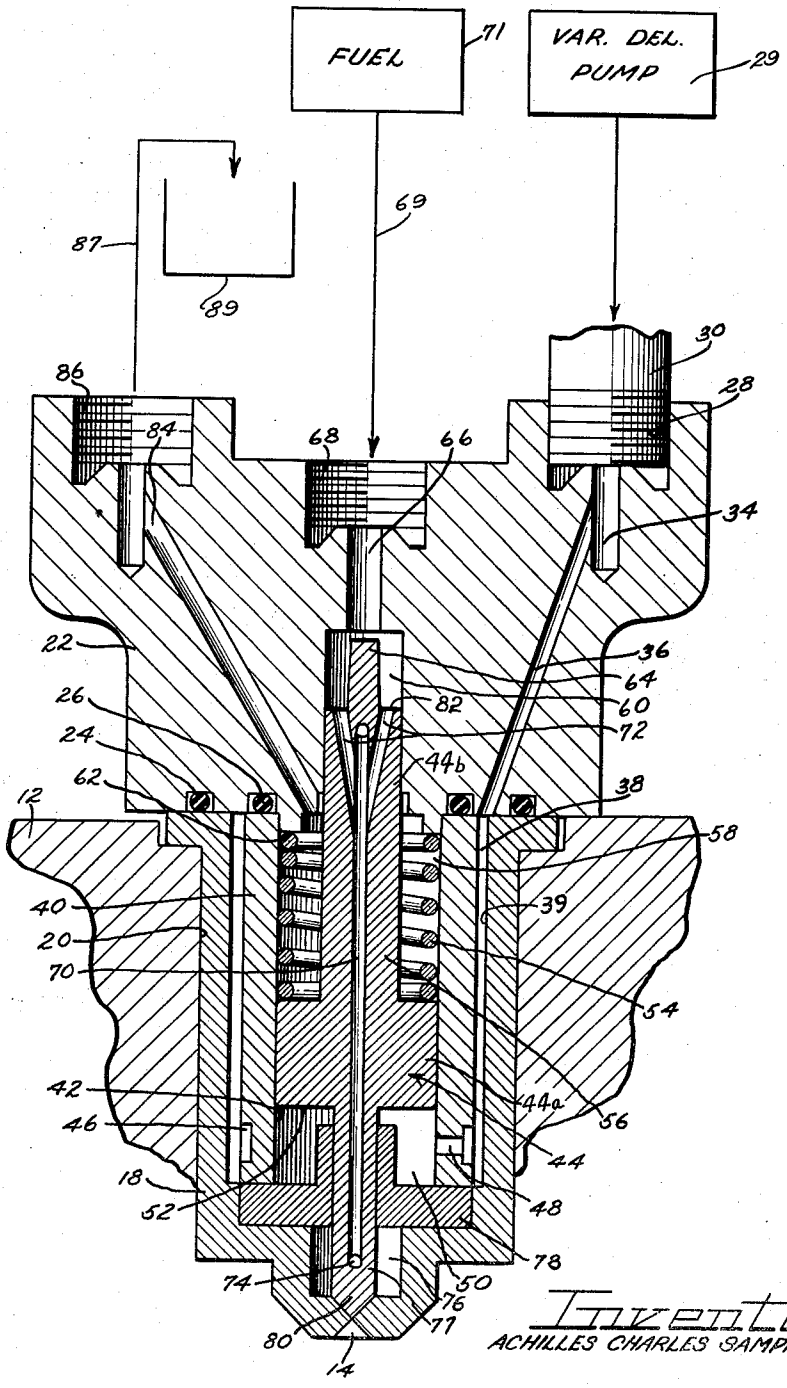
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FUEL INJECTOR

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# FUEL INJECTOR

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7 Claims. (Cl. 239—91)

The present invention relates to improvements in fuel injection systems and more particularly to an improved fuel injector including a nozzle and operating mechanism which is driven by measured amounts of operating fluid provided by a separate pump.

The present application is a division of the copending application for patent "Fuel Injection Pump," Achilles C. Sampietro, Serial No. 612,391, filed September 27, 1956, now Patent No. 2,910,056.

