July 24, 1934. R. J. BROEGE 1,967,987

INTERNAL COMBUSTION ENGINE

Filed June 18, 1931 3 Sheets-Sheet 1

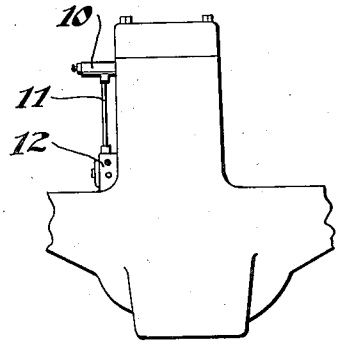


FIG. 1

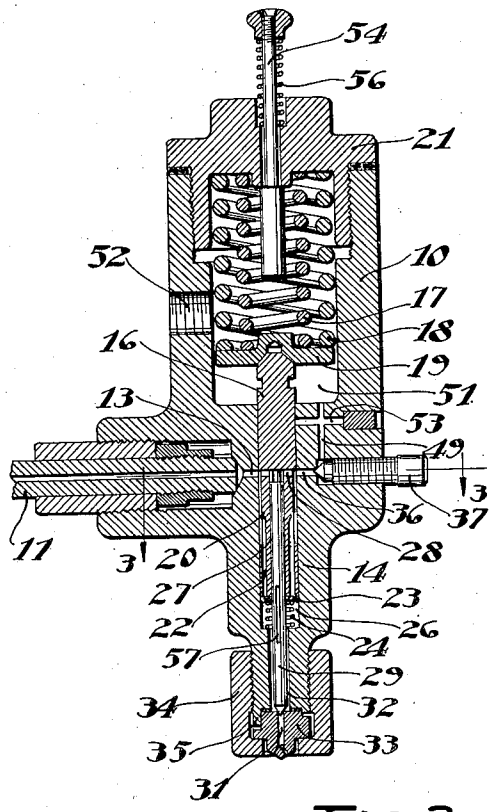


FIG. 2

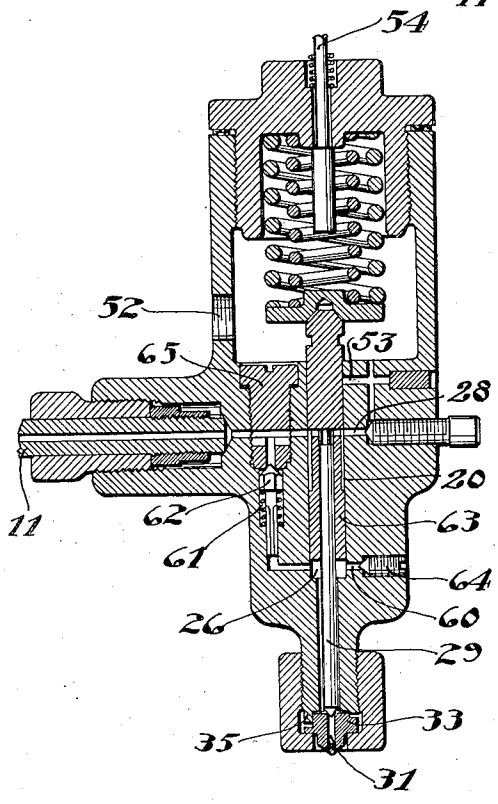


FIG. 4

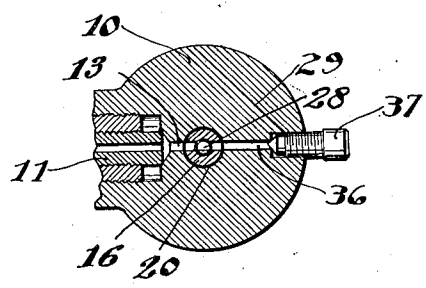


FIG. 3

