

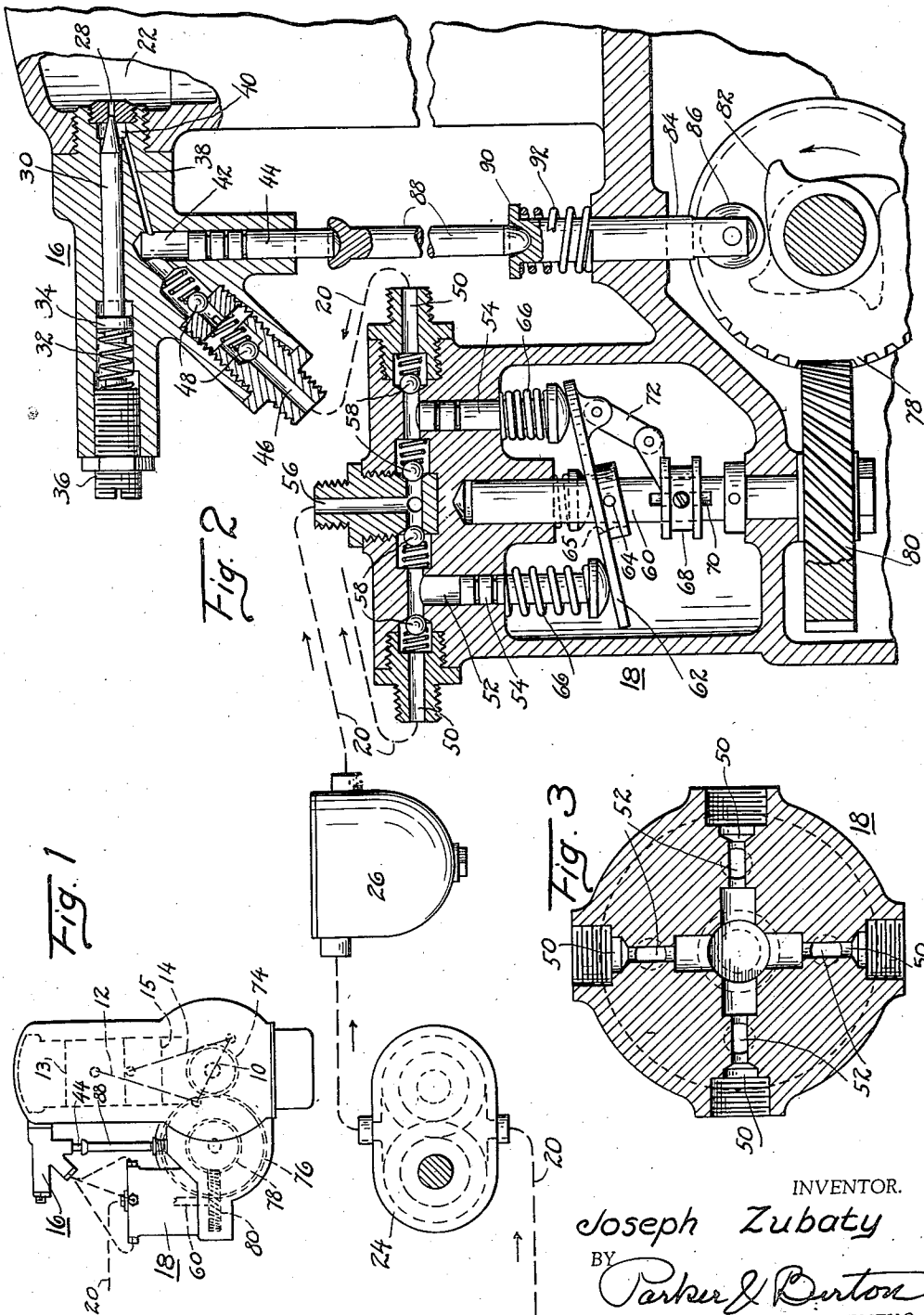
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FUEL FEED MECHANISM FOR INTERNAL COMBUSTION ENGINES

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FUEL FEED MECHANISM FOR INTERNAL COMBUSTION ENGINES

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This invention relates to fuel injection systems for internal combustion engines and has particular reference to the manner of pumping and metering the fuel delivered to the engines. Although this invention is particularly adapted for that type of internal combustion engine generally designated as Diesel engines, it is not entirely limited to such a type but may also be advantageously applied to other types.

