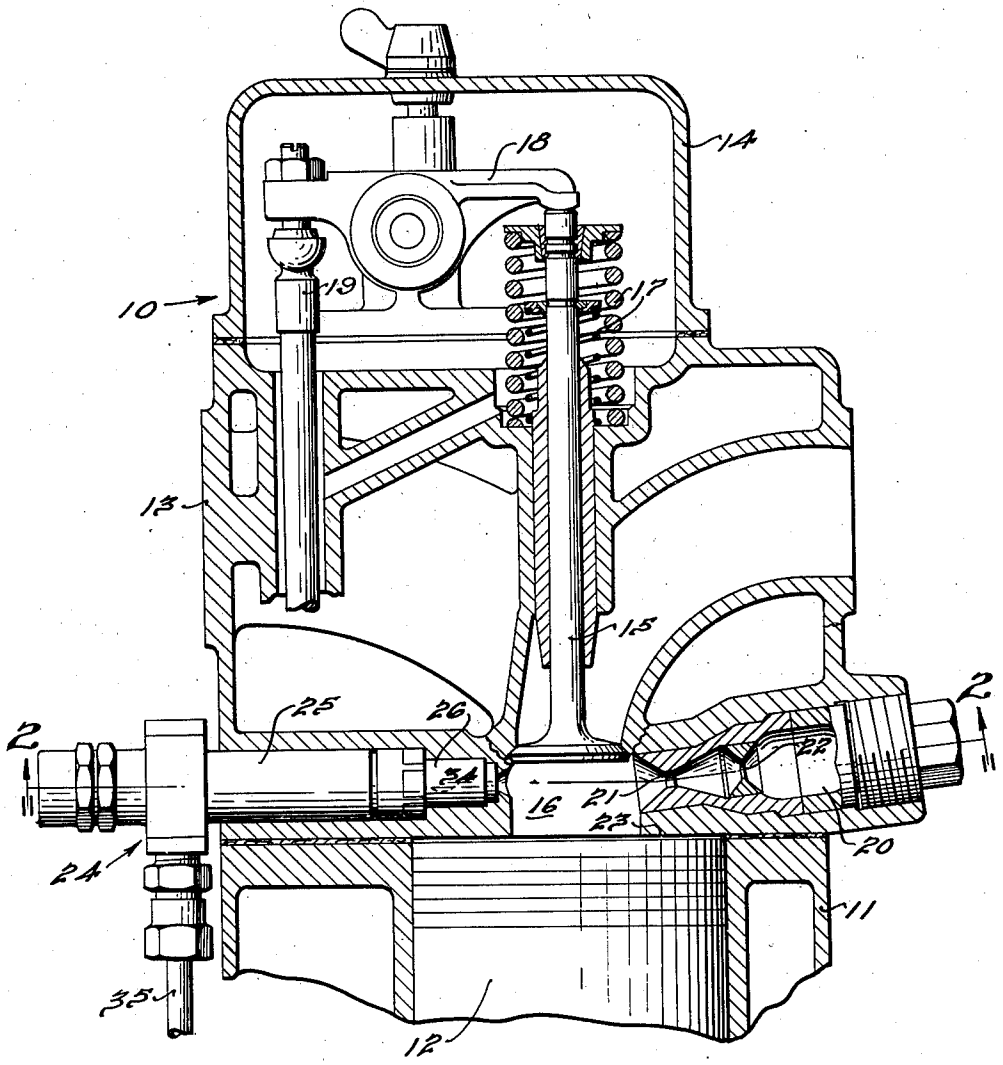
July 23, 1940. H. H. DIETRICH 2,208,631

INJECTION ENGINE

Filed Dec. 20, 1937 2 Sheets-Sheet 1

Fig. 1.



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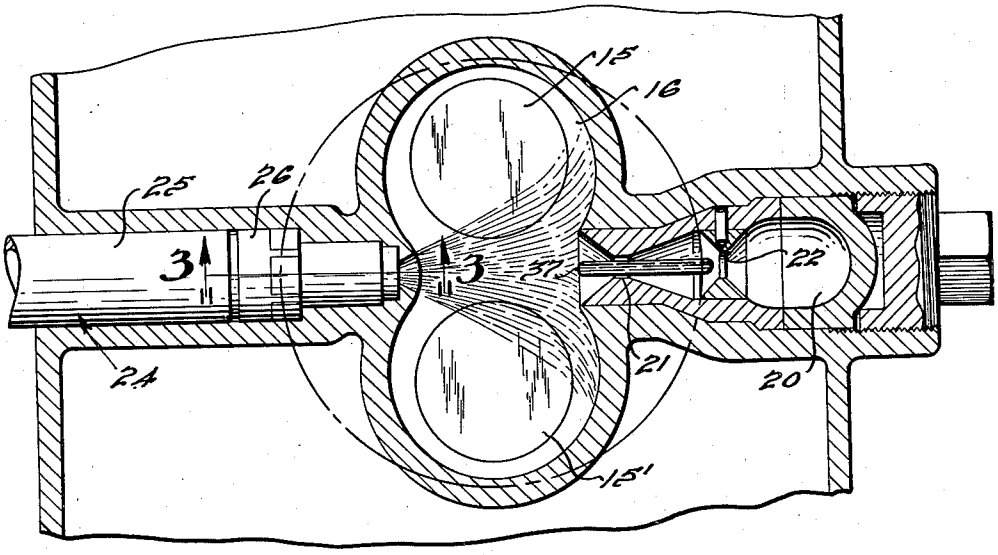

