Aug. 30, 1932. M. J. GOLDBERG 1,874,283

FUEL INJECTION VALVE FOR OIL ENGINES

Filed April 28, 1930

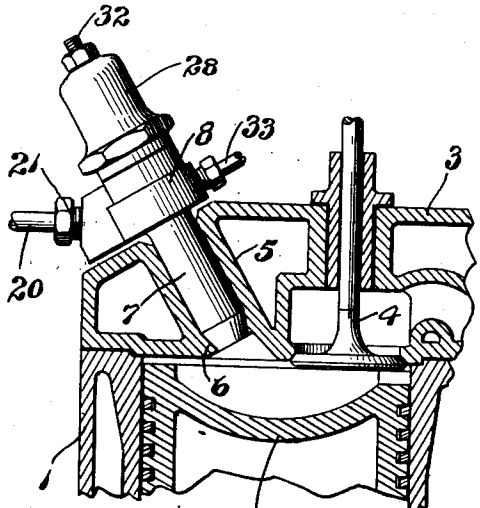


Fig. 1.

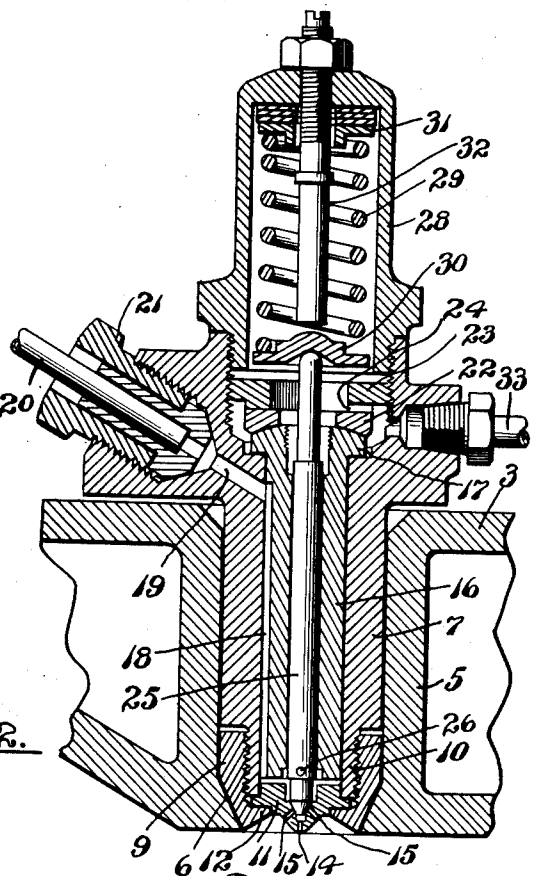


Fig. 2.

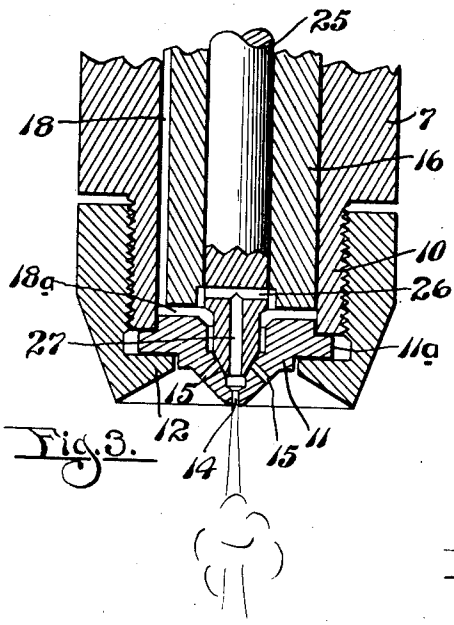


Fig. 3.

