Dec. 13, 1932. E. DODSON 1,891,082

FUEL INJECTION DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 19, 1930 2 Sheets-Sheet 1

FIG. 1.

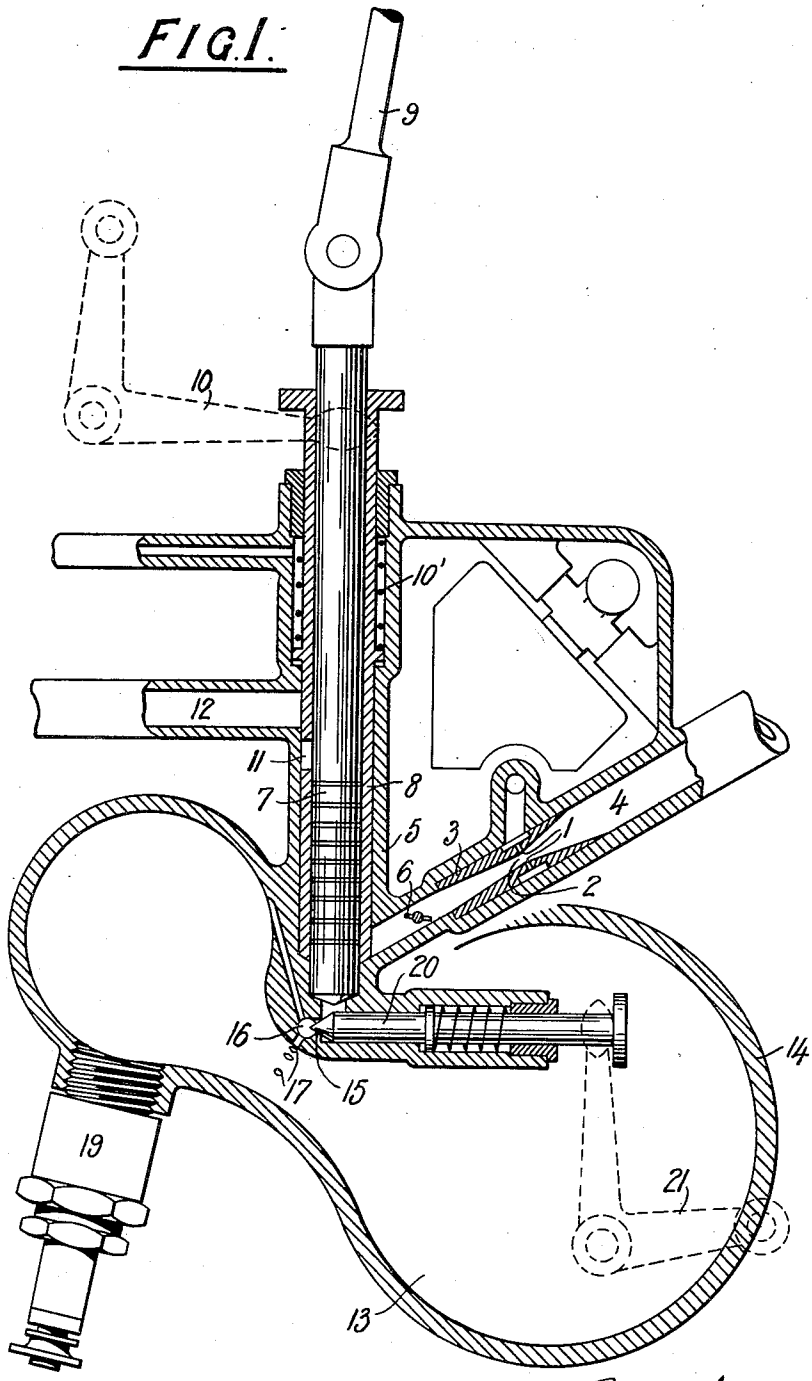

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FIG. 2.