It has been the custom in the past to deliver fuel to the combustion chamber of a Diesel engine under high pressure, and at the same time to regulate the charge of fuel in order to vary the speed of the engine. One of the difficulties presented by such an arrangement is that under the high pressures developed and because of the high speed of the operating parts it becomes exceedingly difficult to accurately control the fuel charge delivered.

It is an object of this invention to overcome the aforementioned difficulty by providing an improved fuel injection system which enables easily and accurately controlled charges of fuel to be delivered to the internal combustion engines. This is accomplished by undertaking the metering of the fuel, which operation requires the greatest accuracy, at low pressures.

A further object of this invention is to increase the responsiveness of the engine to the control exercised by the operator, and this is obtained by providing an improved fuel and distributing pump having operating parts which may be machined with the utmost accuracy and which, if any wear takes place, will affect all the cylinders equally.

A further object of this invention is to provide a fuel pumping system for internal combustion engines which is economical to construct and maintain and which eliminates high pressure piping of the fuel thereby decreasing the likelihood of fuel leakage.

Another object of this invention is to provide a fuel delivery system for internal combustion which combines a low pressure regulatable fuel pump and distributor with high pressure fuel injection devices in such a manner that the quantity of fuel is regulated at low and easily controlled pressures but is delivered into the cylinders under high pressures.

A still further object of this invention is to provide in a fuel delivery system of an internal combustion engine a fuel injection device which is adaptable to receive already metered charges of fuel and to automatically vary its fuel charge

capacity directly in accordance with the received metered charges of fuel.

A meritorious feature of this invention is the fuel pumping system as a whole. The fuel is conducted from a fuel supply to the internal combustion engine by a low pressure distributing pump and a plurality of high pressure injection pumps associated with each cylinder of the engine. Control mechanism is associated with the low pressure distributing pump for accurately determining the amount of fuel charge delivered thereby, and this pump distributes this measured amount of fuel under low pressure to the injection devices. These injection pumps, which are operatively connected with the engine, force the measured fuel that they have received at timed intervals and under high pressure into their respective cylinders. The high pressure injection pump is so associated with the operation of the low pressure pump that it is adapted to vary the extent of its operation directly in proportion to the measured charges of fuel received.

Various other objects and meritorious features of my invention will become apparent from the following description taken in conjunction with the drawing wherein like numerals refer to like parts throughout the several figures and wherein:

Figure 1 is a diagrammatic view of an internal combustion engine showing a pair of adjacent pistons for driving the crank shaft and the distribution of the fuel pumps with respect to the engine,

Figure 2 is an enlarged view, partly in cross section, of the fuel delivery system showing in detail the operating arrangements of the low and high pressure means for metering and injecting the fuel into the cylinders of the engine, and

Figure 3 is a sectional view of a portion of the fuel distributing pump showing the manner of distributing the fuel from the pump.

In Figure 1 a diagrammatic illustration of an internal combustion engine includes a crank shaft 10 about which are mounted a plurality of piston rods as 12 and 14 for driving the crank shaft when the pistons 13 and 15, to which the rods are connected, are moved by the pressure of the burning fuel. The pistons are mounted within aligned cylinders (not shown) and to each cylinder there is connected a fuel injection device generally designated as 16. Associated with each of these fuel injection devices 16 is a fuel

distributing pump generally indicated at 18. The dotted lines extending from the distributing pump to the injection device represent, diagrammatically, the manner in which the fuel is distributed from the former to the latter. Both the distributing pump and the injection device are operatively connected with the engine as shown in Figure 1 and as will be more fully pointed hereinafter.

In Figure 2 a more detailed view of one embodiment of the invention is shown. The dotted line 20 indicates diagrammatically a fuel conduit extending, as shown by the arrows, from a source of fuel supply (not shown) to combustion chamber 22 of an internal combustion engine. In this fuel conduit there are located a gear supply pump 24 for forwarding the fuel in the direction of the combustion chamber, a fuel filtering mechanism 26, and the aforementioned fuel distributing pump 18 and injection device 16.

The fuel inlet 28 into the combustion chamber is normally closed by the nozzle of a needle valve 30 of usual design which forms part of the injection device 16. The needle valve 30 is normally held in closed position by the spring 32 seated at one end against a flange 34 on the needle valve and at the other end against an adjustable mounting 36. The spring 32 is normally so tensioned that for relatively low pressures exerted on the nozzle of the needle it maintains the latter in closed position, but when the pressure reaches a predetermined relatively high pressure the spring yields allowing the valve to open.