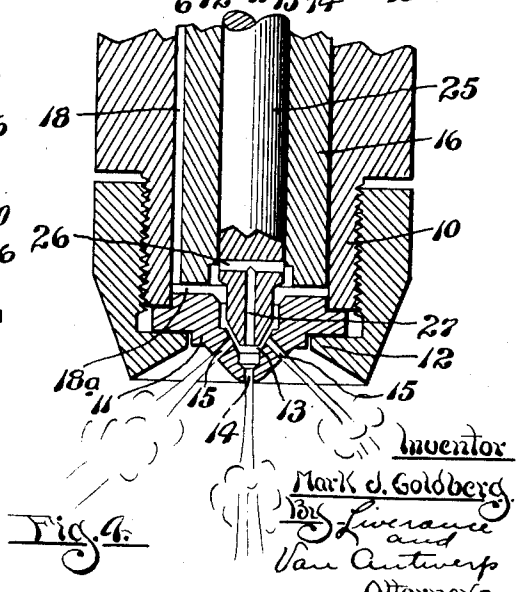


Fig. 4.

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UNITED STATES PATENT OFFICE

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FUEL INJECTION VALVE FOR OIL ENGINES

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This invention relates to a novel fuel injection valve for oil engines.

In oil engines of the type in which the liquid fuel is injected into compressed air in the engine cylinders the device through which the fuel is introduced in the cylinder is known as an injection valve.

Such oil engines of the present day most approved and accepted types have two characteristic features. The first is that the compression of the air is carried to a point where self-ignition takes place, this being in accordance with the well known Diesel principle. The second feature is that a measured quantity of the fuel is projected into compressed air in the engine cylinder by pressure from a fuel pump without auxiliary means to aid such fuel injection.

There are in practice two fundamental types of injection valves for engines of this kind in general use. The first one, the open type, includes fundamentally a tube of small interior diameter which is in constant communication with the engine cylinder. The other or closed type is open to the cylinder during the time that the fuel pump is operating to deliver fuel and a spring actuated valve completely closes the passage for the fuel during the rest of the time.

Satisfactory results have been obtained with such valves on engines of large size having a more or less constant speed of rotation. But on the engines of smaller size, and particularly in those where the speed of rotation is widely variable, as in automobile and marine engines, the results coming from such types of valves have not been satisfactory, as it has been impossible to obtain the necessary and desired flexibility of operation within the wide range of speed and load conditions encountered.

The size of the injection orifice or orifices is determined by the maximum load and speed and, therefore, are too large for idling and slow speeds. Accordingly in idling the quantity of fuel required for each cycle being very small or, for example, being only a drop or so of the liquid fuel when it is forced into the compressed air of the cylinder, which is at about 500 pounds per square inch, from a relatively large orifice or passage, the drop of fuel is not broken up and atomized to disseminate throughout the compressed air but merely leaks or oozes from the orifice. With the closed type of valve, the fuel, after being measured by the fuel pump, has to be subjected to pressure which may vary within ranges of 1600 to 6000 pounds per square inch or more before its pressure will lift the spring closed valve. What compressibility of the fuel there is and the flexibility or expansion in the line which carries the fuel from the pump to the engine under these very high pressures become features detrimental to the proper injection of fuel into the cylinders particularly for idling speeds or under light loads. The introduction of the fuel is irregular with an irregular performance of the engine so that any ordinary operation of the engine within the necessary wide range required for automobile or marine engines is most difficult, if not impossible, from a practical standpoint.

Furthermore the necessarily relatively large area of the fuel injecting orifices for maximum load and speed make the problem of starting the engine when cold very difficult. Firing a cold engine is always made harder by the slow rotative speed which is given to the engine either in cranking or by the usual starter and the fuel not penetrating and not being properly atomized and disassembled through the air in the cylinder further hinders the starting of a cold engine of the self ignition type.

In my invention it is a primary object and purpose to provide a fuel injection valve for engines of the type described which overcomes the lack of flexibility and the starting difficulties. Essentially, the valve combines characteristics of both the open and closed types of valves, there being a small orifice or passage in constant communication with the combustion chamber and other orifices closed at times and at other times in communication with the combustion chamber of the engine cylinder; and the fuel being forced through this small orifice by the fuel, pump, does not leak into the combustion chamber but is projected and disseminated to a much greater de-

gree through the compressed air than it would be when coming from an orifice capable of supplying fuel for the maximum needs of the engine.

For the higher speeds and heavier loads other orifices are automatically opened by pressure of the fuel whereby a greater quantity of fuel when needed is injected into the compressed air to take care of the heavy load and higher speed operative conditions.

