

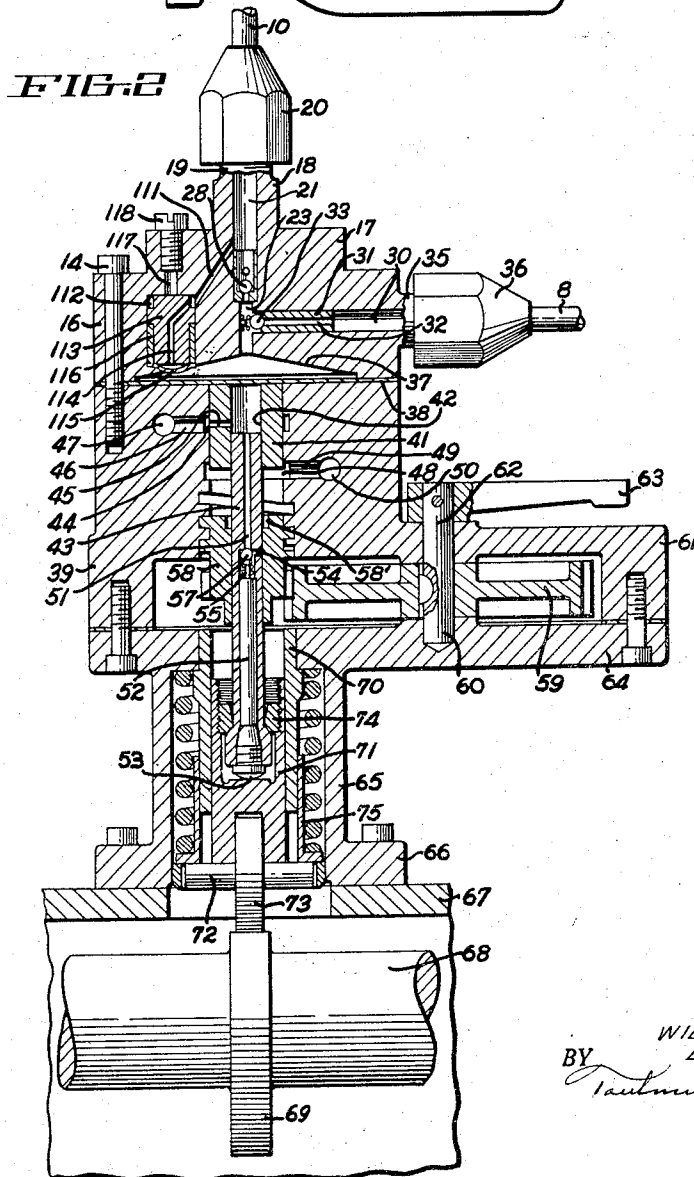
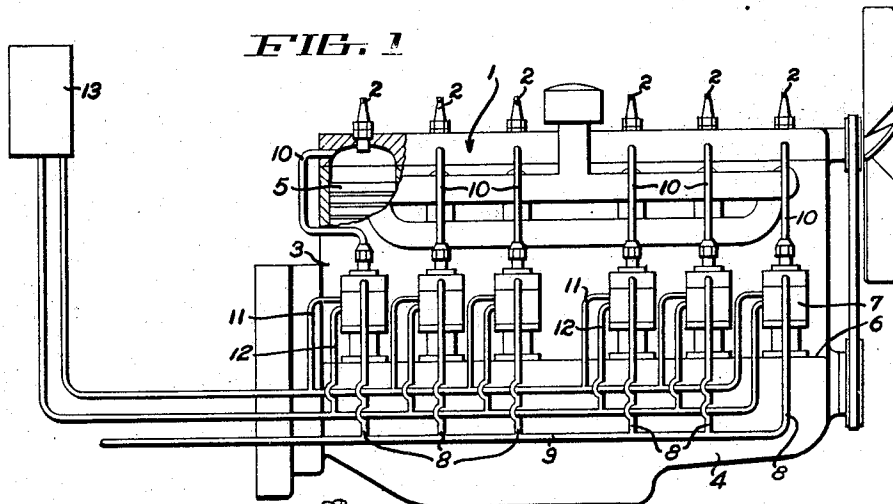
Nov. 14, 1944.