Fuel is delivered through the passage 38 and a chamber 40 located adjacent the nozzle of the needle valve 30. Communication is established between the chamber 40 and the inlet 28 when the needle valve is opened under pressure of the fuel in the chamber 40. Mechanism for exerting a pressure on the fuel to open the valve 30 is provided in the form of a compression chamber 42 communicating directly with the passage 38 and a reciprocating pump plunger 44 operable within the compression chamber. The pump plunger 44 is operatively connected with the engine as will be more clearly described hereinafter.

Fuel is delivered into the compression chamber 42 through the passage 46 of the injection device 16. A pair of check valves 48 prevent the fuel under pressure in the compression chamber from returning back into the fuel lines. Each of the passages 46 of the injection devices is in communication with one of the discharge outlets 50 of the fuel distributing pump 18. The discharge outlets 50 are shown arranged in a circular formation as indicated in Figure 3, and associated with each of these outlets is a pumping chamber 52 and a plunger 54. Fuel is delivered to each of these pumping chambers 52 through the inlet 56 which is connected with the fuel line leading to the fuel supply. A number of check valves 58 are disposed within the communicating passages of the fuel distributing pump 18 for forwarding the fuel in the direction of the fuel injection devices 16.

A shaft 60 is disposed along the axis of the circularly arranged pump plungers 54. A cam plate 62 is pivotally mounted on the shaft 60 by the pin 64. The opening 65 in the cam plate through which the shaft 60 extends is of a considerably larger diameter than the latter, and it is readily apparent that the cam plate may be tilted to a number of planes angularly displaced with respect to the shaft. As shown in Figure 2 the cam plate engages the exposed end of the

plungers 54, and the latter are constantly maintained in contact with the cam plate by means of the springs 66. Means for tilting the cam plate 62 are provided in the form of an axially slidable collar 68 which is slidable for a portion of the length of the shaft in the keyway 70. Pivotaly connected between the collar 68 and the cam plate 62 is a link 72 which transfers the axial movement of the collar to the edge of the plate tilting the latter with respect to the shaft 60. A bifurcated control mechanism of any suitable design could readily engage and move the collar 68 and thereby tilt the cam plate to regulate the fuel discharge of the distributing pump.

In the embodiment illustrated herein, both the fuel distributing pump and the injection device are driven from the engine. This driving relation is diagrammatically represented in Figure 1 where a gear wheel 74 on the crank shaft 10 is geared to a larger gear 76. The latter in this figure is adapted to be driven at half crank shaft speed. Mounted on the same shaft as the gear 76 is the gear 78 which engages gear 80 fixed to the shaft 60 in Figure 2. Also mounted on the said shaft as the gears 76 and 78 are the cams 82 which are adapted to rotate at half crank shaft speed and operate the plungers 44 in the fuel injection device. This is merely illustrative of a driving mechanism for this purpose.

Mechanism extending from each cam 82 for actuating the pistons 44 comprises a lifter 84 to which is secured a roller 86 adapted to be contacted by the cam, and a push rod 88 for transmitting the motions of the lifter to the piston. A flange 90 is provided on the lifter 84 and between the flange and a portion of the cylinder housing there is mounted a spring 92 which supports the weight of the push rod 88 and the piston 44 and normally spaces the roller 86 from the less cammed portions of the cam 82 as shown in Figure 2. The spring 92 is yieldable to fuel pressures in the compression chamber 42, and in so yielding it lowers the piston 44 increasing the volume of the compression chamber. The extended portion of the cam 82 is adapted upon rotation to contact the roller 86 and force the piston through the medium of the lifter and push rod, up into the compression chamber.

In the operation of the device disclosed herein, both the fuel distributing pump and the fuel injection devices are driven by the engine. The up and down motion of the plungers 54 in the distributing pump is obtained from the tilted cam plate 62 which rotates with the shaft 60. Since the same plate actuates each of the plungers, they all discharge the same quantity of fuel, and any variation in the angle of the plate affects the operation of all of the plungers in the same proportion. The fuel discharged by each plunger is delivered to its respective cylinder under relatively low pressure. This is due to the fact that the tilt of the rotating plate 62 forms a gradual cammed surface forcing the plungers through the chambers 52 at a comparatively slow speed.