The essential principle upon which my invention is based is that for the fuel injection, two sets of orifices are used, one for one end of the operating range of the engine and the second set used in addition to and combined with the first for the other operating range of the engine.

The construction which I have devised and by means of which the stated results and advantages are attained, as well as many others not at this time specifically stated, is set forth in the following description and illustrated in the accompanying drawing, in which,

Fig. 1 is a fragmentary vertical section of the upper end portion of an engine showing the manner in which the fuel injection valve of my invention is installed in the engine head, said valve being shown in side elevation.

Fig. 2 is a fragmentary enlarged vertical section through the injection valve and the adjacent part of the engine head in which it is mounted.

Fig. 3 is a fragmentary enlarged elevation of the lower end of the valve structure showing the position of the valve parts for the injection of fuel at idling or low speeds and light loads, and

Fig. 4 is a similar section showing the position of the valve parts for the higher speeds and heavier load operating range of the engine.

Like reference characters refer to like parts in the different figures of the drawing.

In the drawing the engine cylinder block 1, for the reception of a reciprocating piston 2, the end of the block being covered by a head 3, in which the exhaust valve 4 is mounted to operate at the proper time to permit the escape of exhaust gases, is more or less conventional. In the head 4 of each cylinder is a guide sleeve 5 extending from the outer side of the head to the combustion chamber at the end of the piston and this sleeve at its inner portion is provided with an inwardly extending conical seat 6.

In the construction of the valve an outer housing sleeve 7 is used, having a head 8 at its outer end, the sleeve being adapted to be received within the guide sleeve 5 with the head 8 located outside of the engine head 3. A nut 9 is interiorly threaded and the lower end of the housing sleeve 7 is reduced in diameter and exteriorly threaded, as indicated at 10, to screw into the nut. Between the lower end of the reduced section 10 and an inwardly extending lip or ledge 12 on the nut 9 a cap 11 is located having an outwardly extending annular flange 11a clamped between the lower end of the part 10 and the annular ledge or lip 12. The cap 11 is recessed in its upper side and formed with a conical seat 13 (see Fig. 4). Its lower portion extends through the opening in the nut 9 within the ledge 12. This part which extends through said opening is formed with a passage 14 therethrough which is of very small diameter.

Other passages 15 are made through the cap 11 leading from the sides of the conical seat 13 at an angle to the axis of the passage 14. There may be as many of the passages 15 as may be required for fuel to be forced therethrough and through the passage 14 to take care of the maximum fuel requirements in the engine operation.

Within the sleeve 7 is a second and inner sleeve 16 which extends lengthwise thereof and has its lower end spaced a short distance from the upper side of the closing cap 11. The sleeve 16 is formed with a head 17 at its upper end which bears upon an annular shoulder around the opening through the sleeve 7 into which the inner sleeve 16 is inserted. The sleeve 16 is formed with a longitudinal groove 18 at one side extending from its lower end to a point above a passage 19 made laterally in the head 8 of the injection valve housing, through which the fuel passes from any suitable supply line 20 connected by a conventional attaching means 21 to the head 8 of the valve. The sleeve 16 is held securely against movement through a collar 22 bearing upon the upper end of the head 17 and pressing and clamping thereagainst by a nut 23 which threads into the upper end of the head 8 of the valve housing, it being interiorly bored and threaded as shown in Fig. 2; and between the upper side of the collar 22 and nut 23 a drainage passage 24 is made (see Fig. 2), the purpose of which will be later described.

A rod 25 passes lengthwise through the inner sleeve 16 and at its lower end has a conical or tapered terminal adapted to fit snugly against the conical seat 13 of the cap 11 previously described. The rod 25 has a transverse opening 26 therethrough a short distance above its lower end and an axial or central opening or passage 27 which extends from the transverse passage 26 to the end of the rod 25 and in substantial alignment with the passage 14.

A housing cap 28 is threaded into the upper end of the head 8 of the valve housing within which a strong coiled compression spring 29 is disposed, bearing at its lower end on a member 30 which in turn bears against the end of the rod 25, the upper end of the spring 29 seating against a collar 31 located in the

upper end of the housing 28 and another rod 32 threads through the closed end of the housing cap, being equipped with a locking nut so that said rod 32 may be adjusted and locked in different positions and thereby limit the distance that the rod 25 may lift.

