July 16, 1957 L. O. FRENCH 2,799,263

FUEL INJECTION APPARATUS

Filed Nov. 24, 1954

Fig. 1

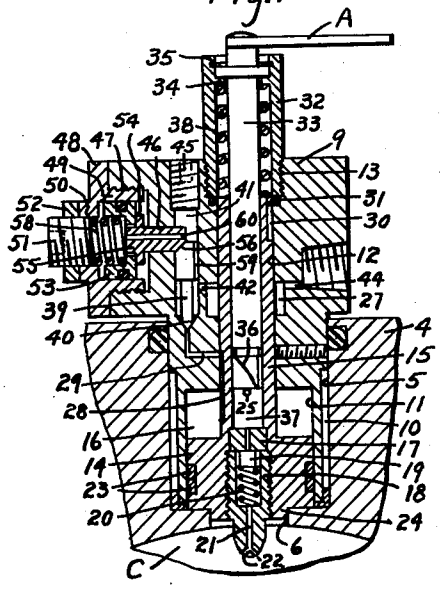


Fig. 2

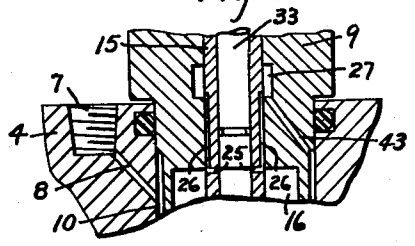
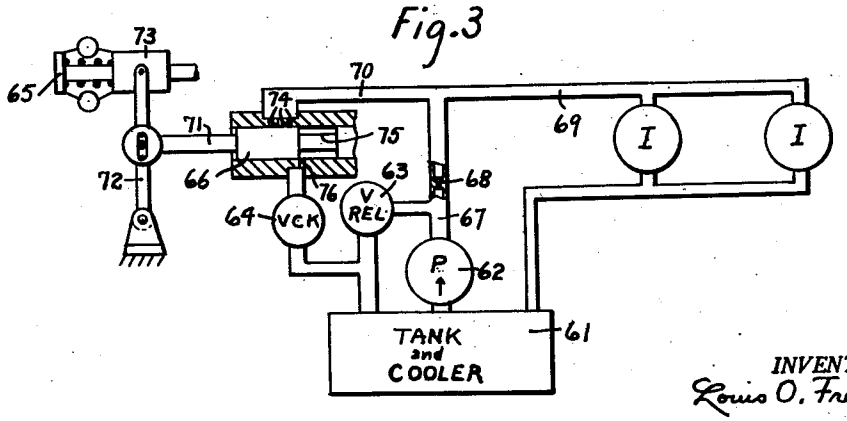


Fig. 3



INVENTOR.
Louis O. French

United States Patent Office

2,799,263

Patented July 16, 1957

2,799,263

FUEL INJECTION APPARATUS

Louis O. French, Milwaukee, Wis.

Application November 24, 1954, Serial No. 470,978

19 Claims. (Cl. 123—139)

The invention relates to fuel injection pumps for internal combustion engines and more particularly to compression pressure operated pumps.

The operating piston of a compression pressure operated fuel injector only moves intermittently and for a relatively brief interval during the engine's cycle and for efficient operation should be sealed against gas leakage during the times the piston is at rest and while it is moving. The usual split type piston rings may not be leak proof, and any ring type seal will not operate efficiently unless it is adequately cooled and lubricated. One object of the present invention is to provide a new and improved type of liquid pressure seal for the operating piston of the injector in which the operating piston acts as the motivator for maintaining a liquid sealing pressure in a chamber back of the head end of said piston that will effectively seal against leakage during the rest periods of the piston particularly at the high pressure period of the engine's cycle after injection and which in the preferred form will also seal against leakage before and during the injection stroke of the piston, said seal also acting to cool and lubricate said piston and preclude access of combustion tars into the piston clearance and its rings.

A further object of the invention is to provide a compression pressure operated fuel injector in which the leakage sealing chamber above referred to is associated with a timing valve whereby the movement of said piston is controlled by the release of pressure fluid from said chamber.