FIG. 2.

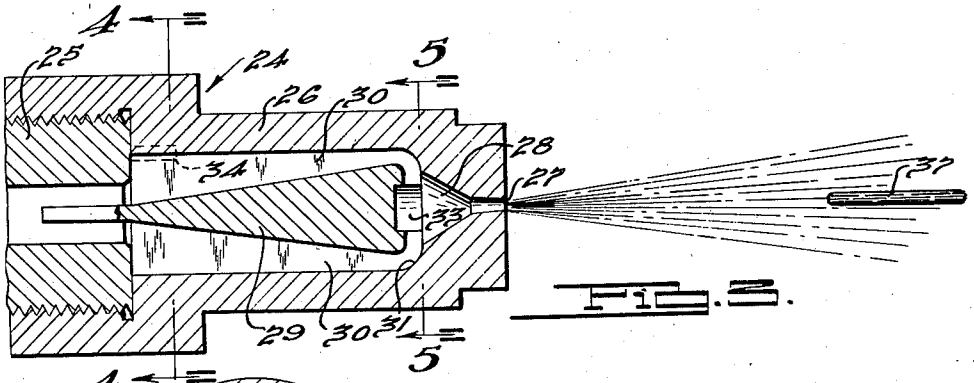

FIG. 3.

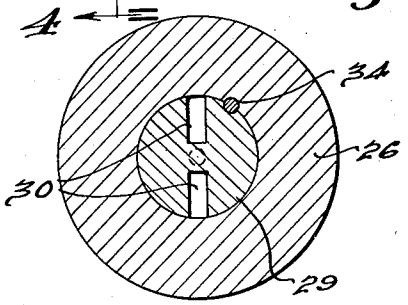

FIG. 4.

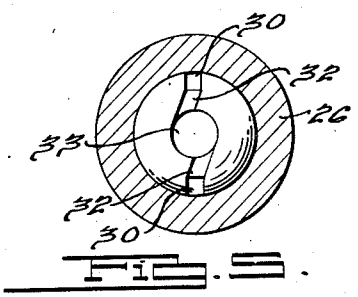

FIG. 5.

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UNITED STATES PATENT OFFICE

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INJECTION ENGINE

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Application December 20, 1937, Serial No. 180,706

3 Claims. (Cl. 123—32)

This invention relates to an improved fuel injection system for internal combustion engines and the like.

More particularly, the invention pertains to improved fuel injection apparatus and method for injection internal combustion engines of the type comprising a combustion chamber having an air chamber, or energy cell, in which some fuel is compressed during the compression stroke of the engine piston and from which the fuel issues or burns during the working stroke of the engine piston.

One of the main objects of the invention is to provide an improved fuel injection system for internal combustion engines having a simple and inexpensive means for increasing its efficiency and by virtue of which may be obtained a greater benefit from the energy cell of a combustion chamber.

More specifically, the invention has for one of its objects the provision of a fuel injection system of this character by which a predetermined amount of fuel, in this particular embodiment a slug of liquid fuel of predetermined quantity, is automatically injected into the energy cell just prior to the injecting of a charge of swirling, vaporized and atomized fuel into the combustion chamber during the compression stroke of the piston.

Other objects of the invention are to provide in a fuel injection system of this kind a fuel injector comprising a liquid fuel storing cavity immediately adjacent the outlet of the nozzle portion of the injector and in advance of the swirling and atomizing parts thereof so as to prevent the initial fuel discharge from being swirled and atomized when a stream of fuel is discharged from the injector; to provide an injector of this character comprising a means for atomizing the fuel and whirling grooves operatively interposed between the point at which the injector receives the liquid fuel and a liquid fuel storing cavity immediately adjacent the nozzle portion of the injector, so as to automatically shoot out a slug of liquid fuel of predetermined quantity into the energy cell prior to the injection into the combustion chamber of swirling atomized fuel through the medium of said whirling grooves; and to provide an injector of this kind which automatically ejects a slug of liquid fuel of predetermined quantity through a constriction and into the energy cell so that, as soon as the combustion of the fuel commences, a predetermined quantity of gas is discharged from the energy cell into the combustion chamber to support combustion and to produce atomization and intermixing of the fuel and air inasmuch as it is usually desirable to have the injection of fuel continue after the energy cell commences to discharge.