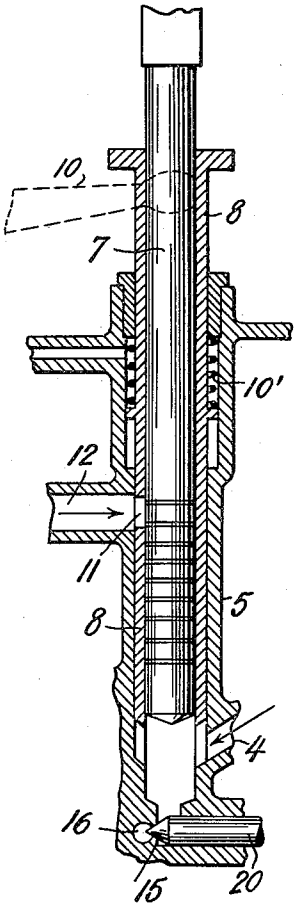


FIG. 3.

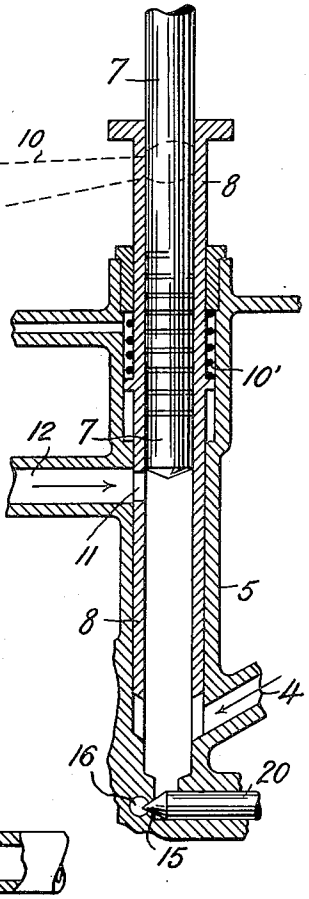
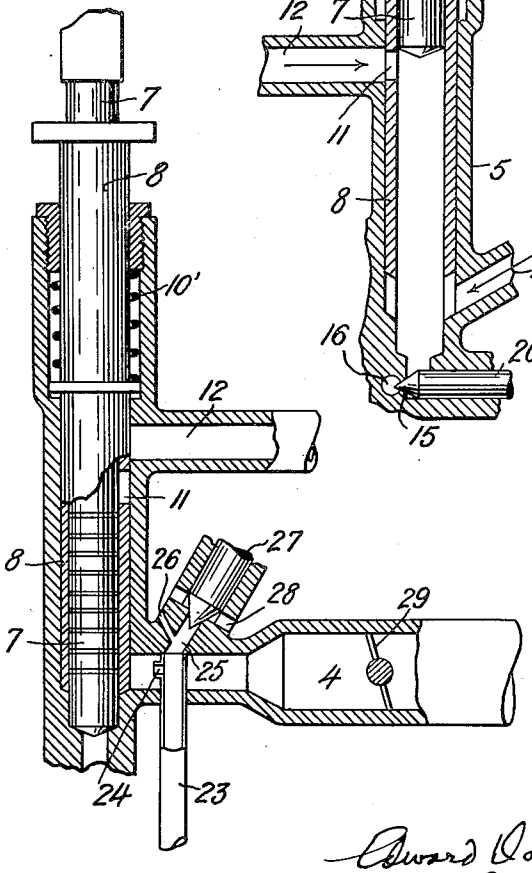


FIG. 4.



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Patented Dec. 13, 1932 1,891,082

UNITED STATES PATENT OFFICE

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FUEL INJECTION DEVICE FOR INTERNAL COMBUSTION ENGINES

Application filed September 19, 1930, Serial No. 483,098, and in Great Britain December 13, 1929.

This invention relates to improvements in means for injecting a rich mixture of liquid fuel and a gaseous medium into internal combustion engines.