A further object of the invention is to supply the checking or sealing chamber above referred to with fuel as a sealing liquid by providing an inlet port for said chamber controlled by the operating piston.

This application is a continuation in part, as to claims to common subject matter, of my following abandoned applications for Fuel Injection Apparatus: Serial No. 224,225, filed May 2, 1951; Serial No. 271,319, filed February 13, 1952; Serial No. 389,760, filed November 2, 1953; Serial No. 407,415, filed February 1, 1954; and Serial No. 435,770, filed June 10, 1954.

A further object of the invention is to provide an improved arrangement of porting connecting the timing valve controlled passage with the checking and sealing chamber, whereby the length of the head of the operating piston is not dependent upon the location of said passage so that the length of the head of the piston may be reduced and thus reduce its weight and consequently the inertia forces set up by said piston during its operation.

A further object of the invention is to provide a simple arrangement for varying the timing of the beginning of injection where a compression pressure released timing valve is used comprising means for hydraulically loading said valve so that all of the pumps of a multiple cylinder engine may be simultaneously loaded to vary the timing of injection. Preferably, the hydraulic loading of the valves is accomplished by using the fuel supply system as the hydraulic pressure source so that no extra piping for the pumps is required. In this connection this application is a continuation in part of my copending application Serial No. 408,484, filed February 5, 1954, for Fuel Pump, now abandoned.

The invention further consists in the several features hereinafter described and more particularly defined by the appended claims.

In the drawings:

Fig. 1 is a vertical sectional view through a fuel pump embodying the invention;

Fig. 2 is a detailed vertical sectional view taken on the line 2—2 of Fig. 1, parts being broken away;

Fig. 3 is a diagrammatic view of control means for the injection timing means.

Referring to Figs. 1 and 2, the numeral 4 designates a portion of the cylinder or head of an internal combustion engine having concentric bores 5 and 6, the bore 5 being supplied with fuel as a coolant from a suitable fuel supply circulatory system through an inlet 7 and passage 8.

A pump housing or cylinder 9 has its lower end mounted in the bore 5 and held therein in any suitable manner and is recessed to provide a coolant space 10 with which the passage 8 communicates. Housing 9 has differential diameter bores 11, 12, and 13.

An operating piston has a head part 14 working in the bore 11, and a plunger part 15 working in the bore 12, these parts cooperating with the housing to form a coolant, checking, and sealing chamber 16.

The head part 14 is bored to receive an apertured valve seat member 17 clamped in position by a valve housing and nozzle member 18 which has a threaded connection with the head. Member 18 has a bore in which a peripherally grooved discharge check valve 19 is slidably mounted and normally held against the seat member 17 by a spring 20, and it has a discharge passage 21 leading from this bore to spray orifices 22 communicating with the combustion chamber C. Head part 14 also carries sealing rings 23 and has a cylindrical portion 24 of less diameter than the body of the head working in the bore 6.

The plunger part 15 has diametrically disposed pump inlet openings 25, grooves 26 connecting these openings and also the chamber 16 with an enlargement 27 of the bore 12 and a groove 28 operatively connecting the chamber 16 with a relief passage 29 in the housing. Part 15 also has a key slot 30 engaged by a key projection formed on a washer 31 mounted in the housing and clamped in position by a spring housing and pump plunger support member 32 that has threaded engagement at its lower end with the threaded bore 13 of the housing.

A pump plunger 33 works in the bore of the plunger part 15 and is held against longitudinal movement by the seating of its head between an annular flange 34 on member 32 and a retainer ring 35 mounted in said member. Plunger 33 has an arm A operable either manually or by a governor or by both to angularly adjust it so that the position of its metering scroll including the control edge 36 may be varied relative to one of the ports 25 to thereby vary the amount of fuel by-passed from the pump chamber 37 as the operating piston moves outwardly on its injection stroke.

A spring 38, interposed between the flange 34 and the top of plunger part 15, acts to return the operating piston to its inner position.