J. E. HOUSER ET AL

2,362,822

FUEL INJECTION PUMP

Original Filed June 22, 1940 2 Sheets-Sheet 1



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FIG. 3

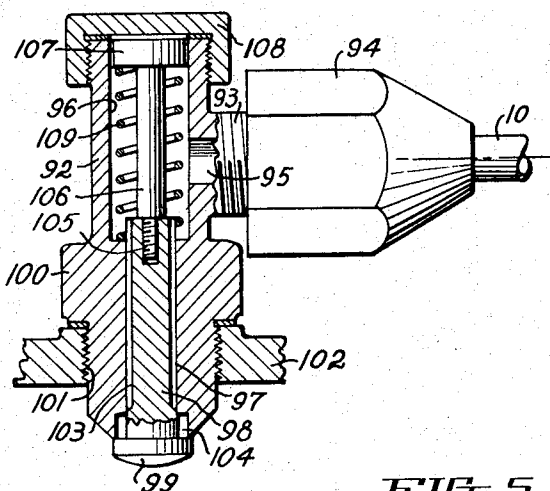


FIG. 4

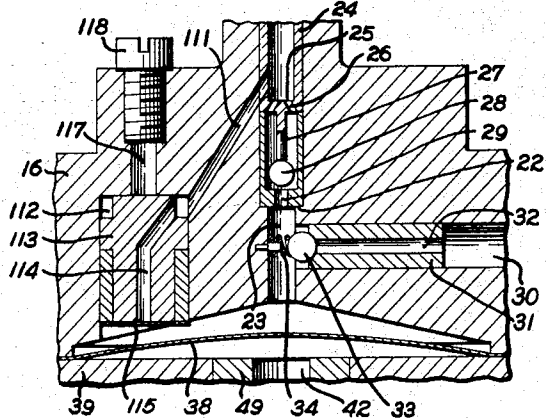
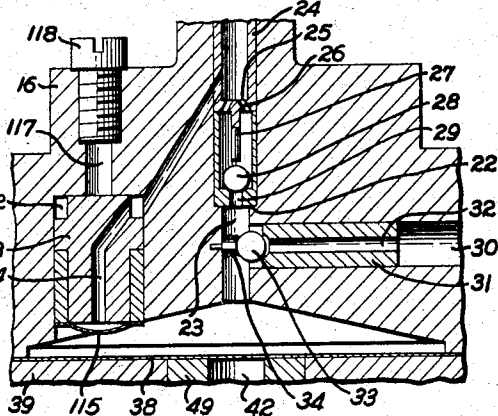


FIG. 5



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2,362,822

FUEL INJECTION PUMP

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Original application June 22, 1940, Serial No. 341,840. Divided and this application May 9, 1941, Serial No. 392,696

12 Claims. (Cl. 299—107.2)

The present invention relates to an injection pump drip preventing means for use with an injection device for high speed engines. The problems to be encountered in devices of this type have been fully described in our application Ser. No. 341,840, filed June 22, 1940, now Patent No. 2,301,407, of which the present application is a division.

An object of the invention, herefore, is to provide an improved drip preventing means for fuel injection pumps.

Other objects will appear hereinafter.

In the drawings:

Figure 1 represents a diagrammatic view of a typical engine provided with the improved injector pump for controlling the flow of fuel to the respective cylinder.

Figure 2 is a sectional view, partly in elevation, of the improved pump together with the additional feature by which dripping at the injector nozzle is prevented.

Figure 3 is a fragmentary view of a form of fuel nozzle which cooperates with certain structural features of the present invention.

Figures 4 and 5 are enlarged detail views of the check valves employed in the suction and injection lines of the improved pump. These figures show in magnified form the construction of the improved injector pump above the injection diaphragm.

