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FUEL INJECTION SYSTEM

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2 Sheets-Sheet 1

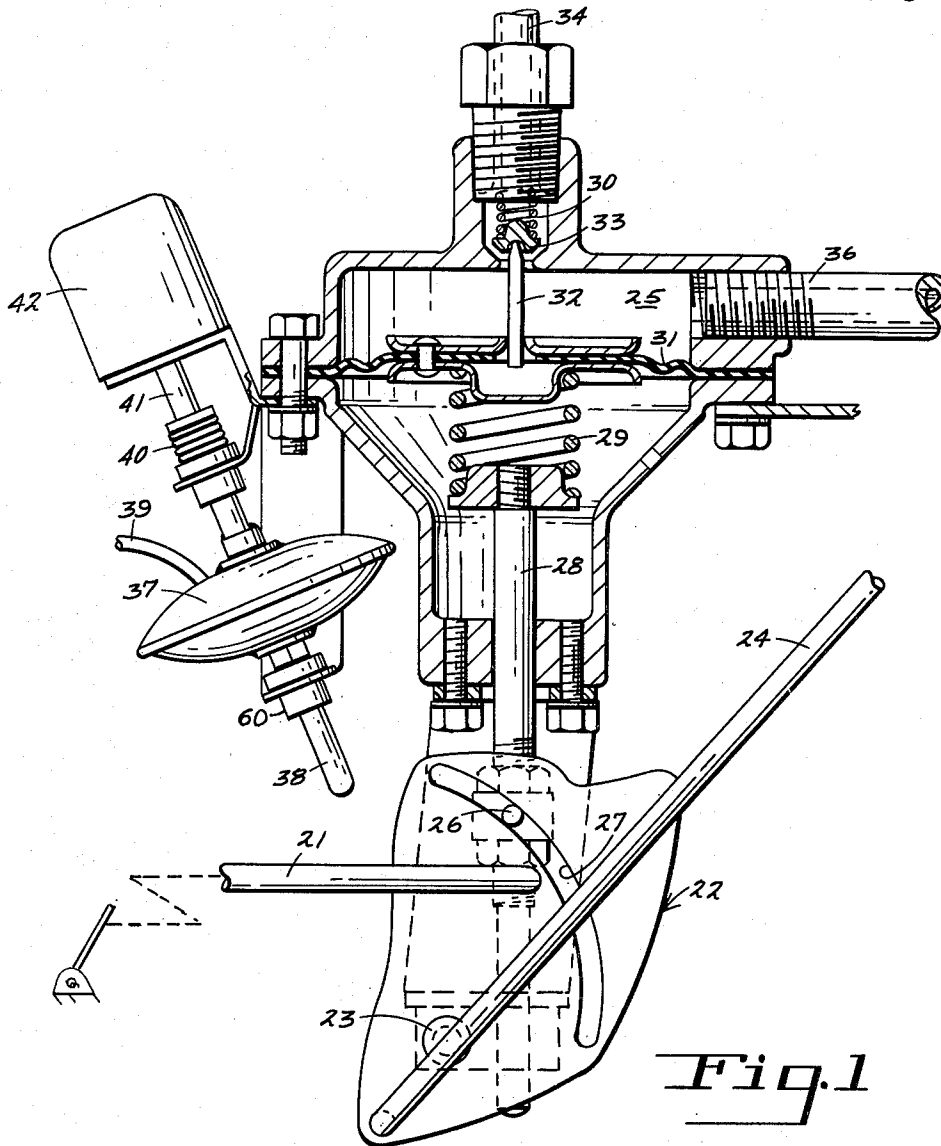


Fig. 1

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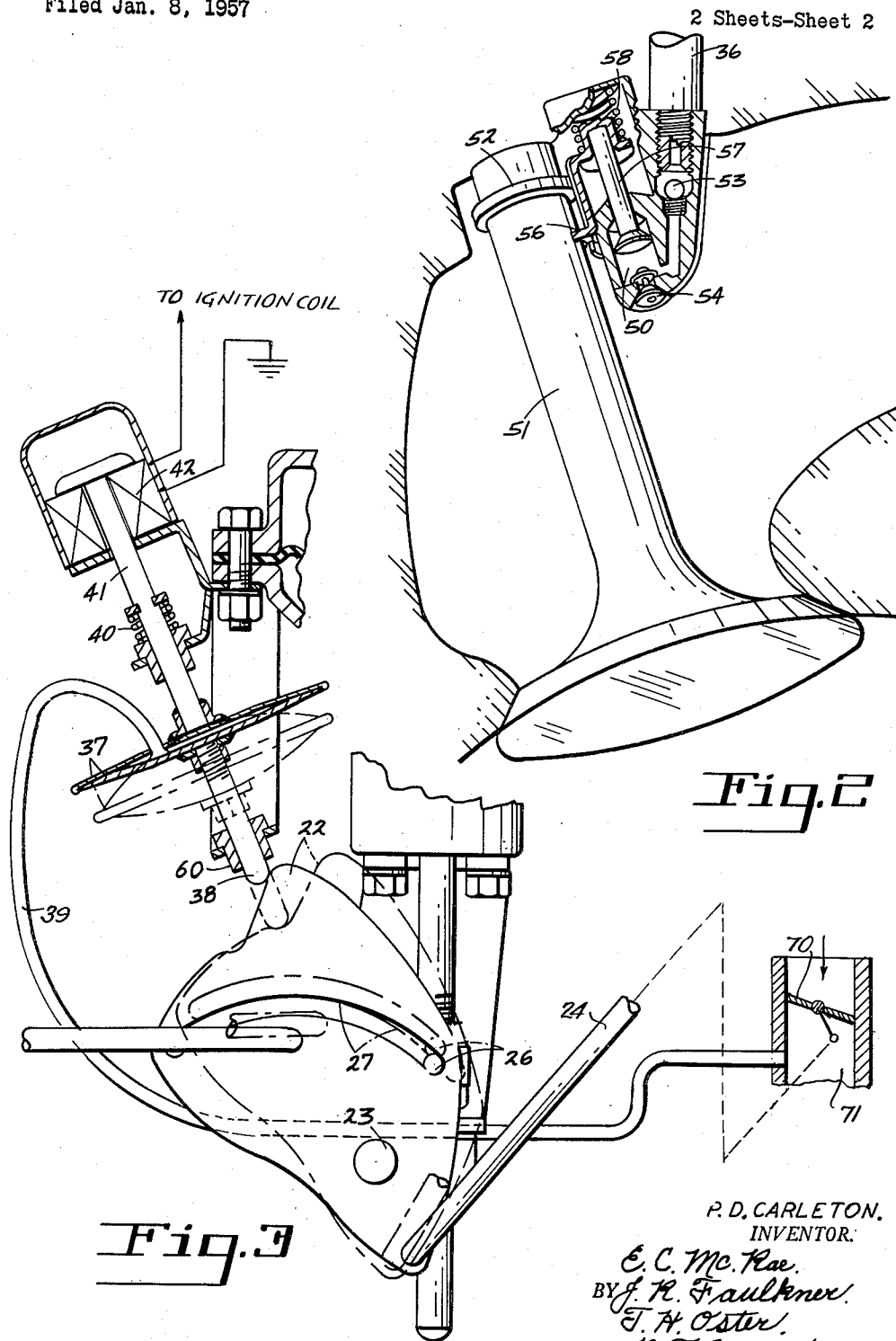


Fig. 2

Fig. 3

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This invention pertains to a fuel injection system for internal combustion motor vehicle engines.

In fuel injection systems a relatively high pressure is desired at the nozzle to provide a good atomization of the fuel. It is desirable, however, to employ low pressures due to pumping difficulties and leakage problems. This invention provides for a low pressure system up to the point of injection when a higher pressure is generated by the act of opening the intake valve or crankshaft responsive movement. Due to a check valve this pressure is not felt in the rest of the system.