A timing valve 39 is seated on a seat 40 at the inner end of a bore 41 that forms a continuation of the passage 29, said bore being connected with the enlargement 27 by a passage 42.

Enlargement 27 connects by a passage 43 with the space 10 and with an outlet passage 44 suitably connected with the return piping of the fuel circulatory system.

The upper end of bore 41 is closed off by a plug 45, and this bore is intersected at right angles by a bore 46

in the housing which connects with an enlarged threaded bore 47 therein.

A cap 48 has a cylinder portion 49 mounted in the threaded bore 47 and a threaded bore 50 alined with said portion. An adjusting screw 51 is mounted in bore 50 and held in adjusted position by a lock nut 52.

A piston 53 is mounted to slide in the cylinder portion 49 and has a self-centering engagement with the annular flange 54 of rod member 55 that is slidably mounted in the bore 46.

The upper end of valve 39 has a forty-five degree angled surface 56 contacting with a similar surface on the rod member so as to hold the valve closed under a load imposed on said member. Valve 39 is adjustably loaded by a spring 58 interposed between the piston 53 and the screw 51 where the loading control means hereinafter described is used so that fuel under fuel supply pressure via one or more grooves 59 in the valve, bore 41, and a bore 60 in member 55 may act on the piston 53 to provide a variable loading for the valve in addition to a predetermined loading by the spring 58.

Referring to Fig. 3, the fuel supply system includes a supply tank and cooler 61, a pressure supply pump 62, a variably settable relief valve 63, a check valve 64, and an engine operated governor 65 operatively connected with a pressure varying valve 66. The pump 62 supplies a pipe 67 with fuel at a substantially constant pressure determined by the setting of the relief valve 63, and this pipe through a fixed diameter orifice 68 connects with the piping 69 supplying port 7 of Fig. 2, and hence through the porting above described supplying the injector or pump I of the type above described and hence the bore 49 so that the fuel pressure will act on the piston 53 and rod member 55 together with the loading of the spring 58 to hold the valve 39 closed so that injection will be timed to occur late in the compression stroke, for example, 10° to 5° before upper dead center. As the speed of the engine increases, the injection timing can be advanecd by reducing the fuel pressure, and for this purpose, the piping 69 is provided with a by-pass branch 70 which includes the valves 64 and 66. Valve 66 is a piston valve operatively connected by a rod 71 to a pivoted lever 72 which is moved by the governor 65 through the operative connection of this lever with the governor collar 73 so that as the engine speeds up, the valve 66 is moved toward the left, exposing one or more of the relief holes 74 to permit fuel to flow through the balanced recessed portion 75 of the valve to the port 76 and back past the check valve 64 to the tank.

Opening up more or less of the holes 74 causes a more or less reduction in fuel pressure so that the valve 39 will be opened earlier or later in the compression stroke by the pressure of the sealing liquid in the chamber 16 so that the beginning of injection of fuel will be advanced or start earlier as the speed of the engine increases. Individual adjustment of the spring 58 for each valve may be made to accommodate the particular compression characteristics of each engine cylinder so all valves will then respond similarly to the uniform loading pressure of the fuel supply.

The hydraulic loading of the valve 39 is also of advantage where the engine is designed to run at a substantially constant speed because in engine testing such an engine, independent of any governor regulation, the relief valve 63 may be set to different positions by the tester to determine the fuel pressure best suited to load the valves 39 so that they will open at a time permitting operation of the pumps at cyclic periods which will not produce knocking.

With the above construction, fuel from the supply tank and cooler 61 is continuously circulated by the pump 62 through the piping 69 connected with each of the injectors, whereby the lower end of the housing 9 is cooled by fuel circulating through the space 10 and the upper portion by fuel circulating through the enlargement 27.