In internal combustion engines of the fuel injection type, a measured amount of fuel is injected into the cylinder for combustion. Among the factors that will insure successful injection and successful operation of the engine is a complete and thorough atomization of the fuel which requires an extremely high injection pressure. Since the injector has to be in close proximity to the cylinder, these high injection pressures are sometimes difficult to obtain because of operating space limitations that restrict the mechanism used. It is also important that the quantity of fuel injected at these high pressures be accurately controlled and it is desirable that the amounts delivered to each of the cylinders be uniform. Further, the uniformity of fuel delivery for each of the cylinders and high injection pressures must be maintained throughout the life of the engine and the mechanism to attain these objectives must be such that it does not require frequent replacement to maintain high performance standards.

It is an object of the present invention to provide an improved fuel injector which avoids difficulties encountered with devices previously used and to provide a fuel injector of improved structure which delivers a controlled amount of fuel dependent on the metered amount of operating fluid delivered to a pump.

Another object of the invention is to provide an improved injector nozzle and operating mechanism which may be positioned close to the engine and which may be driven by periodic deliveries of metered quantities of operating fluid from a pump which is spaced from the injector.

Another object of the invention is to provide a fuel injector for use in a fuel injection system wherein an accurate metered control of the amount of fuel injected into an engine is achieved and the amount of fuel injected can be varied over a range with an accurate control of the amount.

Another object of the invention is to provide an improved fuel injector for use in the system wherein an accurately timed pressure discharge of atomized fuel into the engine is possible.

A further object of the invention is to provide fuel injectors adapted to be used in an injection system wherein a plurality of individual injectors are employed and will deliver uniform amounts of fuel to the engine as controlled by a single pump unit delivering measured quantities of operating fluid.

A further object of the invention is to provide fuel



injectors capable of high pressure injection wherein the high pressures are countered only at the injection zone of the injector unit and the injector may be driven by an operating fluid having a lower pressure.

Yet another object of the invention is to provide a fuel injection apparatus having individual injectors operated by a pressurized actuating fluid wherein the amount of fuel injected by each injector is a fixed fraction of the amount of actuating fluid delivered to the injector.

A still further object of the invention is to provide a fuel injector unit wherein an improved high pressure atomization of fuel is achieved.

Another object of the invention is to provide an improved fuel injector which is operated by fluid pressure and wherein an improved fluid circulation arrangement for both the operating fluid and fuel is utilized.

Other objects, and advantages of the invention will become more apparent with the teaching of the principles of the invention in conjunction with the disclosures of the preferred embodiment disclosed in the specification and claims and the accompanying drawing, which shows a vertical sectional view of an injector embodying the principles of the present invention.

As shown on the drawing:

A fuel injector is illustrated in the drawings, and is adapted to be embodied in the system incorporating a metering pump which will deliver a measured or metered amount of operating or actuating fluid to drive the injector. Usually a plurality of injectors will be employed with a metering pump providing individual timed discharges of operating or actuating fluid to the injectors.

The metering pump is preferably of the form illustrated and described in the above referred-to copending application, Serial No. 612,391, and operates to deliver intermittent charges of metered quantities of actuating fluid under pressure so as to drive the injector.

The fluid delivered by the pump is metered and the quantity delivered determines the amount of fuel which will be injected into the combustion zone of the engine. The actuating fluid delivered by the metering pump is much larger in volume than the small amount of fuel injected, and the injector is constructed so that it will always deliver a quantity of fuel which is a fixed fraction of the quantity of actuating fluid delivered to it. Therefore, by accurately determining the amount of fluid which is delivered from the pump to the injector, the amount of fuel injected can be accurately controlled. Also the arrangement wherein the fuel injected is a fixed fraction of the fluid delivered by the pump obtains a mechanical advantage whereby the pump and the lines carrying the fluid to the injector can measure the fluid out in larger quantities and, therefore, can obtain a high degree of accuracy in quantities injected at the injector with a smaller degree of accuracy in the quantities of fluid pumped. Also, the parts of the pump can be made larger and more durable than if the entire operating system were limited to delivering quantities of the small minute volume required for the injection of the fuel.

The amount of fluid delivered from the pump and, hence, the amount of fuel delivered to the combustion zone is varied to control the speed of operation of the engine. The quantities delivered by the pump are varied to obtain proper idling, running, acceleration, and top speeds. A mechanism may also be provided to include the factors of temperature and pressure of the manifold of the engine in the control of the pump.

The injector includes a body portion 18 which is preferably cylindrical in shape and which is mounted in a mating cylindrical opening 20 in the engine block 12. The body portion 18 of the injector may be mounted in any position, but for purposes of reference it will be re-

ferred to as the lower portion of the injector. The lower portion **18** receives an upper body portion **22** which is suitably clamped thereto by means not shown and which contains passageways for the supply of fuel, for the supply of actuating fluid, and the removal of the actuating fluid and fuel which leak past the operating parts. To isolate the various compartments and conduits, gaskets **24** and **26** are provided which may be annular in form to seal the upper body portion **22** against the lower body portion **18**.

The upper body portion has openings to receive threaded pipes, and the opening **28** receives a pipe or line **30** for the supply of actuating fluid from a pump **29**. The pump is of the type intermittently delivering metered charges of actuating fluid or liquid such as an oil or the like, to actuate the injector. The pump is provided with means (not shown) to vary the delivery whereby the quantity of fluid injected is controlled. A pump suited to operate with the injector is shown in the above referred-to patent application, Serial No. 612,391.

The actuating fluid supply line **30** leads to drilled passageways **34** and **36** through the upper injector body **22** to communicate with an annular chamber **38** which is defined between a cylindrical opening **39** in the lower body portion **18** and an annular sleeve **40**. The sleeve **40** is tubular in shape having an inner wall **42** in which slides the injector plunger **44**. The outer diameter of sleeve **40** may carry splines (not shown) for some portion of its length to insure proper centering within the body portion **18**. An annular groove **46** extends around the outer surface of the sleeve **40** in communication with annular chamber **38** and a bore hole **48** leads actuating fluid from the annular chamber **38** into the actuation pressure chamber **50** within the cylinder **42**. The actuation fluid in the pressure chamber **50** acts on the lower surface **52** of the injection plunger to force it upwardly or to the right as shown in the drawing.

The plunger **44** has a main body portion **44***a* forming a piston sliding within the cylinder **42**. The upper end **44***b* of the body portion is reduced in diameter and a coil compression spring **54** surrounds this end **56**. The area between the end **56** of reduced diameter and the cylinder wall **42** may be termed a leakage chamber **58**, since the chamber receives the leakage of actuating fluid from the pressure chamber **50** and the leakage of fuel from the intake chamber **60**.

The compression spring **54** bottoms on a shoulder **62** on the upper injector body **22**. Coaxially within the shoulder is a bore of smaller diameter which forms the intake chamber **60**. The reduced end **56** of the injector plunger **44** slides within the intake chamber **60** and narrows to an end **64** of even smaller diameter and this end is tapered and will enter an opening **66** of smaller bore which communicates between the intake chamber and the intake port **68**. The intake port is threaded to receive a supply line **69** which leads from a fuel supply such as a tank **71** and which supplies fuel to the small passageway **66** leading to the intake chamber **60**.

It will be seen that as the plunger **44** moves upwardly as is shown in the drawing, the reduced sealing end **64** enters the passageways **66** effectively sealing the intake chamber. This intake chamber is filled with fuel and this fuel has been drawn in on the intake stroke of the plunger **44**. When the plunger moves upwardly as is shown in the drawing, in its discharge stroke, the intake chamber **60** is sealed and the fuel is compressed and forced through the center of the injection plunger. The plunger contains a central coaxial passageway **70** which communicates with the intake chamber **60** through several small lateral passageways **72**. Fuel passing through the coaxial plunger passageway **70** discharges through a lateral passageway **74** at the injection end of the plunger. This fuel enters the injection chamber **76** and is forced out through the injection or discharge nozzle **14**.



The lower end **77** of the plunger **44** is also reduced in size and is slidably mounted in a guide **78** mounted within the body **18**. The guide contains a cylindrical opening to slidably receive the reduced discharge end **77**, and the guide there forms a divider between the actuating fluid chamber **50** and the injection chamber **76**. The reduced end **77** has a conically pointed end **80** which extends into the upper end of the injection nozzle **14** to seal it when the plunger is at the end of its intake stroke and before starting its discharge stroke.

In the discharge stroke, since the area **52** at the top of the injection plunger is much larger than the area **82** at the reduced end of the injection plunger, the force on the fluid can be greatly multiplied in the ratio of the difference of areas from the plunger.

The fluid in the actuation chamber **50** and the fuel in the intake chamber **60** will both be at a relatively high pressure. Although the tolerance of the relative parts are held very close, a small amount of leakage may occur past the sliding surfaces. This leakage flows into the leakage chamber **58** and passes out through the bore passageways **84** and out through the leakage port **86**. This is shown threaded for purposes of connecting a leakage line **87** for receiving both the fuel and actuating fluid. The line **87** leads to a sump **89** for collecting the leak-by fluid and fuel.

While only one injector is shown in the drawing, it will be understood that a plurality of identical or similar injectors are used with an individual injector being provided for each cylinder of the engine. Only one pump need be provided, however, as the pump is designed to sequentially deliver metered quantities of actuation fluid at the proper time for injection of fuel into the engine and the pump is designed to meter the amount of fluid delivered to each injector in an equal amount.

Metered amounts of actuating fluid are delivered to the individual injectors such as shown in the drawing. The pressurized metering fluid enters through the opening **28** to pass in through the pressure chamber **50**. This forces the plunger **44** in the discharge direction whereupon the intake chamber will be sealed by the extension **64** of the plunger entering the passageway **66**. Further movement of the plunger will force the fuel through the passageway **70** within the discharge plunger. This fuel then passes into the fuel injection chamber **76** to be forced out through the discharge port **14** into the cylinder of the engine.

The plunger **44** is returned by the compression spring **54** which aids in returning the actuating fluid to the pump. Since the intake chamber **60** is considerably smaller than the pressure chamber **50**, a magnification of pressure is obtained and the injector delivers a fixed fraction of the actuating fluid delivered to it. Any of the actuating fluid or fuel which leaks past the plunger **44** passes out through special leakage passageways **84** and **86**.

Thus, it will be seen that I have provided an improved fuel injector which meets the objectives and advantages hereinbefore set forth. The injector embodies an injection nozzle and operator which are compact in construction and may be located closely adjacent the combustion zone while the pump for delivering an operating fluid may be positioned some distance away. Accurate measurements of the quantities of fuel can be obtained since the quantity of actuating fluid used is considerably larger than the fuel delivered. Thus very minute adjustments can be made in quantities of fuel delivered by variations in the quantity of actuating fluid delivered with each stroke of a pump.

The injector obtains an improved constructions capable of long reliable operating life without adjustment. The device is rugged in construction and overcomes disadvantages of injectors heretofore used.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiment of my

invention, and it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. A device for fuel injection comprising a fuel injection plunger, a fuel injection housing having a chamber therein in which said plunger is movably mounted for movement in an intake stroke and a discharge stroke, said chamber terminating in a discharge port at one end and in an intake port at the other end, means defining a chamber in said housing for the receipt of plunger actuation fluid, means having an actuation surface movable in said chamber and operatively connected to the plunger to move it in a discharge stroke when pressurized actuating fluid is admitted to said chamber, and a variable delivery actuation fluid pump connected to be in communication with said actuation chamber to deliver the fluid thereto to cause the plunger to move in a discharge stroke.