In the operation of the engine fuel is pumped at periodical intervals and in variable measured quantities in accordance with the needs of the engine through the pipe 20, from which it passes through the passage 19 and the groove 18 to the space below the lower end of the sleeve 16 and above the cap 11 described. The fuel passes into the passages 26 and 27 and, irrespective of the position of the rod 25, whether in its lower position as shown in Fig. 3, or whether in its upper position as shown in Fig. 4, fuel under the pressure of the pump is injected through the passage 14 into the cylinder. The pressure on the fuel exerted by the pump takes place at the proper times so that the fuel is injected when the piston 2 is on its up stroke and the pressure of air is relatively high, for instance, approximately 500 pounds per square inch. For idling low speeds and light load, or on starting the engine, the quantity and pressure of the fuel will not be sufficient to lift the rod 25 against the spring 29 and the only fuel injected into the cylinder will be that passing through the small passage 14.

On higher speeds and heavier loads requiring a greater amount of fuel, the pump, which forms no part of the present invention, but which will be shown in another application, pumps the requisite amount of fuel but the passage at 14 is not sufficient to pass the same. The pressure of fuel against the end of the rod 25 and against the annular shoulder between the reduced end portion of the rod 25 and its major portion, upon attaining sufficient force, moves the rod 25 and thereupon uncovers the passages 15 and provides space around the sides of the rod for the fuel to go to said passages 15, whereupon the fuel is injected into the combustion chamber of the engine through both sets of passages of orifices 14 and 15.

It is apparent from the foregoing description that the passage at 14, of relatively small diameter, will pass the fuel necessary for idling and lower speeds and in starting the engine, and that the fuel will not merely ooze from such passage but will be injected with considerable pressure and forced into the compressed air and disseminate much more thoroughly therethrough than if the area of such passage 14 was the area required for the passage of the maximum consumption of fuel in the engine cylinder. This aids very materially in cold engine starting and assures a steady and unfluctuating slow and idling engine speed as long as the load and control conditions of the engine are not changed. On opening the control wider for greater speeds or for handling heavier loads the pressure of the fuel automatically builds up until, the passage at 14, being unable to take care of the quantity of fuel pumped, it moves the rod 25 upwardly, and the passages at 15 come into play to carry such fuel to and inject it in the compressed air in the combustion chamber of the engine.

Inasmuch as the rod 25 does not have a driving fit in the sleeve 16, but is longitudinally movable therein there is a small passage of fuel past such rod. This fuel is conducted through the opening at 24 and is drained from the head of the valve housing through an outlet pipe 33, leading back to the main fuel supply.

The injection valve of the present invention is one permitting a wide flexibility of operation of the engine due to the valve having a passage for the minimum quantity fuel consumption conditions of the engine, coupled with the automatic opening of additional passages for fuel supply and consumption up to and including the maximum. Fuel passes through all of the passages 14 and 15 upon moving the rod 25.

The construction of injection valve described is practical, simple to make and with the engines having a multiple of relatively small cylinders may be operated through all the ranges of speed needed and the varying conditions of load met, as for instance in automotive operation, the invention making it possible to operate automotive or other engines on the principle of the Diesel engine, the engine being thoroughly flexible and ready and easy for starting when cold. The invention is defined in the appended claims and is to be considered comprehensive of all forms of structure coming within their scope.

I claim:

1. In an injection valve, means for conducting liquid fuel under pressure to adjacent the inner end of the valve, said valve at said inner end having a continuous outlet passage for fuel of small size and sufficient to pass fuel for the minimum requirements jacent the inner end of the valve, said valve there being other passages at the inner end of the valve, means for normally closing said other passages against the passage of fuel, and means for uncovering said other passages automatically for fuel passage therethrough upon requirements for fuel by the engine cylinder in excess of what the first fuel passage will supply.