Fuel from enlargement 27 passes down through the grooves 26 into the checking and sealing chamber 16 and through ports 25 into the pump chamber 37 to fill these chambers. When the gases in combustion chamber C, then acting on portion 24, reach a pressure sufficient to overcome the initial loading of return spring 38, the operating piston moves outwardly until the ports 25 and grooves 26 are lapped by the housing to trap fuel in chamber 16 and at the same time the ports 25 are lapped by the plunger 33 so that the outward movement of the operating piston is arrested until near the end of the compression stroke, the gas pressure in chamber C then acting on the entire area of the piston head 14 puts sufficient pressure on the fuel trapped in chamber 16 and the passages 28 and 29 to overcome the loading of valve 39, whereupon checking liquid is forced out of chamber 16, through port or groove 28, passage 29, and bore 41 to the port 42 and enlargement 27 so that the operating piston moves outwardly on its pumping stroke with fuel being forced from the pump chamber 37 past check valve 19, through passage 21, and spray orifices 28 into the combustion chamber C. During this movement the portion 24 of the piston head moves out of the bore 6 so that the gases then act on the entire lower area of the head, thus accelerating the movement of the operating piston. Sooner or later, depending upon the angular adjustment of plunger 33, the control edge 36 registers with one of the ports 25 to by-pass more or less fuel through said port from the pump chamber and through the alined groove 26 back to the enlargement 27. As the operating piston nears the end of its stroke, the port 28 is lapped by the housing, and on the lapping of this port, fuel is again trapped in chamber 16, and the upward or outward movement of the piston is checked until on the reduction in pressure of the gases in chamber C, the spring 38 acts to move the operating piston inwardly to its initial position ready to repeat the cycle. During the last part of this inward movement the part 24 enters the bore 6 so that gases between the larger portion of the piston head and part 24 are compressed to some extent depending on the clearance of bore 6 and thus act to slow down and cushion the final inward movement of the piston.

It is to be noted that after the grooves 26 are lapped, that the pressure per unit area of fuel in chamber 16 will be greater during the rest periods of the operating piston, and also while the piston is moving to cut off the port 28, than the per unit gas pressures acting on the front end of the piston so that any gas leakage by the rings 23 will not reach chamber 16. In this connection the passage 29 with the seat 40 forms a throttling orifice when the valve 39 is opened as the piston moves outwardly so that a pressure differential between the pressure of the sealing liquid in chamber 16 and the pressure of the gases acting on the exposed face of the head 14 is maintained during the high speed movement of the piston so that the pressure rise in chamber 16 will always be in excess per unit area to that of the gases.

It is also to be noted that cooled fuel taken in and expelled from the chamber 16 serves to cool the head of the operating piston and lubricate it.

It is also to be noted that unless specifically specified other forms of timing valves, such as for example, crank shaft timed valves, may be used without departing from the invention.

What I claim as my invention is:

1. In a fuel injector, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, a fuel pump having relatively movable parts including a plunger forming a part of said piston, said piston having a head of larger diameter than said plunger and exposed at its front end to said gases, said piston and said housing cooperating to form a checking chamber directly back of said head to check the outward movement of said piston, a checking liquid inlet port for said chamber formed in said plunger and

adapted to be lapped by said housing on the initial outward movement of the piston by said gases, a timing valve, and an outlet port for said checking chamber controlled by said timing valve and including a port in said plunger adapted to be lapped by said housing to trap liquid in said chamber to stop the outward movement of said piston.

2. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, an operating piston movable in said cylinder in response to gases under compression, said cylinder and piston formed to provide a checking chamber adapted to contain a checking liquid, means for supplying said chamber with said liquid, said operating piston controlling the introduction of fuel into the combustion chamber of the engine, means including a timing valve for controlling the release of liquid from said chamber to permit movement of said piston on its injection stroke and adapted to be opened during the compression stroke by pressure built up in said checking chamber, and means for loading said valve to a closed position including a source of hydraulic pressure.