Referring more particularly to Figure 1, the numeral 1 generally designates a typical form of automotive engine as specifically having six cylinders, as indicated by the six spark plugs 2. The engine block is indicated at 3 and the bed at 4. Only the left-hand cylinder has been shown in detail and this cylinder contains a piston 5. The bed of the engine is provided with a flange 6, and on this flange rests as many injector pumps of the improved type as there are cylinders, these pumps being preferably secured to the engine and positioned directly below the respective cylinders.

The parts of the improved injector pumps are contained within a casing 7, which may be of a general cylindrical form, and from the upper portions of each casing there is a fuel intake line 8 which connects through a common pipe 9 to a fuel tank (not shown). There are fuel discharge pipes 10 taken from the upper end of the casing 7 and terminating at each cylinder just above the uppermost position of the pistons 5. There is also a pair of pipes secured to the side of each casing 7, the upper pipe 11 serving as an oil inlet pipe and the lower pipe 12 serving as an oil outlet pipe, the circuit being completed

through a combined oil reservoir and filter 13. The details of the improved injector pump are illustrated in Figure 2. It will be noted that the casing 7 is actually constituted of two members, joined together by screws 14. The upper casing 16 is provided with multi-shouldered portions 17, 18, the latter terminating in a screw threaded member 19, to which the pipe 10 is secured by any suitable form of coupling 20. There is a cylindrical opening 21 passing down through the casing 16 and in line with the opening in the discharge pipe 10.

This opening 21 has the same diameter down as far as the shoulder 22 (Figure 4), and the opening emerges into another opening of smaller diameter, as indicated at 23. At the lower part of the opening 21 and resting on the shoulder 22 there is a hollow thimble member 24 (Figure 4) which has a transverse portion 25 containing two diagonally directed openings 26. A pin 27 projects downwardly from the transverse portion or web 25, this pin being in line with a ball 28 which in cooperation with opening 29 at the bottom of the thimble constitutes a check valve.

It will be apparent that the pin 27 merely serves to limit the upward movement of the ball when pressure is applied to the fuel passing through the thimble 24. The upper casing 16 is also provided with a transversely extending opening 30, which contains a sleeve 31 having a centrally aligned aperture 32. The ball 33, forming part of a second check valve, is urged by the spring 34 against the left-hand end (Figure 4) of the opening 32. There is a projection at 35 extending to the right (Figure 2) of the casing 16, this projection being threaded to receive a coupling 36 for securing the fuel inlet pipe 8 to the casing in line with the opening 30.

The casing 16 is provided at its lower end with a countersunk conically shaped opening 37, this opening being adapted to receive a diaphragm 38, preferably of a steel composition which resists corrosion by all of the known types of fuel. This diaphragm may have any desired thickness, but we have found that it performs particularly well when having a thickness less than $\frac{1}{1000}$ of an inch. The diaphragm is seated between an annular rim portion formed on the casing 16 and the upper surface of a lower casing 39 of the fuel injector pump, which together contain the main parts of the injector pump.

The lower casing 39 contains the injector pump particularly described and claimed in our aforesaid patent. This pump and its associated parts include the cylinder 41, cylinder bore 42, plunger

43, groove 44, openings 45, 46 and 47, groove 48 and openings 49 and 50. The plunger has an opening 51, and there is a plug within the plunger having an arcuate portion 53.

Additionally the structure defined by the numerals 54 through 91 correspond to the parts set forth in our patent and relate to the pump for actuating the diaphragm 38.

The nozzles which are attached to the cylinder end of the discharge pipes 10 are shown in Figure 3. This nozzle may conform to any of the well known types on the market which produce a spray injection and are provided with a spring tension cap for closing off the nozzle when the fluid pressure therein becomes less than the predetermined amount. The preferred form of nozzle is illustrated in Figure 3, and consists of a hollow cylinder 92 having a rounded portion 93 projecting from one side and screw threaded to receive a coupling 94 for securing the pipe 10 to the projection 93. The projection 93 contains a bore 95 which communicates with a bore 96 within the cylinder 92.