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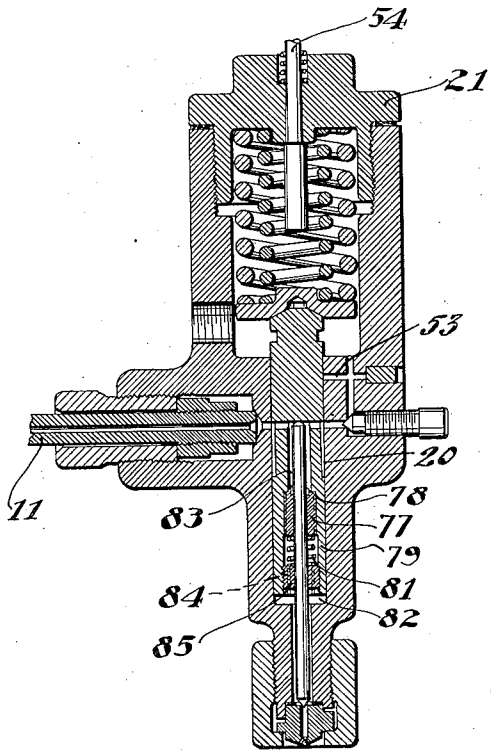


FIG. 6

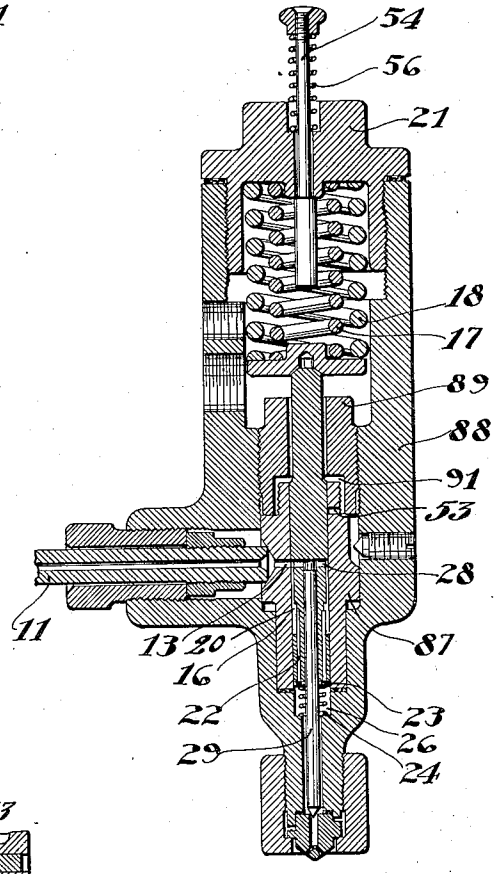


FIG. 7

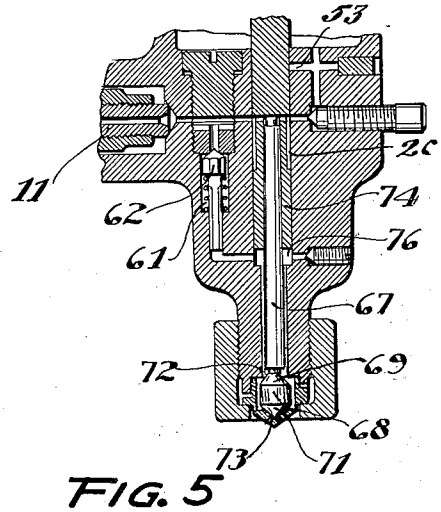


FIG. 5

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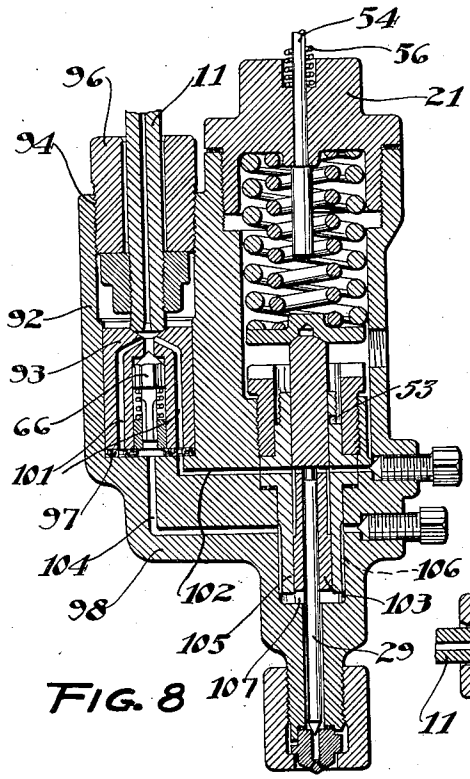