Other objects and advantages of the invention will be more apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a partial vertical sectional view of a fuel injection engine embodying the invention.

Fig. 2 is a mainly horizontal sectional view taken approximately as indicated by the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary, vertical sectional view taken as indicated by the line 3—3 of Fig. 2.

Fig. 4 is a vertical sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a vertical sectional view taken as indicated by the line 5—5 of Fig. 3.

In the form of the invention illustrated in the drawings, the improved fuel injection system is shown with one particular form of fuel injection internal combustion engine, although this system may be used with other types of internal combustion engines and the like without departing from the scope of the invention.

With injection engines of the type illustrated comprising an air chamber, or energy cell, in which the fuel is compressed during the compression stroke of the engine piston and from which the fuel issues and burns during the working stroke of the engine piston, it has heretofore been common practice to inject atomized fuel into the combustion chamber without being able to control the amount of fuel which entered the energy cell. This lack of control of the charging of the energy cell frequently resulted in insufficient and variable amounts of fuel entering the cell, and thereby effected a loss of available energy cell benefit and efficiency and smoothness of operation.

It is a well known fact that it is desirable to automatically have a sufficient quantity of fuel in the energy cell so that, as soon as the combustion of the fuel commences, the gas is discharged from the energy cell into the combustion chamber to support combustion and to produce vaporizing and intermixing of the fuel and air inasmuch as it is usually desirable to have the injection of fuel continue after the energy cell commences to discharge. In the novel fuel injection system shown in the drawings, a predetermined quantity of fuel is automatically injected into the energy cell prior to the injection into the combustion chamber of the swirling

atomized fuel charge so that, as soon as the combustion of the fuel commences, a predetermined quantity of fuel and air is discharged from the energy cell into the combustion chamber to support combustion and prolong high compression to the degree desired, and to produce atomization and intermixing of the fuel and air.

The illustrated injection engine, generally designated by the numeral 10, is of the valve-in-head type and comprises a cylinder block 11 within which a piston 12 reciprocates. A cylinder head 13, having a valve mechanism cover plate 14, slidably supports inlet and exhaust valves 15 and 15', respectively, which open to a combustion chamber 16. The valve 15 is yieldingly urged to its closed position by springs 17 and is controlled by a walking beam 18 which has its other end portion fixed to a valve actuating rod 19 in a manner well known to those familiar with the art.

The combustion chamber 16 is located on the under side of the head 13, and is of approximately figure 8 shape in plan having its longitudinal axis extending longitudinally of the head and comprising a constriction and lobes at opposite sides thereof. This chamber 16 overlies and opens downwardly into the cylinder.

An outer main air storage chamber or energy cell 20 is disposed on one side of the head 13. The cell 20 communicates at its inner end with the combustion chamber through spaced aligned restricted orifices 21 and 22, the orifice 21 being preferably larger than the orifice 22.

When the engine piston 12 is in its upper dead center position, as shown in Fig. 1, a slight clearance 23 is left between the upper face of the piston and the cylinder head. During the compression stroke of the piston, the displaced air flows through the orifices 21 and 22 into the cell 20.

A fuel injector, generally indicated by the numeral 24, is suitably mounted in the head 13. The injector 24 comprises threadedly engaged tubular casing portions 25 and 26. The casing portion 26 has formed at its closed end a discharge nozzle opening 27 and a liquid fuel storing cavity 28 which is in alignment and adapted to receive fuel from the opening 27 of the nozzle. This particular cavity increases in size away from the opening 27 and is preferably of a predetermined capacity in order to function as desired under conditions as will hereinafter be more apparent.

The casing portion 26 receives therein a fuel guide member 29 having a pair of passages 30 which communicate at their opposite ends. These passages extend substantially radially of the fuel guide 29 and decrease in depth from a maximum at the inner end of the fuel guide to a minimum at the discharge end of the nozzle where they extend toward each other at 31. The portions of the passages 30 which extend toward each other communicate through whirling grooves 32 with a central recess 33 in the guide 29 which is in alignment with and constitutes a predetermined fuel retaining space complementary to that of the cavity 28 and the opening 27.

These grooves 32 extend at an inclination with respect to a longitudinal, central, axial plane of the nozzle and they are adapted to discharge fuel tangentially into the recess 33 from respectively opposite directions in order to produce a swirling and subsequent atomizing effect when fuel accommodated in the nozzle rearwardly of the recess 33 is discharged into the combustion chamber. A key 34 prevents the member 29 from turning relative to the casing portion 26.