Also, this invention has, through the use of a unique variable pressure valve assembly, a direct connection between the accelerator pedal and means for regulating the fuel pressure in the system up to the nozzle area. In combination a vacuum chamber or dash pot is used which allows complete fuel cutoff during deceleration yet will provide adequate fuel during engine idling. When the ignition is turned off means are incorporated to reduce all fuel to the system unless the accelerator pedal is pumped or depressed and the pre-supply pump is operating.

These and other objects will become more apparent when an embodiment of this invention is considered in connection with the following drawings in which:

Figure 1 is a partially sectioned view showing the variable pressure valve assembly in combination with an accelerator linkage and cam plate;

Figure 2 shows in perspective a partially sectioned view at the nozzle area showing the pressure chamber which is actuated by the intake valve; and

Figure 3 shows dash pot and solenoid which provide respectively for fuel cutoff during deceleration and during ignition switch off condition with the dash pot being shown in a collapsed position and in phantom in the expanded position.

In Figure 1 is seen accelerator-operated rod 21 which pivots cam plate 22 about pivot 23. Link 24 leads to an air control valve 70 on an intake duct 71 (Figure 3). Pin 26 which is attached to shaft 28 rides in slot 27 of cam 22, causing shaft 28 to reciprocate varying the pressure on spring 29. Attached to diaphragm 31 is peg 32 which rides against valve 33 shown in the open position. Pressure from a fuel pump, not shown, is present in tube 34 and urges diaphragm 31 downwardly tending to close valve 33. As valve 33 closes, fuel pressure on diaphragm 31 decreases and spring 29 tends to open valve 33 to maintain an equilibrium depending on the pressure of spring 29. Duct 36 leads to the fuel injectors while dash pot 37, shown in an expanded position, controls the position of stud 38 which reciprocates in bearing 60 and influences cam 22 when said cam is in a fuel cutoff position such as is shown in Figure 3. Tube 39 is connected to the intake duct 71 while the upper side of dash pot 37 is connected to rod 41 which is influenced by solenoid 42.

Looking at Figure 2 is seen the nozzle assembly for one cylinder which has intake valve 51 with collar 52 fixed thereto. Fuel enters from the pressure regulator shown

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in Figure 1 at duct 36 where it passes ball check valve 53, shown in an open position, into variable chamber 50 and out past valve 54 when the intake valve is opened and collar 52 acts against tang 56 bringing piston 57 downwardly in a compression stroke. Spring 58 acts against piston 57 to oppose the intake of fuel from duct 36.

In Figure 3 cam plate 22 is shown in a fuel cutoff position with dash pot 37 collapsed under very low manifold pressure allowing pin 26 to assume full travel in slot 27. It may be seen that with dash pot 37 expanded stud 38 will force cam plate 22 rightwardly allowing for engine idling by changing the position of pin 26. Solenoid 42 is connected to be energized by the ignition system to hold rod 41 downwardly against the action of spring 40 but when deenergized rod 41 and dash pot 37 will move upwardly allowing complete fuel cutoff even though dash pot 37 is expanded.

The operation of this embodiment is as follows. In Figure 1 fuel enters in tube 34 from a supply pressure not shown and which may be of relatively low value but which should result in a force which when acting on the area of diaphragm 31 and in combination with spring 30 to be more than the opposite force exerted by spring 29 when rod 28 is in its uppermost position. As accelerator rod 21 is depressed or moved rightwardly, cam plate 22 will cause shaft 28 to move upwardly compressing spring 29 which will open valve 33 until the pressure in chamber 25 is enough to overcome spring 29 pressure closing valve 33. In this way it may be seen that a different pressure in chamber 25 is available for each position of rod 28 which is controlled by the position of cam plate 22. This pressure is felt at all the nozzle areas such as the one in Figure 2 and the greater the pressure the higher piston 57 will be lifted against spring 58 increasing the size of chamber 50. As the intake valve is opened, as by a cam shaft, collar 52 will strike tang 56 forcing piston 57 downwardly in a compression stroke injecting the contents of chamber 50 past valve 54 and into the combustion chamber. Ball check valve 53 prevents the injection pressure from forcing any fluid back into the system. In this way the injection timing and the high pressure desired is obtainable from the intake valve simplifying and reducing costs. Of course piston 57 could be compressed to discharge the contents of chamber 50 by any member, rod, arm or means which is actuated by the camshaft or other engine driven shaft.