FIG. 8

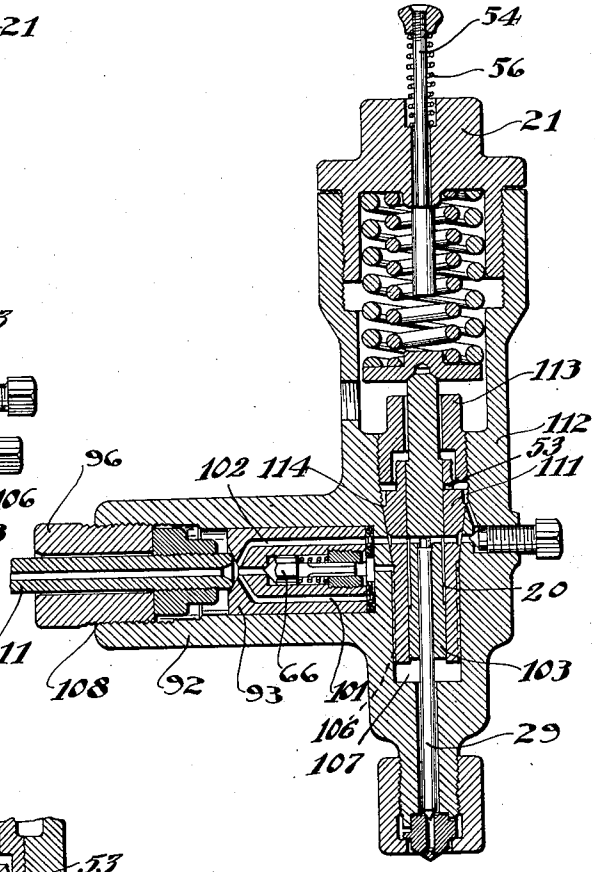


FIG. 9

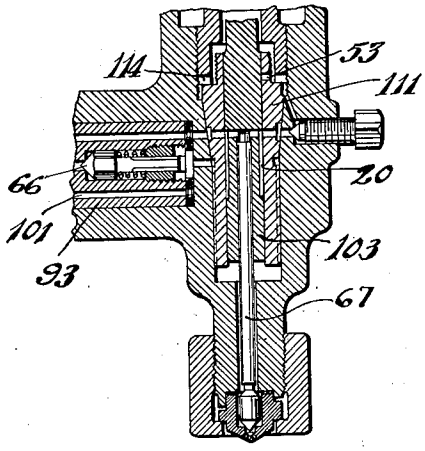


FIG. 10

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UNITED STATES PATENT OFFICE

1,967,987

INTERNAL COMBUSTION ENGINE

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Application June 18, 1931, Serial No. 545,277

2 Claims. (Cl. 299—107.2)

This invention relates to internal combustion engines and more particularly to fuel injectors for engines of the Diesel type. Fuel injectors of various and numerous types have been heretofore used in internal combustion engines, but have usually been characterized by a delivery of a charge that is proportional to the pressure of the fuel in the delivery pipe. In other words, the pressure applied to the fuel during injection is substantially equal to the fuel line pressure at the time of injection. This manner of fuel injection is unsatisfactory in certain respects in that the time for fuel injection is short and regardless of the type of injector used, the pressure drop between the pump and outlet orifice is great enough to reduce the pressure at the outlet to a point where the quantity delivered is irregular and often during the latter part of the injection, the pressure is insufficient to atomize the fuel.

An important feature of the present invention relates to a reversal of the above-described manner of injection, and in the improved injector, the delivery of fuel to the engine does not occur while the supply line is under pressure, but on the other hand, the injection takes place when the pressure in the fuel line is reduced.