The bore 96 is reduced to a small bore indicated at 97, which receives an arcuate headed pin 98. The upper surface of the head 99 of the pin seats against the lowermost surface of an enlarged portion 100 of the cylinder 92. The latter is threaded, as indicated at 101, into a threaded opening formed in the cylinder head 102. The pin 98 has four or more longitudinal grooves 103 extending along its length, and communicating at one end with the bore or opening 96 and at the other end with an annular opening 104 formed at the lower end of the enlarged cylinder portion 100. The pin 98 has a threaded opening 105 in its upper end which receives the threaded shank of a rod 106 contained within the opening or bore 96. The rod is provided with an enlarged head 107. A cap 108 is threaded to the exterior surface of the cylinder 92. There is a compression spring 109 loosely surrounding the rod 106 and which bears at its upper end against the head 107, and at the opposite end against the cylinder portion 100. The purpose of this spring is to resiliently hold the head 99 of the pin 98 against its seat, thereby preventing fuel from flowing beyond the annular space 104 except when the fuel is under high pressure.

The pressure produced by the plunger on the trapped oil serves to flex the diaphragm 38, as shown in Figure 4, causing a reduction in the volume of the space directly above the diaphragm. This, in turn, produces a large increase in pressure on the fuel trapped above the diaphragm, causing the ball 33 to be firmly seated against its sleeve 31, thereby closing off the inlet passage 32 and also forcing the ball 28 in the discharge passageway to be moved away from the opening 29. Fuel under pressure is therefore caused to pass upwardly through the passageways 23, 29, through the diagonal passageways 26, into the respective pipes 10 which lead to the cylinders of the engine. From the pipe 10 (Figure 11) the fuel is caused to pass under extremely high pressure through the bores 95, 96, through the grooves 97, into the annular space 104, forcing the head 99 to be moved downwardly (as seen in the figure) away from its seat, and permitting the fuel under high pressure to be ejected as a spray of circular configuration about the entire under side of the head 99, into the cylinder of the engine.

It will be understood that there are as many

cams 69 and fuel injection pumps as there are cylinders, as indicated in Figure 1, and the cams are so positioned with respect to the cam shaft 68 (Figure 2) as to cause the circular spray to leave the respective nozzles in proper timed relation, depending on the firing order of the engine cylinders. The non-drip device is, in combination with the other claimed features, a principal object of the present invention and permits the nozzle to completely shut off fuel at the termination of the charge provided by the flexed diaphragm 38.

During the flexing of the diaphragm by the oil under pressure, the fuel is transmitted under pressure through the pipe 10, into the annular opening 104, from which it is ejected as a spray of circular configuration. At the moment the pressure exerted on the fuel starts to recede, due to the return of the diaphragm to its unflexed position, the head 99 is withdrawn upwardly by the spring 109 to snap the nozzle closed. It is apparent from the design of the nozzle structure, particularly from a consideration of the differential areas involved, that only a relatively small pressure may be permitted to remain within the nozzle structure during the closing period. If the pressure in the fluid is not reduced at a rate to correspond with the closing snap action, dripping will inevitably take place from the end of the nozzle. This after-drip enters the engine cylinder at a time later than the main injection impulse, and represents waste since it is not withdrawn into the engine cylinder at the suction valve. It will be understood that only a few drippings when multiplied by the number of cylinders, and being repeated many times per minute in the case of high speed engines, may produce considerable waste. In accordance with the present invention we have provided a feature which cooperates extremely satisfactorily with our improved injector pump, and completely eliminates the dripping of fuel.

Referring to Figure 2, the casing 16 is provided with a diagonal opening 111 which communicates at one end with the discharge opening 21 and at the other end with an annular opening 112 formed in a small cylindrical plug 113. This plug is provided with a combined diagonally and longitudinally extending opening 114, which communicates at one end with the annular opening 112 and at the other end terminates at the lower surface of the plug. There is a diaphragm 115, preferably of thin flexible metal and non-corrosive with respect to the fuel, secured to the lower surface of the plug. For practical reasons this diaphragm is welded to a sleeve 116, and the latter is secured to the plug 113. The plug is so positioned within the casing 16 as to permit a free flexing movement of the diaphragm 115, only in a half cycle. In order to remove the plug when necessary a downwardly extending hole 117 may be provided in the casing, directly in line with the plug, and this hole is closed by a screw 118.