3. A fuel injection apparatus according to claim 2 wherein the source of hydraulic pressure is the fuel supply system.

4. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, an operating piston movable in said cylinder in response to gases under compression, said cylinder and piston formed to provide a checking chamber adapted to contain a checking liquid, said operating piston controlling the introduction of fuel into the combustion chamber of the engine, means including a timing valve for controlling the release of liquid from said chamber to permit movement of said piston on its injection stroke and adapted to be opened during the compression stroke by pressure built up in said checking chamber, means for loading the valve to a closed position including fuel under pressure, and means for varying the pressure of said fuel.

5. In a fuel injection pump for internal combustion engines, the combination of a cylinder, an operating piston movable in said cylinder in response to gases under compression, said cylinder and piston formed to provide a checking chamber adapted to contain a checking liquid, a fuel pump having relatively movable parts including a part movable with said piston, means including a timing valve for controlling the release of liquid from said chamber to permit movement of said piston on its injection stroke and adapted to be opened during the compression stroke by pressure built up in said checking chamber, means for loading said valve to a closed position including a source of hydraulic pressure, and governor controlled means for varying the pressure of said source so that said valve opens sooner or later during the compression stroke depending upon the speed of the engine to thereby control the beginning of the injection stroke of said piston.

6. A fuel injection apparatus according to claim 5 in which the governor controlled means for varying the pressure of said source is a by-pass passage provided with a variable governor controlled valve.

7. In a fuel injector for internal combustion engines, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, said operating piston controlling the introduction of fuel into the combustion chamber of the engine and including a plunger forming a part of said piston, said piston having a head of larger diameter than said plunger and exposed at its front end to said gases, said piston and said housing cooperating to form a checking chamber directly back of said head to check the outward movement of said piston, means for supplying said checking chamber with a checking liquid, and an outlet port for said checking chamber including a port in said plunger adapted to be lapped by said housing to trap liquid in said chamber to stop the outward movement of said piston.

8. In a fuel injector, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, a fuel pump having relatively movable parts including a plunger forming a part of said piston, said piston having a head of larger diameter than said plunger and exposed at its front end to said gases, said piston and said housing cooperating to form a checking chamber directly back of said head to check the outward movement of said piston, a checking liquid inlet port for said chamber in said piston and adapted to be lapped by said housing on the initial outward movement of the piston by said gases, a timing valve, and an outlet port for said checking chamber controlled by said timing valve and by said piston.

9. In a fuel injector, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, a fuel pump having relatively movable parts including a plunger forming a part of said piston, said piston having a head of larger diameter than said plunger and exposed at its front end to said gases, said piston and said housing cooperating to form a checking chamber directly back of said head to check the outward movement of said piston, a checking liquid inlet port for said chamber in said plunger and adapted to be lapped by said housing on the initial outward movement of said piston by said gases, a timing valve, an outlet port for said checking chamber controlled by said timing valve and by said piston.

10. In a fuel injector, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, a fuel pump including a plunger mounted on said housing for rotary movement but restrained against longitudinal movement, said operating piston including a head exposed at its front end to said gases and a tubular plunger of less area than said head in which said first named plunger works, said rotary plunger having a by-pass metering scroll cooperating with a port in said tubular plunger to vary the amount of fuel delivered by said pump depending upon the angular adjustment of said scroll relative to said port, said piston and housing cooperating to form a checking chamber directly back of said head to check the outward movement of said piston, means controlled by said piston and housing for simultaneously supplying fuel to the port for said pump chamber and to said checking chamber, a timing valve, and an outlet port for said checking chamber controlled by said timing valve and by said piston.

11. In a fuel injector for internal combustion engines, the combination of a housing having differential diameter bores, an operating piston working in said bores in response to pressure gases, said operating piston controlling the introduction of fuel into the combustion chamber of the engine and including a plunger, said piston having a head exposed at its front end to said gases and of larger diameter than said plunger, the bore in which said head works having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head to the back end thereof, said continuous sealing surface communicating at its inner end with said combustion chamber said piston and said housing cooperating to form a checking and sealing chamber directly back of said head for entrapment of a sealing and checking liquid under pressures greater per unit area than that of the gases acting on said piston to seal and check the outward movement of said piston, means for supplying said checking chamber with a checking and sealing liquid, a fluid pressure operated timing valve, an outlet port for said checking chamber controlled by said timing valve and by said piston, and means for loading said valve to resist its opening movement by the liquid in said chamber until a predetermined time and for maintaining the per unit pressure of said sealing liquid in said checking chamber at a higher value than the gases acting to move said piston while said piston is moved thereby so that the leakage tendency past the head of said piston along said

continuous sealing surface will be that of said liquid toward and into the combustion chamber.