The foregoing result is accomplished by an arrangement of parts that permits a storing of fuel under pressure during the engine cycle prior to injection and automatically injecting the stored fuel when the pressure in the fuel line is reduced by means of a suitable pump or metering distributor similar to that shown in my copending application, Serial No. 549,943 filed July 10, 1931.

An injector constructed according to the present invention permits the fuel pressure to be built up very slowly, and therefore, obviates the necessity of using cams with steep slopes. It will be readily apparent that the fuel pressure may be built up slowly, for the fuel is injected during only a fractional part of the engine cycle and the remaining time is available to store the fuel. It is desirable that the fuel be stored adjacent the engine cylinder in order to reduce the pressure drop to a minimum, and to inject it at the proper time by an arrangement of parts in which the outlet valve from the injector is opened by a decrease in line pressure. This type of injection is somewhat analogous to the present automobile ignition systems, in which the spark occurs at the moment of breaking the circuit, and which systems have almost entirely superseded the former ignition systems, in which the spark occurred when the circuit is closed.

In one desirable arrangement of the invention, the fuel is forced to the fuel storage chamber of the injector under pressure by a suitable pump or metering distributor wherein it raises a spring pressed plunger. A suitable check valve prevents back flow to the supply line and the injection to the engine is controlled by a valve having a portion exposed to the pressure of the fuel supply line and a portion exposed to the chamber. The projected area of the portion exposed to the line pressure is preferably greater than the projected area of the portion within the fuel chamber, in order that the valve may be held on its seat during the time that fuel is forced to the space below the plunger. At some predetermined point in the engine cycle, the line pressure is reduced and the pressure within the chamber acting on the valve forces it upwardly and permits the spring pressed plunger to inject the stored fuel into the engine cylinder. A by-pass port is also preferably provided to allow fuel to escape past the plunger and back to the supply after a predetermined amount of fuel has been introduced to the space below the piston.

An important object of the invention is to provide an improved fuel injector which will force fuel to an engine cylinder when the supply pressure is reduced.

Another object of the invention is to provide a fuel injector in which fuel is stored under pressure adjacent the engine cylinder.

Another object of the invention is to provide an injector in which the fuel pressure is not dependent on the supply line pressure during the time of injection.

Other objects and features of the invention will be apparent from the following description in connection with which I have illustrated certain embodiments in the accompanying drawings in which:

Figure 1 is an elevational view of a portion of an engine showing the general arrangement of the injector and the fuel metering distributor.

Figure 2 is a sectional view through one form of the injector in which the check valve is incorporated within the fuel storage chamber;

Figure 3 is a sectional view taken substantially on the line 3—3 of Figure 2;

Figure 4 is a sectional view through a modified form of the injector illustrating a different type and arrangement of the check valve;

Figure 5 is a sectional view of another modified form similar to the form shown in Figure 4, except that a double seated valve is used, which

closes the outlet if the valve stem should stick in the plunger;

Figure 6 is a sectional view of another modified form showing a variation in the check valve;

Figure 7 is a sectional view of another modified form similar to that shown in Figure 2, but illustrating a removable lining or bushing for the plunger;

Figure 8 is a sectional view showing another modified form in which the check valve is removable through the inlet opening to the injector;

Figure 9 is a sectional view showing a still further modified form in which the removable lining or bushing has a tapered portion providing a fluid tight seal with the body portion of the injector; and

Figure 10 is a sectional view of a still further modified form showing the tapered cylinder lining and a double seated valve similar to that shown in Figure 5.

In the drawings, with particular reference to Figure 2, 10 represents the body of the injector having a supply conduit 11, leading from the fuel metering distributor or supply pump 12. Passageway 13 connects the conduit 11 with the interior of cylinder 14, within which is a plunger 16, urged toward its downward position by springs 17 and 18 which coact between washer 19 and removable cap 21. The diameter of plunger 16 is reduced adjacent its midsection to provide a clearance space 20 which communicates with a plurality of longitudinally drilled holes 22 through which fuel is forced downwardly past the check valve 23 into the storage chamber 26, check valve 23 is preferably of disk form and is urged upwardly by a spring 24 against the lower face of plunger 16 to prevent return flow of the fuel.