Liquid fuel is admitted in a controlled stream and under a desired pressure from a suitable pump (not shown) through a line 35 into the casing portion 25.

During operation, fuel is fed to the nozzle under pressure intermittently through the fuel line 35 in accordance with engine operation. All fuel passages of the nozzle including the cavity 28, recess 33 and passages 30 are constantly maintained filled with fuel so that during the injection strokes of the pump, a definite charge of fuel is expelled. That fuel which is accommodated in the cavity 28 and recess 33 between discharge strokes of the pump is not subjected to the action of the whirling grooves 32 as it is forced from the pump and it is therefore discharged as a slug 37 having a predetermined fuel content as established by the space in advance of the whirling grooves in which fuel is accommodated. The discharge outlet 27 is so shaped as to form the fuel slug 37 to a size such that it is admissible through the openings 21 and 22 of the energy cell, and to accurately direct the slug into the energy cell.

The amount of liquid fuel in the slug 37 is thus predetermined to produce the desired energy cell operating conditions and since it is in a somewhat compact liquid state, it may be more readily introduced into the cell in uniform quantities and during the short period of time available during engine operation.

The remainder of each fuel discharge, namely that portion of the fuel which is accommodated rearwardly of the cavity 28 and recess 33, is subject to the atomizing and whirling action of the grooves 32 and thus when it is discharged into the main body of the combustion chamber it is present in a quantity and state suitable for the purpose for which it is intended.

During the combustion of the fuel, a predetermined quantity of gas is discharged from the energy cell 20 into the combustion chamber 16 to support and to prolong combustion and high compression of the atomized fuel still being injected by the injector 24.

As the piston 12 moves downwardly during combustion of the fuel, the contents of the cell 20 are discharged through the orifices 21 and 22 in a stream and in opposition to the stream of fuel injected from the nozzle opening 27. The entering stream of fuel is broken up and atomized by the opposed air and fuel stream coming through the orifices 21 and 22, and the resulting air and fuel mixture is split by the tip of the nozzle and the adjacent portion of the wall of the combustion chamber 16, so as to be separated into two streams which flow in opposite directions from the nozzle and about the adjacent curved walls of the lobes of the combustion chamber. In this manner, definite and controlled rotary turbulence of a predetermined quantity of gas from the energy cell 20 is imparted to the fuel mixture within the combustion chamber and the cylinder, and prolonging of the power peak for the charge as well as to thorough and intimate commingling of the fuel particles and the air is assured, which contributes to smoothness and efficiency in operation of the engine.

Various modifications and changes may be effected in the illustrated application without departing from the spirit of the invention or from the scope of the appended claims.

What I claim is:

1. In an internal combustion engine comprising a cylinder head having therein a combustion chamber and an air storage chamber provided with a restricted opening communicating with said combustion chamber; a liquid fuel injection nozzle having a liquid fuel inlet at one end and an outlet at its opposite end for discharging fuel into said chamber, means in said nozzle for whirling liquid fuel passing therethrough to subsequently atomize the latter in said combustion chamber, and a reservoir between said means and the outlet end of said nozzle for accommodating a predetermined quantity of fuel in advance of said whirling means to facilitate initial discharging of said predetermined quantity of fuel in an unatomized state adapted for introduction into said air storage chamber during each discharge operation of said nozzle.

2. An injection engine comprising a cylinder and a piston operating therein, a combustion chamber overlying and opening into said cylinder, an inner air storage chamber having a restricted orifice and opening into said combustion chamber, a fuel injection system for intermittently discharging successive fuel charges and having a discharge portion communicating with said combustion chamber, means in said discharge portion for so agitating fuel flowing therethrough as to facilitate atomizing thereof in said combustion chamber, and a reservoir in advance of said means adapted to accumulate a portion of each charge between successive discharging operations of said system for introduction into said air chamber in an unatomized state before the agitated part of each charge is discharged.

3. An injection engine comprising a cylinder and a piston operating therein, a combustion chamber overlying and opening into said cylinder, an inner air storage chamber having a restricted orifice and opening into said combustion chamber, a fuel injection system including a discharge portion communicating with said combustion chamber for supplying successive fuel charges to said cylinder, means in said discharge portion for accumulating a predetermined part of each charge for introduction into said air storage chamber in an unatomized stream, and means in said discharge portion of said fuel injecting system for promoting atomization of the remaining portion of each fuel charge, said first and second mentioned means being so constructed and arranged as to cause a slug of fuel of predetermined quantity to be projected through said orifice and into said air chamber immediately prior to atomizing of fuel in said combustion chamber during the compression stroke of said piston.

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