The measured charge of fuel discharged from any one of the pump chambers 52 is delivered to the compression chamber 42 and the chamber 40 under a pressure insufficient to raise the needle valve 30 from its seat. However, the pressure of the fuel within these chambers is sufficient to compress the spring 92 and as a result the volume of the chambers for the received charges of fuel is increased directly in proportion thereto. When the extended portions of the cam 82 engage the

roller 86, the piston 44 is forced deep into the chamber 42 compressing the fuel therein and building up sufficient fuel pressure to lift the nozzle of the valve 30 from its seat allowing the fuel to be injected into the combustion chamber 22.

To vary the delivery of fuel the collar 68 is moved axially along the shaft 60 changing the plane of the cam plate and increasing or decreasing the extent of the plunger movement. The cam plate is merely a flat disc and can be machined with extreme accuracy. The plungers of the distributing pump move comparatively slowly and develop relative low fuel pressures thereby rendering possible the extremely exact metering of the fuel. Because of the low pressure of the metered fuel the conduit conducting the fuel may be small sectioned thin walled tubing. The only high pressures developed in the fuel line occur adjacent the combustion chamber, and, as shown in Figure 2, short but relatively stronger means may be employed for sustaining these pressures.

Various modifications of my improved mechanism will be apparent to those skilled in the art and for this reason I intend to limit myself only within the scope of the appended claims.

What I claim:

1. Fuel delivery mechanism for an internal combustion engine, comprising, in combination, a relatively low pressure metering pump operable to deliver variable charges, a relatively high pressure force pump communicating with the metering pump to receive metered charges therefrom and adapted to deliver said charges under relatively high pressure, a piston in said high pressure pump means adapted to drive said piston at certain intervals of time and resilient means spacing said piston from said driving means a distance inversely varying as the quantity of the charge delivered by said low pressure pump.

2. A fuel delivery system for an internal combustion engine comprising, in combination, a low pressure variable delivery fuel pump, a high pressure fuel pump adapted to receive variable charges of fuel from the low pressure pump and deliver the same under relatively high pressure, a piston in the high pressure pump, means adapted to act directly upon said piston to discharge the fuel from said high pressure pump, and resilient means spacing said piston from driving contact with said means in the interval of time between the pump operations of said piston, said resilient means being yieldable to varying charges received by the high pressure pump to position the piston at varying distances from said driving means prior to each pumping operation.

3. A fuel delivery system for an internal combustion engine comprising, in combination, a fuel line, a relatively low pressure variable delivery fuel pump in said fuel line adapted to deliver variable quantities of fuel therethrough, a relatively high pressure fuel pump in said fuel line between said low pressure pump and the discharge end of the fuel line adapted to act on the variable charges of fuel in the line and convey the same under relatively high pressure, said high pressure pump having a reciprocating plunger therein, a cam adapted to act upon said plunger to deliver pumping strokes thereto, and a spring resiliently spacing said plunger from said cam except when said cam is acting to drive said plunger, said spring yieldable under variable charges of fuel received by the high pressure pump to vary the length of the stroke of the plunger.

4. Liquid delivery mechanism comprising, in

combination, a low pressure metering pump, a high pressure pump communicating therewith to receive variable charges therefrom, driving mechanism for the high pressure pump, said driving mechanism including means yieldable to the metered charge received to vary the length of the delivery stroke of the pump directly as the received metered charge varies in quantity.

5. Fuel delivery mechanism for an internal combustion engine comprising, in combination, a relatively high pressure fuel injection device having a compression chamber and a piston reciprocable therein, a low pressure fuel metering device communicating with said compression chamber and operable to deliver measured charges of fuel thereto under relatively low pressure, means for positively driving said piston intermittently through said compression chamber to discharge fuel therefrom under relatively high pressure, and means yieldingly tending to urge said piston into said compression chamber and responsive to the pressure of the fuel charges delivered by said metering pump to permit said piston to yield and vary its initial position prior to its movement through the compression chamber.

6. Fuel delivery mechanism for an internal combustion engine comprising, in combination, a fuel injection device having a compression chamber and a plunger reciprocable therein, a valve controlling the flow of fuel from said compression chamber held normally closed but yieldable to a determined fuel pressure to open and permit the fuel from said compression chamber to flow therethrough, a fuel metering device communicating with said compression chamber and operable to deliver measured quantities of fuel thereto at pressures insufficient to open said valve, means adapted at timed intervals to move said plunger and exert pressure on the fuel in said compression chamber sufficient to open said valve and discharge the fuel therethrough, means yieldingly mounting said plunger and adapted at other than said timed intervals to permit the plunger to yield to the pressure of the fuel in the compression chamber as it is delivered thereto by said metering device whereby the volume of said injection device may be automatically varied by the low pressure metering pump prior to each fuel injection operation.