Plunger 16 is also provided with an axial bore 27 which terminates at the cross passage 28, and within which is a slidable valve 29 having its upper end normally contacting with the upper surface of the cross passage 28 as shown in Fig. 2, and its lower end forming a closure for the outlet passage 31. The lower end of valve 29 also has a small portion of its projected area exposed to the clearance space 32 between the valve and the body portion, which is in communication with the fuel storage space 26. The outlet passage 31 is preferably formed in a removable member 33, secured to the body of the injector by threaded cap 34 and held against rotation by tongue 35. Cross passage 28 is also in communication with a passage 36 normally closed by plug 37, which may be used for rendering the injector inoperative by opening passage 36 and permitting fuel to flow upwardly through passage 49 into chamber 51, from which it may drain back to the source of supply through opening 52. Plug 37 may be removed in order to bleed air from the injector, that may have entered while the engine has stood idle for some time or after cleaning the nozzle. The plug may also be used to cut out its cylinder when desired in testing the engine.

A second cross passage 53 communicates with the interior of cylinder 14, which acts as a relief passage and permits excess fuel to flow into chamber 51 when sufficient fuel has been forced below plunger 16 to raise it until cross passage 28 aligns with relief passage 53 and thereby insures a charge of fuel no greater than the volume beneath piston 16 corresponding to the position occupied when the relief passage opens.

In the operation of the device, fuel under pressure is supplied by metering distributor or pump 12 which is preferably of the type similar to that shown in my copending application, Serial No. 549,943, filed July 10, 1931, although any suitable pump or distributor may be used which will show a reduction in pressure at some predetermined point in its cycle.

The fuel flows from conduit 11 through passage 13 and downwardly through clearance space 20 and holes 22 past check valve 23 to chamber 26 and raises plunger 16 against the force of the springs 17 and 18 until a predetermined amount of fuel has been pumped into the storage chamber. At this point, the fuel pressure is reduced by means of the pump or distributor and the pressure of the fuel acting upon the lower end of valve 29 forces it upwardly into contact with the upper surface of the passage 28, from which the pressure has been reduced by the action of the pump. Springs 17 and 18 then force plunger 16 downwardly and inject the fuel into the engine cylinder through the open discharge passage 31, the downward movement of the plunger being limited by a valve 29 coming into contact with its seat in member 33 which closes the outlet passage 31.

If for any reason, valve 29 should fail to open, the plunger 16 will not be raised beyond the point where passage 28 coincides with relief passage 53 and during the subsequent injection of fuel into the engine, the quantity will not be greater than the amount determined by location of the relief passage and there will be no danger of the engine being flooded with fuel. A pin 54 normally urged upwardly by spring 56, may be used as an indicator to determine the amount of upward movement of plunger 16, and may be manually operated to either force plunger 16 downwardly or to indicate its position.

The normal clearance between valve 29 and the bore of the plunger will ordinarily provide enough leakage to obviate any chance of pressure within chamber 26 urging check valve 23 to the closed position and prevent entrance of fuel into the fuel storage chamber, but if desired, a small clearance groove 57 may be formed in valve 29 to form a by-pass around the valve and relieve excess pressure within the storage chamber.

In the form of the invention shown in Figure 4, I have eliminated the holes in the body of the plunger and have provided a fuel passage 61, closed by check valve 62, seated in a removable plug 65 through which fuel flows to the under side of plunger 63, and I have also provided a clean-out plug 64 for closing a passage 60 in communication with fuel storage chamber 26. The operation of this form of the device is substantially the same as that illustrated in Figure 2.

In the form shown in Figure 5, which is similar to the form shown in Figure 4, valve 67 is provided at its lower end with an enlargement 68, having inner and outer tapered valve portions 69 and 71 designed to alternatively seat against shoulder 72 and close outlet opening 73. The tapered portion is the normal operating portion of the valve and seat 69 forms with shoulder 72 an emergency valve to close the outlet passage, if for any reason valve 67 should stick in plunger 74 and be raised at the time fuel is introduced into the storage chamber 76. The valve portions 69 and 71 are so spaced that portion 69 will not seat during normal operation of the engine, and will only function in case the valve is raised beyond its ordinary range of movement.