Looking at Figure 3 is seen a device for completely cutting off fuel supply to the nozzle areas when the intake manifold pressures are very low, as they would be during vehicle deceleration. Dash pot 37 is collapsed under influence of the low pressures in duct 71 allowing cam plate 22 to turn to its extreme leftward position. However, as the pressure increases dash pot 37 expands urging cam plate a few degrees rightwardly providing sufficient fuel for idling. When the ignition switch, not shown, is turned off solenoid 42 becomes deenergized and spring 40 moves rod 41 and dash pot 37 outwardly permitting cam plate 22 to assume a fuel off position.

Slot 27 may take any desired form so that just the right amount of fuel will be administered to the combustion areas for each accelerator depression. Since the concept of this invention includes utilizing the intake valve or other engine driven discharging member for timing and a high pressure source, a simplified, inexpensive assembly is provided.

It will be understood that the invention is not to be limited to the exact construction shown and described, but that various changes and modifications may be made without departing from the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. A throttle controlled motor vehicle fuel injection system comprising a throttle linked cam plate, said plate connected to one side of a diaphragm through spring means, the other side of said diaphragm subject to fuel pressure, fuel inlet means being connected to said diaphragm, said inlet means in fuel restricting position when said diaphragm is in a predetermined position.

2. A motor vehicle fuel injection system comprising a fuel source, a fuel compression chamber having a piston and being located near the injection area, a combustion chamber having a fuel intake valve, means to open said valve, said valve having a member for actuating said piston so that on an opening stroke the fuel in said compression chamber will be discharged under a predetermined pressure into said combustion chamber.

3. A motor vehicle fuel injection system comprising a throttle pedal link, a slotted plate pivotable by movement of said link, a spring having a compressor engageable with said slot, a fuel source valve sensitive to the injection system fuel pressure and said spring, said valve being closed when said system pressure overcomes said spring force.

4. The system of claim 3 with said plate having a cammed surface engageable with holding means, said means directed towards said plate and engageable with said plate to hold said plate in a minimum fuel pressure position, said means having a collapsible chamber connected to intake manifold pressures so that upon low intake pressures corresponding to deceleration pressures said chamber will collapse releasing said plate from said minimum position decreasing said fuel pressure.

5. The system of claim 4 with said means being held in said minimum fuel pressure position by an ignition system solenoid, said means being spring urged in a plate releasing direction when said solenoid is deenergized.

6. A fuel injection system for an internal combustion engine having a camshaft operated intake valve comprising an annular ring fixed to the stem of said valve, said ring registerable with a piston tang so that on an opening movement of said valve said piston will be actuated in a compressing direction, forcing fuel past a valve, said piston being spring urged in a fuel compressing direction against a variable pressure fuel source so that the higher the pressure of said source the higher said piston is lifted against said spring increasing the fuel forced past said valve, a ball check valve preventing flow to said fuel source on a compressive stroke of said piston.

7. The system of claim 6 with said variable pressure source comprising an accelerator pedal actuated slotted cam, a diaphragm spring compressing rod riding in the slot of said cam, a diaphragm actuated valve for admitting fuel into a diaphragm chamber with said valve being open until the pressure in said chamber corresponds to the pressure of said diaphragm spring.

8. A motor vehicle fuel injection system comprising a fuel chamber for each combustion cylinder subject to a variable pressure fuel source and expandable as the pressure of said source increases, engine driven means to discharge said chamber into said cylinder in timed relation to the opening of the intake valve for said cylinder.