7. Fuel delivery mechanism for an internal combustion engine comprising, in combination, a fuel compression chamber, means for delivering metered charges of fuel thereto, a plunger reciprocable in said compression chamber adapted to eject fuel therefrom, means operable at certain intervals of time to drive said plunger through said compression chamber, and resilient means yieldingly urging said piston into said compression chamber and providing a lost motion drive relationship between said driving means and said plunger.

8. Fuel delivery mechanism for an internal combustion engine comprising, in combination, a fuel compression chamber having a discharge passage, a valve controlling said passage, a spring urging said valve to closed position, a plunger mounted for reciprocable movement in said compression chamber and operable at certain intervals of time to force the fuel from the chamber at sufficient pressures to open said valve, a spring urging said plunger into said chamber, said plunger spring being yieldable at a pressure lower than said valve spring.

9. Fuel delivery mechanism for an internal combustion engine comprising, in combination,

a fuel line, a normally closed control valve in said fuel line responsive to a predetermined fuel pressure to open and permit passage of fuel thereby, a fuel pump in said fuel line adapted to deliver variable charges of fuel therethrough under pressure insufficient to open said control valve, a fuel injection mechanism in said fuel line adapted to receive said variable charges of fuel, said injection mechanism having a part yieldable to the pressure of said variable charges of fuel to increase the volume of the injection mechanism in accordance with the pressure of the variable charges of fuel received, and means operable to drive said fuel injection mechanism at timed intervals and at sufficient pressure to cause the fuel discharged thereby to open said control valve and pass thereby.

10. A fuel injection device comprising, in combination, a pump chamber having a fuel inlet and a fuel discharge outlet, a plunger reciprocable in said chamber, means operable to move said plunger at timed intervals, and resilient means yieldingly spacing said plunger from operative association with said means except when the latter functions to move said plunger, said resilient means permitting said plunger to yield to the pressure of the fuel introduced into said pump chamber.

11. A fuel injection device including a reciprocating part, means for delivering pumping strokes to said part, and a spring yieldingly spacing said part from operative relationship with said means in the intervals of time between the action of said pumping strokes.

12. Drive mechanism for a fuel injection device including means for delivering pump strokes, a member adapted to receive said strokes, and a spring engaging said member and yieldingly supporting the same except when said means is delivering said pump strokes.

13. A fuel injection apparatus comprising, in combination, a fuel pump including a compression chamber and a piston reciprocable therein, means for intermittently driving said piston through said chamber to eject fuel therefrom, and a spring yieldingly restraining said piston

from rearward movement between said ejection operations to permit the piston to yield to the pressure of the fuel introduced into said chamber prior to each ejection operation.

14. A two stage fuel delivery system comprising, in combination, a low pressure metering fuel pump having a fuel chamber and a plunger reciprocable therein, a relatively high pressure fuel injection pump having a fuel compression chamber and a plunger reciprocable therein, fuel conduit means connecting said chambers and adapted to convey the metered charges of fuel discharged by said low pressure pump to the chamber of said high pressure injection pump, means for driving the plunger of said low pressure pump, means for varying the stroke of the plunger of said low pressure pump to vary the fuel charges delivered to said injection pump, means for driving the plunger of said injection pump on the injection stroke, and resilient means yieldingly spacing the plunger of the injection pump from operative connection with said last mentioned means in the intervals of time between injection strokes, said resilient means permitting the plunger of the injection pump to yield variable distances in said compression chamber prior to each injection stroke and in proportion to the size of the fuel charge delivered thereto by said low pressure pump.

15. A fuel delivery system comprising, in combination, a relatively high pressure fuel injection pump having a fuel compression chamber and a plunger reciprocable therein, means for intermittently feeding fuel charges into said compression chamber, means for varying the size of the fuel charges thus delivered, means for driving said plunger intermittently through said chamber to eject fuel therefrom under relatively high pressure, and means rendering said plunger yieldable to the pressure of fuel in the compression chamber as it is delivered thereto whereby said plunger will yield to the fuel charges delivered to the compression chamber in direct proportion to the size of the fuel charges.

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