Now assume that the nozzle (Figure 3) is in the act of closing, after having ejected a full charge of fuel into one of the cylinders, so that the head 99 is snapped upwardly. In the unimproved form of nozzle, the back pressure may remain high or fail to reduce sufficiently quickly and cause dripping of fuel. In accordance with our invention, this excess pressure is relieved by the flexing of the diaphragm 115 (Figure 5) which permits the column of trapped fuel to expand, thereby lowering the pressure and per-

mitting the head 99 to seat promptly. Figure 2 shows the diaphragm 115 in its extended position to prevent dripping of fuel at the nozzle after the diaphragm 38 has started to retract to its initial flat position. In Figure 4 the diaphragm 115 is in its seated position, i. e., unextended, because the main diaphragm 38 is in the act of causing the ejection of fuel at the nozzle, and no back pressure has been built up because the head 99 is maintained in its open position by the pressure in the fuel.

It will be noted that the non-drip feature described immediately above cooperates with the improved injector pump in such a way as to prevent any dripping from the nozzle after the metered charge of fuel has been ejected at the nozzle due to the flexing of the main diaphragm 38. Consequently, the operation of the latter serves accurately to measure the fuel content of each charge and to cause the full charge to be ejected at the nozzle without any after-drip.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims and the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a diaphragm having its sides communicating respectively with the inlet and outlet sides of the check valve.

2. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a diaphragm having its sides communicating respectively with the inlet and outlet sides of the check valve, one of said chambers being formed by a bore and a removable plug therein.

3. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including an expansion compartment having a diaphragm with its sides communicating respectively with the inlet and outlet sides of the check valve whereby when excess pressure occurs in the fuel after the injection device has closed, a portion of said fuel is permitted to enter said expansion chamber in order to relieve the excess pressure in said injection device.

4. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including

a plurality of compartments communicating with the inlet and outlet sides of the check valve and a diaphragm separating said compartments.

5. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a diaphragm, a compartment on either side of said diaphragm, each compartment having means communicating respectively with the inlet and outlet sides of the check valve, said compartments being out of alignment with each other.

6. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a diaphragm, an elongated chamber on each side of said diaphragm, and passageways communicating respectively with the inlet and outlet sides of the check valve and said chambers.

7. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a drip diaphragm having its sides communicating respectively with the inlet and outlet sides of the check valve, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

8. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a drip diaphragm having its sides communicating respectively with the inlet and outlet sides of the check valve, one of said chambers being formed by a bore and a removable plug therein, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

9. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means includ-

ing an expansion compartment having a drip diaphragm with its sides communicating respectively with the inlet and outlet sides of the check valve whereby when excess pressure occurs in the fuel after the injection device has closed, a portion of said fuel is permitted to enter said expansion chamber in order to relieve the excess pressure in said injection device, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

10. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a plurality of compartments communicating with the inlet and outlet sides of the check valve and a drip diaphragm separating said compartments, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

11. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predeter-

mined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a drip diaphragm, a compartment on either side of said drip diaphragm, each compartment having means communicating respectively with the inlet and outlet sides of the check valve, said compartments being out of alignment with each other, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

12. In a fuel injection pumping means for use with an injection device, said pumping means having a piston, a discharge check valve and means for relieving pressure between the piston and said discharge check valve after a predetermined movement of the piston on its discharge stroke, means for preventing drip at the injection device, said drip preventing means including a drip diaphragm, an elongated chamber on each side of said drip diaphragm, passageways communicating respectively with the inlet and outlet sides of the check valve and said chambers, and a pump diaphragm one side of which is in communication with said piston and the other side of which is in communication with that side of the drip diaphragm which communicates with the inlet side of said check valve, the operation of said piston and said injection device causing said diaphragms to be alternately flexed and depressed.

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