9. A fuel injection system for metering and distributing fuel to an internal combustion engine having cylinders with inlet poppet valves comprising a source of fuel under pressure, controllable pressure reducing means connected to receive fuel from said source and operable to reduce the pressure thereof by regulated amounts, high pressure pumping means one each for each engine cylinder, said pumping means defining a chamber, a pumping piston in said chamber actuated by an intake valve, said pumping means further defining a chamber inlet in communication with pressure regulated fuel from said pressure reducing means, said piston being loaded by a resilient bias whereby the quantity of fuel received through

said inlet is a function of the regulated fuel pressure, said pumping means defining an injector outlet adjacent said valve through which fuel is forced at high pressure upon the actuation of said piston by said valve.

10. A fuel injector comprising a body defining a cylindrical chamber and a fuel inlet and an outlet in communication therewith, a piston slidably received in said chamber, spring bias means urging said piston toward one end of said chamber, a source of fuel under pressure, a check valve, said inlet in communication with said source through said valve to permit fuel flow only from said source into said chamber, an injector nozzle in communication with said outlet, said source normally having sufficient pressure to cause fuel to flow into said chamber against the resistance of said bias, and driving means operable to periodically cause said piston to displace fuel from said chamber through said nozzle.

11. A fuel injection system comprising a source of fuel under pressure, controllable pressure regulator means connected to receive fuel from said source and operable to selectively vary the pressure of the fuel so received, means defining a variable volume pump cavity, said cavity in communication with said pressure regulator means to receive fuel therefrom, means connected with said variable volume pump cavity for varying the volume thereof in accordance with the regulated pressure of said fuel, said variable volume pump cavity being fillable by an amount proportionate to the regulated pressure of said fuel, a fuel injection nozzle in communication with said cavity, and fuel displacement means operable to displace the fuel so received out of said cavity through said nozzle.

12. In a fuel injector, a variable pressure fuel source, means defining an expansible fuel-receiving chamber in communication with said source, means connected with said expansible fuel receiving chamber for permitting expansion thereof by an amount proportionate to the fuel pressure of said source, said fuel receiving chamber also being fillable from said source by an amount proportionate to the fuel pressure of said source, means defining a spray orifice, means operable to periodically discharge the fuel thus filled within said chamber through said orifice, and means operable concomitantly with said last-named means to prevent the flow of fuel out of said chamber into said source.

13. A throttle controlled motor vehicle fuel injection system comprising, a throttle linked cam plate, a diaphragm, a spring means, said throttle linked cam plate being connected to one side of said diaphragm through said spring means, a source of fuel under pressure, a conduit connecting said source of fuel under pressure with the other side of said diaphragm, and means connected to the other side of said diaphragm and positioned in said conduit for controlling the flow of fuel to said other side of said diaphragm in accordance with the position of said diaphragm.

14. A motor vehicle fuel injection system for an internal combustion engine having a plurality of combustion chambers provided with intake valves comprising, a variable pressure fuel source, a fuel chamber for each combustion chamber, each of said fuel chambers connected to the variable pressure fuel source and expandable as the pressure of said variable pressure fuel source increases so that said fuel chamber holds a volume of fuel proportionate to the pressure of said variable pressure fuel source, and engine driven means operable in timed relation to the opening of the intake valve of each combustion chamber for discharging the fuel in said fuel chamber into said combustion chamber.

15. In a fuel injector, a variable pressure fuel source, a fuel receiving chamber in communication with said variable pressure fuel source, fuel displacement means slidably positioned within said fuel receiving chamber and subject to the pressure of fuel from said variable

pressure fuel source, spring means acting upon said fuel displacement means against the pressure of the fuel whereby the volume of said fuel receiving chamber is varied in accordance with the pressure of the fuel, and means operable upon said fuel displacement means for periodically discharging fuel present in the fuel receiving chamber from said fuel receiving chamber. 5

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