arm providing a journal engaging the wall of one of said bores, means providing cooperating abutment surfaces for preventing turning movement of the pumps about the axes of their respective arms, and a yoke engaging two adjacent pumps for removably clamping the same in operative position to said cylinder block.

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