12. In a fuel injector, the combination of a housing, an operating piston working in said housing under the action of gases under pressure, a fuel pump including a plunger mounted in said housing for rotary movement but restrained against longitudinal movement, said operating piston including a head and a tubular plunger of less area than said head in which said first named plunger works, said rotary plunger having a by-pass metering scroll cooperating with a port in said tubular plunger to vary the amount of fuel delivered by said pump depending upon the angular adjustment of said scroll relative to said port, said piston and housing cooperating to form a checking chamber to check the outward movement of said piston, a fuel supply source in said housing, a passage in said tubular plunger connecting said source with said checking chamber in the inner position of said piston and also to the port controlled by said rotary plunger and adapted with said last named port to be lapped by said housing under its initial outward movement by said gases, a timing valve, and an outlet port for said checking chamber controlled by said timing valve and by said piston.

13. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, an operating piston having a head movable in said cylinder in response to gases under compression acting on said head, said piston controlling the introduction of fuel into the combustion space of the engine, a contractible and expandable chamber formed between said cylinder and piston back of the head of said piston, said cylinder having a continuous sealing surface when traversed by said head and cooperating therewith to seal against gas leakage along said head into said chamber, said continuous sealing surface communicating at its inner end with said combustion space, means for supplying said chamber with a sealing liquid, said chamber having a timing valve controlled throttling orifice outlet cooperating with a part of said piston and cylinder for producing a pressure in said sealing liquid during the injection movement of said piston greater than the pressure of gases tending to leak by said piston so that the leakage tendency past said head along said continuous sealing surface will be that of said liquid toward and into the combustion space.

14. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, an operating piston having a head movable in said cylinder in response to gases under compression acting on said head and having differential diameter portions including said head working in said cylinder and forming therewith a chamber back of the head of said piston of less area than said head and adapted to contain a checking and sealing liquid, said cylinder having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said chamber, said continuous sealing surface communicating at its inner end with the combustion chamber of the engine, the head of said piston which is the larger diameter portion thereof being exposable to the gases in the combustion chamber of the engine so that prior to and following injection the pressure of the liquid in said checking and sealing chamber will be greater than that of the gases in the combustion chamber of the engine and thus act to hold the piston at rest and the leakage tendency past the larger diameter portion of said piston along said continuous sealing surface will be that of said liquid toward and into the combustion chamber, a fuel pump having relatively movable parts including a part movable with said piston, means for supplying said checking and sealing liquid to said chamber, and means for releasing liquid from said chamber to permit movement of said piston to operate said pump.

15. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, a fuel control operating piston having a head movable in said cylinder

in response to gases under compression acting on said head and having differential diameter portions including said head working in said cylinder and forming therewith a chamber back of the head of said piston of less area than said head and adapted to contain a checking and sealing liquid, said cylinder having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said chamber, said continuous sealing surface communicating at its inner end with the combustion chamber of the engine, the head of said piston which is the larger diameter portion thereof being exposable to the gases in the combustion chamber of the engine so that prior to and following injection the pressure of the liquid in said chamber will be greater than that of the gases in the combustion chamber and thus act to hold said piston at rest and the leakage tendency past the larger diameter portion of said piston along said continuous sealing surface will be that of said liquid toward and into the combustion chamber, a fuel pump having relatively movable parts including a part movable with said piston, means for supplying said checking and sealing liquid to said chamber, and means for releasing liquid from said chamber to permit movement of said piston including a port, and a timing valve controlling said port, said port adapted to be lapped by said piston to entrap liquid in said chamber to terminate the piston's outer movement.