2. A device for injecting fuel into an internal combustion engine comprising an injector housing having a fuel intake port and a fuel discharge port to be connected to deliver fuel to an engine, means defining an actuation fluid pressure chamber within the housing, a fuel injection plunger movable within the housing to deliver fuel from the discharge port, means having a reaction surface movable in response to actuation fluid pressure within the fluid pressure chamber and operatively connected to the injection plunger to cause actuation thereof when actuating fluid is admitted to the actuation chamber, and a controlled variable delivery actuation pump positioned remotely from the injector housing of said pump adapted to intermittently deliver measured quantities of actuation fluid to the injector housing to cause a measured delivery of fuel from the injector.

3. A device for fuel injection comprising a fuel injector housing having a fuel intake port and a fuel discharge port therein, a plunger movable within the housing to deliver fuel by movement in a discharge stroke, means defining an actuating fluid chamber within said housing, means having a reactance surface operatively connected to said plunger and movable in the actuating fluid chamber to move the plunger in its discharge, means defining a fuel chamber communicating with said discharge and intake ports, means positioned to close the intake port in the discharge stroke so that the fuel will be forced from the fuel chamber, means defining a leakage chamber positioned between said fuel chamber and said actuating fluid chamber to receive fuel and fluid leaking past the plunger, and means defining a leakage passageway leading to the leakage chamber to receive the leakage of both the fuel and the actuating fluid to drain them from the housing.

4. A fuel injection device comprising a housing having having an elongated chamber therein, means defining a fuel intake passage connected to an intake end of said chamber, a fuel injector plunger slidably movable in said chamber in an intake stroke and an injection stroke with said plunger moving toward said intake end of the chamber in the injection stroke and moving away from the intake end in said intake stroke, means defining an injection port in said housing, means defining an injection passage connected between said injection port and said intake end of said chamber, a sealing projection of a size smaller than said plunger connected to the plunger to project into said fuel intake passage for a portion of said injection stroke of the plunger to close off the intake passage, and a pumping surface on the plunger adjacent said sealing projection for forcing fuel from the intake end of the chamber through said injection passage during the injection stroke.



5. A fuel injection device comprising a housing having an elongated chamber therein, means defining a fuel intake passage connected to an intake end of said chamber, a fuel injector plunger slidably movable in said chamber in an intake stroke and an injection stroke with said plunger moving toward said intake end in the injection stroke and away from said intake end in the intake stroke, means defining an injection port in said housing, a sealing projection of a size smaller than the plunger connected to the plunger and positioned to project into said fuel intake passage for at least a portion of said injection stroke to close off said intake passage, a pumping surface on the plunger adjacent said sealing projection for forcing fuel from the intake end of the chamber, and an injection passageway opening from said pumping surface and extending through the plunger by communicating with said injection port for the injection of fuel during the injection stroke of the plunger.

6. A fuel injection device comprising in combination a fuel injector housing having an elongated chamber therein, a fuel intake passage connected to an intake end of said chamber, a fuel injector plunger slidably movable in said chamber in an intake stroke and an injection stroke, means defining an injection port in said housing, means defining an injection passage connected between said injection port and said intake end of said chamber, a pumping surface on the plunger facing said intake end of the chamber for forcing fuel from the chamber end through said injection passageway, and a sealing projection on the plunger of a size smaller than the plunger positioned to project into said fuel intake passage for at least a portion of said intake stroke to close off said intake passage and being tapered toward the end.

7. A fuel injection device comprising a fuel injector housing having an elongated cylindrical chamber therein with a larger actuating fluid portion and a smaller fuel portion, means defining a fuel intake passage communicating with the fuel portion of said chamber, means defining a fuel injection port in said housing, a fuel injector plunger slidably movable in said chamber in an intake stroke and an injection stroke, said fuel injector plunger having an integral larger portion in said larger portion of said chamber and an integral smaller portion in said smaller portion of said chamber, an integral sealing projection extending axially from the smaller portion of said plunger and being of a smaller size than said smaller portion and positioned to extend into said fuel intake passage for at least a portion of an injection stroke of said plunger with the plunger moving toward the smaller portion of said chamber, a pumping surface from the plunger adjacent said sealing projection for pumping fuel from said smaller portion of said chamber, and an injection passage extending through the plunger and opening from said pumping surface and communicating with said injection port for injecting fuel during the injection stroke of the plunger.

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