In the construction shown in Figure 6, the check valve 77 is arranged within a recess 78 in the plunger 79 and is upwardly pressed against its seat by spring 81. In this construction the fuel enters the storage chamber 82 by means of passages 83 and holes 84 formed in threaded plug 85.

In Figure 7, I have shown a check valve arrangement similar to that shown in Figure 2, in which the plunger and valve assembly is mounted in a removable guide cylinder lining 87, secured in body 88 by a threaded plug 89. Clearance 91 acts as a relief passage through which the fuel may escape from passage 28 when the plunger 16 is raised beyond its normal movement.

In the form shown in Figure 8, the valve and plunger assembly is similar to the form shown in Figure 7, but the check valve 66 is mounted in a separate cylinder 92, forming the fuel intake passage, and the valve cage 93 may be removed through the opening 94, upon the removal of threaded plug 96, which holds intake conduit 11 against check valve cage 93 and makes a fuel tight connection therewith. A gasket 97 is preferably provided for sealing the joint between cage 93 and the body portion 98 of the injector. In this form of the invention, the fuel divides at the top portion of the valve cage 93, a portion of it passing through passages 101 and suitable openings in gasket 97 to passageway 102 and into the interior of plunger 103 for subjecting the upper portion of valve 29 to the line pressure. Another portion of the fuel passes check valve 66 through passageway 104 and reduced portion 106 of lining or bushing 105 to fuel storage space 107.

In the form shown in Figure 9, cylinder 92 is arranged at right angles to the body of the injector and valve cage 93 may be removed through the outer opening 108. The principal difference in this form of construction is in the construction of the plunger bushing 111, which has its upper portion of tapered construction, whereby it may be seated in body portion 112 by tightening threaded plug 113 and forcing the tapered portion 114 into a corresponding taper formed in the body of the injector.

In the form shown in Figure 10, I have shown a construction similar to that shown in Figure 9, but with the addition of the double seated valve 67 similar to that shown in Figure 5.

It will be readily understood from the foregoing description that I have provided a fuel injector for an internal combustion engine in which the time of fuel injection may be accurately determined by a reduction in the fuel line pressure and in which the pressure of injection is independent of the fuel line pressure during the injection period. It will also be noted that the present fuel injector is wholly enclosed and all leakage of fuel will be taken care of within the body of the injector and the excess returned to the source of supply without danger of an excessive amount of fuel being introduced into the engine cylinder.

While I have illustrated and described certain embodiments of my invention, it is understood that this showing and description are illustrative only, and that I do not regard the invention as limited to the forms shown and described, or otherwise, except by the terms of the following claims.

I claim:

1. A fuel injector comprising a source of fuel pressure, a body portion forming a cylinder, a spring pressed plunger therein, an outlet valve slidable in the plunger, a fuel conduit communicating with the source of fuel pressure and having two branches the first of which is provided with a check valve and leads to the space beneath the plunger, the second of which leads to a passage extending through the plunger and applies fuel pressure to the outer end of the outlet valve, said body portion being provided with a relief port which in a given position of the plunger will be in juxtaposition with said passage, and a longitudinal groove in said plunger communicating with said passage and with the second branch in all positions of the plunger, whereby communication between the second branch and the relief port is established when the plunger moves to said given position.

2. A fuel injector comprising a cylinder having an inlet port, a plunger reciprocable therein having a peripheral groove adapted to communicate with the inlet port, means for resiliently urging the plunger inwardly, a valve for controlling a discharge opening slidable in the plunger and shaped to be lifted by fuel pressure at its head upon a decrease of pressure at its outer end, means for conducting fuel under pressure to the valve head and to the outer end of the valve to normally maintain said valve closed, and a check valve controlling the flow of fuel between the inlet port and the valve head, said cylinder being provided with a relief passage positioned to communicate with the groove upon predetermined movement of the plunger.

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