2. An injection valve for oil engines comprising, a valve having an injection cap at its inner end with a plurality of passages therethrough, said valve having a conducting passage for fuel to said cap, a member movably mounted in said valve and formed at its inner end to cover said passages when in its normal position, said member at its inner end portion having a passage therethrough in

communication with one of the passages through the cap whereby the fuel carried to the inner end portion of the valve is conducted through said passage in said member to one of the passages in the cap, the remaining passages being completely closed, and spring means yieldingly holding said movable member in its closing position but yielding upon attainment of a predetermined pressure of the fuel on said member to thereby permit movement of the member to uncover said remaining passages in the cap for fuel passage therethrough.

3. An injection valve adapted to be applied to a cylinder of an oil engine comprising, a housing having an injection cap at its inner end and means including a conducting passage in the valve for carrying liquid fuel under pressure to said cap, said cap having a plurality of spaced apart injection openings or passages therethrough, spring actuated movable means normally closing all of said passages except one whereby fuel may pass through said one passage for the minimum requirements of the engine cylinder, said spring actuated means being acted upon by the fuel on the attainment of a predetermined pressure thereof to move the same to uncover the remaining fuel injection passages for requirements of the engine cylinder in excess of minimum requirements.

4. An injection valve for oil engines comprising, a valve housing having a central opening therethrough, an injection cap having a plurality of passages therein secured at the inner end of the housing, a sleeve extending lengthwise of and through the opening in the housing having its inner end spaced a short distance from the injection cap, there being a conducting passage between said housing and sleeve for carrying oil under pressure into the space between said sleeve and cap, a rod extending through said sleeve and formed at its lower end to engage with the cap and cover the injection passages through the cap, said member at its lower end portion having a passage therethrough to conduct oil to one of said injection passages when the rod is in passage closing position, spring means to yieldingly hold the rod in said position but yielding upon attainment of pressure of oil against said rod to a predetermined amount whereby the rod is moved to uncover all of the fuel injection passages in said cap.

5. An injection valve for oil engines comprising, an outer valve housing having a longitudinal opening therethrough, an injection cap secured at the inner end of the housing over the inner end of said opening, a sleeve having a central longitudinal opening therethrough located lengthwise of and within said valve housing having its lower end spaced a short distance from the cap, there being passages in said housing and sleeve for conducting oil fuel under pressure to the space between the cap and sleeve and said cap having a plurality of injection passages therethrough, a rod mounted longitudinally of said sleeve and formed at its lower end with a reduced portion, the end of which normally engages with the cap to cover all of said injection passages therein, said rod at the lower end portion thereof having a passage therethrough for conducting fuel from the passage between the sleeve and cap to one of said injection passages, a housing connected to the upper end of the valve housing, and a coiled spring therein under compression bearing against the outer end of the rod to normally hold the same against movement, said spring yielding on attainment of a predetermined oil pressure at the lower end portion of said rod.

6. An injection valve for oil engines comprising, an outer valve housing having a central longitudinal opening therethrough and a reduced threaded inner end portion, an injection cap located against said reduced end portion of the valve housing and across the opening therethrough, a securing nut threaded on to said inner reduced portion of the valve housing and against said cap for securing the cap in place, said cap having a tapered seat at its inner side and a plurality of injection passages leading from said tapered seat together with an additional injection passage substantially at the apex of said seat, a sleeve located lengthwise of and secured in the longitudinal opening through the valve housing and having its inner end spaced a short distance from the cap, there being fuel conducting passages through the valve housing and between the same and said sleeve for carrying liquid fuel under pressure to the space between the cap and lower end of the sleeve, a rod extending lengthwise through said sleeve and having a reduced lower end portion at the end of which it is tapered to seat against said seat in the injection cap to close the first mentioned passages when thus seated, said rod from its inner end upwardly for a short distance having a small longitudinal passage therein and a transverse passage therethrough connecting with the longitudinal passage, said transverse passage at its ends coming into conjunction with the space between the sleeve and injection cap, and yielding spring means acting upon the outer end of said rod to normally hold it in engagement with said seat in the cap whereby the first mentioned passages are normally closed and the additional injection passage may pass fuel received through the passages in the lower end portion of said rod.

In testimony whereof I affix my signature.

MARK J. GOLDBERG.