The object of the present invention is to enable the quantity of fuel injected by said means into the combustion chamber to be very accurately determined. To this end, the means for injecting the rich mixture is so arranged that the mixture is adapted to be supplied to the injection pump chamber adjacent one end of the plunger stroke, and a gas other than that carrying fuel is adapted to be admitted to the pump chamber adjacent the other end of the plunger stroke, and means is provided for regulating the supply of mixture to the pump and for isolating the means for supplying the rich mixture to the pump chamber during the compression stroke of the plunger.

By this means, in which the mixture is supplied to the pump instead of liquid fuel, the richness of the fuel can be accurately gauged and the quantity of fuel more accurately measured, due to the greater volume of the mixture, and by the stratification of the mixture and said gas in the pump chamber, the injection into the combustion chamber of the whole of the fuel in the pump can be ensured, with the result that the quantity of fuel injected can be very accurately determined.

This invention will be more particularly described with reference to two practical embodiments shown in the accompanying drawings in which:—

Figure 1 is a sectional view through the combustion chamber of an internal combustion engine showing one embodiment of the means for injecting fuel according to this invention applied thereto with the means in their initial position.

Figure 2 shows a fragment of Figure 1 with the injecting means drawing in the gaseous mixture.

Figure 3 is a similar view to Figure 2 but with the injecting means in a position in which it takes in air over the gaseous mixture.

Figure 4 is a similar view to Figure 1 of the other embodiment of the means for injecting fuel.

In Figures 1 to 3 the gaseous mixture is obtained by velocity suction from liquid fuel issuing at the nozzles 1 in throat 2 of a venturi 3, in the passage 4, through which air is drawn to the plunger casing 5. The speed of travel permitted to the mixture to the casing may be regulated by a valve or baffle 6. The plunger 7 works in a longitudinally sliding sleeve 8, in such a manner that the said sleeve 8 closes the exit of the passage 4 containing the venturi leading from the carburetter, when the said sleeve is at one end of its stroke as shown in Figure 1. The plunger of the pump is operated through the link 9, and the sleeve, is moved outwardly by the bell crank lever 10 and is returned by the spring 10′ in such a manner that the sleeve when moved outwardly to the other end of its stroke, as shown in Figure 2, brings an aperture 11 in the sleeve opposite to an air inlet passage 12, while the plunger maintains the aperture 11 closed until it uncovers the aperture by its end passing free beyond the aperture, as shown in Figure 3. In the outward stroke of the plunger, the carburetted air is drawn into the plunger casing at the speed permitted by the baffle 6, and when the plunger uncovers the aperture in the sleeve 11, air is drawn in through the passage 12 over the charge below the end of the plunger, and the sleeve then moves in the opposite direction so as to close the aperture 11 and close the entry of the passage 4 to the casing of the plunger. The plunger then descends, compressing the charge. Admission of this gaseous fuel to the combustion space 13 of the engine cylinder 14 through the pump outlet port 15, semi-annular duct 16 and inlet orifices 17 is prevented by the control valve 20 until this is opened, and admits the charge to the combustion chamber of the engine where it is ignited by the sparking plug 19 or other means. The control valve 20 is opened by the bell crank lever 21 and is returned by the spring 22.

In the other embodiment shown in Figure 4, the arrangement of the injecting means is the same as that in Figure 1, and these parts are indicated by like references to those in Figure 1, but the means for introducing the gaseous mixture into the injecting means is

modified in order that the richness of the gaseous mixture may be regulated. Instead of liquid fuel issuing in the throat of a venturi, in the passage 4, this passage is provided with a liquid fuel supply pipe 23 having a nozzle 24, said pipe extending diametrically across the passage 4 and having its upper end open to an air passage 25, which air passage communicates with a small bore 26 which is constantly open, the main passage 25 having a valve 27 by which the air supply through inlet ports 28 can be regulated. Air from the passage 25 and liquid fuel from the supply pipe 23 are caused, by static suction of the injecting means on the nozzle 24, to issue through this nozzle and to pass into the plunger casing 5. In this case, air can pass through the passage 4 around the upper end of the pipe 23 under the control of the valve or baffle 29. By regulating the valve 27 the richness of the mixture can be varied, and by regulating the valve or baffle 29 the speed of travel permitted to the mixture flowing to the casing can be regulated.

By means of this invention the quantity of fuel injected at each stroke of the piston of the engine, may be determined more accurately than when liquid fuel alone is injected. Greater accuracy is secured in measuring the quantity of carburetted air injected into the engine than by measuring the actual quantity of liquid fuel thus injected, because the volume of carburetted air mixture is considerably greater; and the quantity of fuel may be regulated not only by regulating the quantity of mixture drawn in by the plunger, but by the adjustment of the richness of that mixture by proportioning the quantity of fuel-laden air drawn past the carburetter with the quantity of air admitted below the plunger at each stroke of the latter.

In cases where it is desired to use a pump pressure so high that incipient combustion may occur in the pump, an inert gas such as cooled exhaust gas, or a fuel gas such as hydrogen, may be used both as a carrying medium for the fuel through the carburetter and as the gas entering the upper ports of the pump. Thus inert gas may be used both to convey the fuel to the pump, and to form the other part of the pump charge before mentioned. Under these conditions, the fuel will be mainly injected at the first part of the stroke, followed by a charge of other gases, to force the last vestiges of fuel out into the cylinder.

Fuel measurement by known carburation means presents no unknown difficulties or problems, and the variation of fuel quantity to alter the loading (i. e. the relative amount of fuel in the gaseous mixture to the air or gas carrying same) as required, is easy to accomplish by means of the small carburetter throttle, as obviously with a very great restriction here, the pump charge will consist of relatively little of the gas that has been fuel laden by passage through the carburetter, and a very high proportion of the total pump charge will consist of air or gas that is admitted through the ports in the upper portion of the pump cylinder.

Conversely, if the small carburetter throttle is widely open, the pump cylinder will be mainly filled by fuel loaded gas from the carburetter, and the gas from the upper ports will be only a small portion of the charge. Other known means of varying the richness of the mixture delivered by the carburetter may be used.

It will be seen that the actual fuel measurement is made by known and well tried means of carburation, and the initial accuracy of measurement is maintained during discharge or expression, because the small necessary leakage past the piston will only consist of air or gas, not fuel.

If desired means may be provided for taking two or more kinds of fuel into the pump either together or alternatively. For instance, means may be provided for supplying petrol when starting the internal combustion engine and heavier fuel when the engine is warm; or a rapidly burning easily ignitable fuel may be supplied together with a less ignitable fuel; or a fuel and an anti-detonant may be supplied together; or a fuel with a wide explosive mixture range and one with a more restricted mixture range may be supplied together to the pump.

What I claim as my invention and desire to secure by Letters Patent is:—

1. Means for injecting fuel into internal combustion engines comprising, an injection pump, including a pump cylinder and a plunger adapted to reciprocate in said cylinder; an ejection port adjacent one end of said cylinder; an inlet port adjacent said ejection port; a carburetter communicating with said inlet port; a throttle valve for said carburetter; an unregulated inlet port adjacent the other end of said pump cylinder; a sleeve valve surrounding said plunger for controlling said inlet ports and means for mechanically actuating said sleeve valve independently of the plunger.

2. A fuel injector for internal combustion engines comprising, in combination, a cylinder; a plunger reciprocable in said cylinder; an ejection port adjacent one end of said cylinder; an inlet passage adjacent said ejection port; a carburetter in said passage; a throttle valve in said passage; an inlet port adjacent the opposite end of the cylinder; a sliding sleeve valve between said cylinder and said plunger and reciprocable independently of said plunger for controlling said inlet passage and said inlet port, and means for mechanically actuating said sleeve valve, whereby on the suction stroke a strata of fuel mixture drawn through said

inlet passage into the cylinder can be varied proportionally to a strata of non-fuel bearing fluid drawn through said inlet port, and whereby on the compression stroke said inlet passage and said inlet port are closed.

In witness whereof I have hereunto set my hand.

EDWARD DODSON.