16. In a fuel injection apparatus for internal combustion engines, the combination of a cylinder, a fuel control operating piston having a head movable in said cylinder in response to gases under compression acting on said head and having differential diameter portions including said head working in said cylinder and forming therewith a chamber back of the head of said piston of less area than said head and adapted to contain a checking and sealing liquid, said cylinder having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said chamber, said continuous sealing surface communicating at its inner end with the combustion chamber of the engine, a circulatory source of sealing liquid having lubricant and cooling characteristics, means for supplying said chamber with liquid from said source, the head of said piston which is the larger diameter portion thereof being exposable to the gases in the combustion chamber of the engine so that prior to and following injection the pressure of the liquid in said chamber will be greater than that of the gases in the combustion chamber of the engine and thus act to hold the piston at rest and the leakage tendency past the larger diameter portion of said piston along said continuous sealing surface will be that of said liquid toward and into said combustion chamber, and means for releasing liquid from said chamber to permit movement of said piston.

17. In a fuel injection device for internal combustion engines, the combination of a cylinder, an operating piston having a head movable in said cylinder in response to gases under compression acting on said head, said piston controlling the introduction of fuel into the combustion chamber of the engine, a sealing space in said cylinder back of said cylinder, said head having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said space, said continuous sealing surface communicating at its inner end with said space, means for supplying said space with a sealing liquid, and means cooperating with, said head operable to restrain the escape of said liquid to produce a pressure therein during the injection stroke of said piston and during the high pressure period of the engine's cycle following injection during which the piston is at rest which varies with the engine cylinder pressure but is always in excess whereby the leakage tendency past said piston head along said continuous sealing surface will be that of said liquid toward and into said combustion chamber.

18. In a fuel injection device for internal combustion engines, the combination of a cylinder, an operating piston having a head movable in said cylinder in response to gases under compression acting on said head, said piston controlling the introduction of fuel into the combustion chamber of the engine, a sealing space in said cylinder back of said head, said cylinder having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said space, said continuous sealing surface communicating at its inner end with said space, means for supplying said space with a sealing liquid, and means cooperating with said head operable to restrain the escape of sealing liquid to produce a pressure in said sealing liquid greater than the gases acting on said head while the piston is at rest prior to injection and during the high pressure period of the engine's cycle following injection during which the piston is at rest which varies with the engine cylinder pressure but is always in excess thereof whereby the leakage tendency past said piston head along said continuous sealing surface will be that of said liquid toward and into said combustion chamber.

19. In a fuel injection device for internal combustion engines, the combination of a cylinder, an operating piston having a head movable in said cylinder in response to gases under compression acting on said head, said piston

controlling the introduction of fuel into the combustion chamber of the engine, a sealing space in said cylinder back of said head, said cylinder having a continuous sealing surface where traversed by said head and cooperating therewith to seal against gas leakage along said head into said space, said continuos sealing surface communicating at its inner end with said space, means for supplying said space with a sealing liquid, and means cooperating with said head operable to restrain escape of said liquid to produce pressures in said sealing liquid greater than that of the gases acting on said head while the piston is at rest prior to injection, during the injection stroke of said piston and the high pressure period of the engine's cycle following injection while the piston is at rest which vary with the engine cylinder pressures but are always in excess thereof whereby the leakage tendency past said piston head along said continuous sealing surface will be that of said liquid toward and into said combustion chamber the head of said piston acting as a motivator for the build up of pressures in said space.

References Cited in the file of this patent

UNITED STATES PATENTS

2,642,315	French	June 16, 1953
2,662,476	French	Dec. 15, 1953

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,799,263 July 16, 1957

Louis O. French

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 39, for "advanecd" read -- advanced --; column 7, line 33, for "when" read -- where --; column 8, line 61, for "back of said cylinder, said head having a continuous seal-" read -- back of said head, said cylinder having a continuous seal- --; line 67, after "with" strike out the comma.

Signed and sealed this 1st day of October 1957.

(SEAL)
Attest:
KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents