

May 7, 1940.

J. P. BURKE

2,199,739

FUEL INJECTION HEAD

Filed Oct. 28, 1938

3 Sheets-Sheet 1

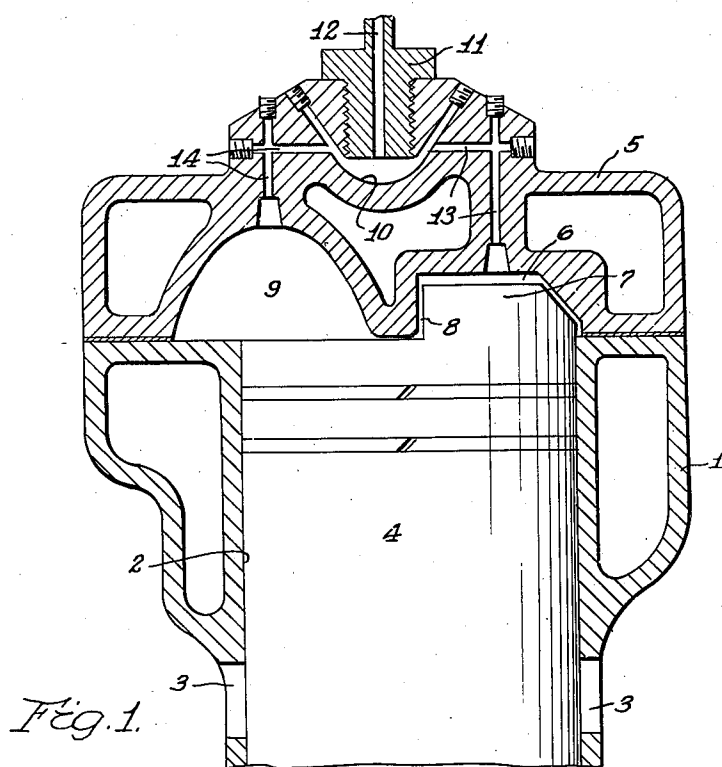
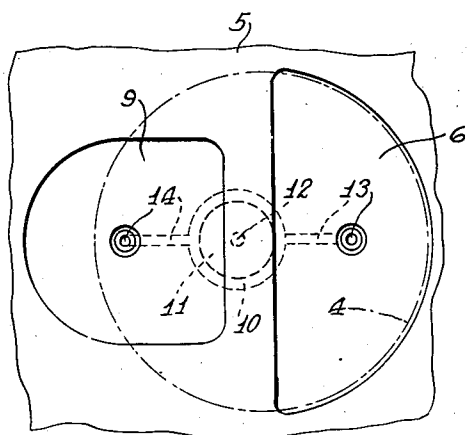
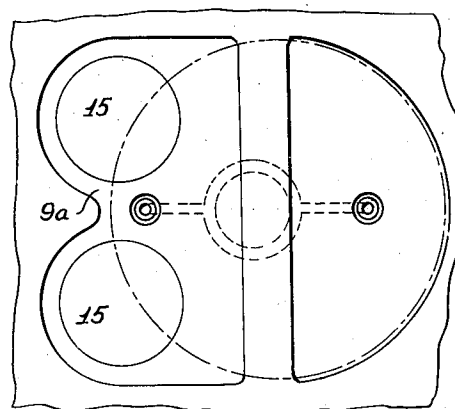


Fig. 2.

Fig. 3.

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3 Sheets-Sheet 2

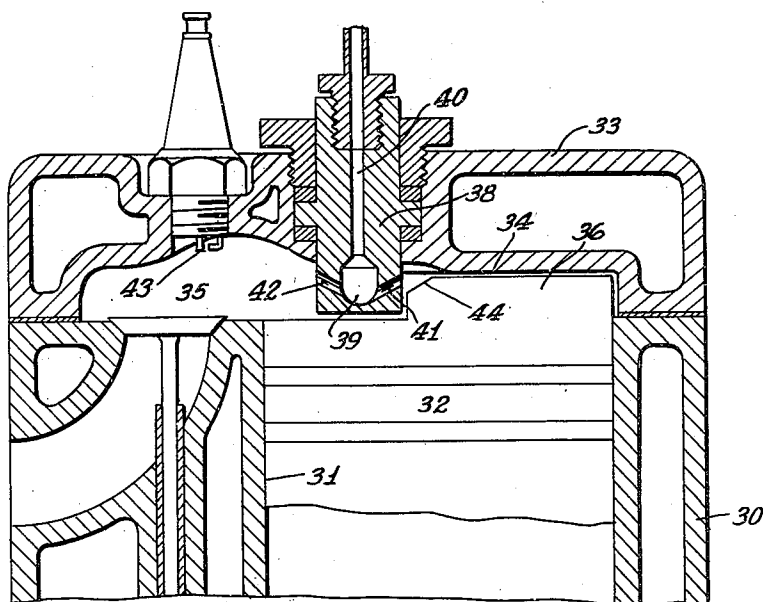


Fig. 4.

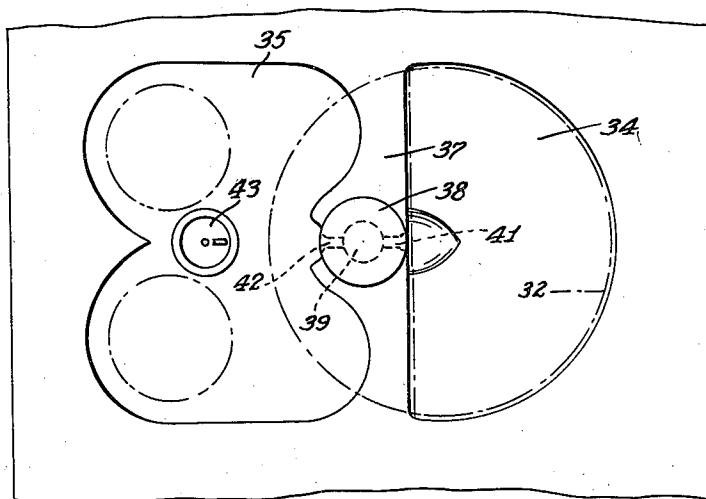


Fig. 5.

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3 Sheets-Sheet 3

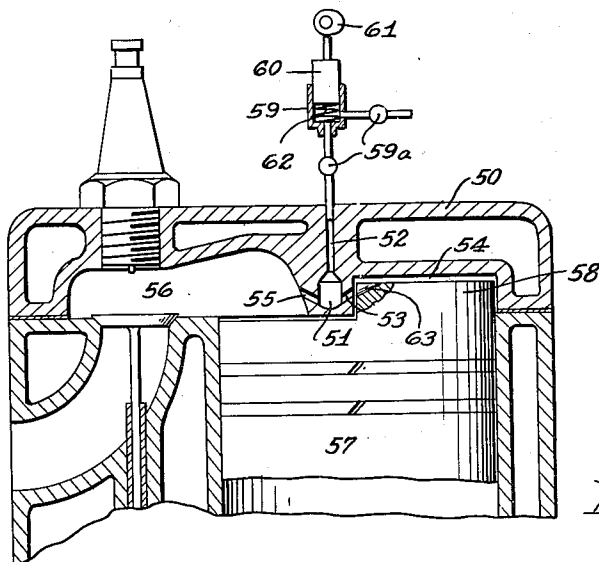


Fig. 6.

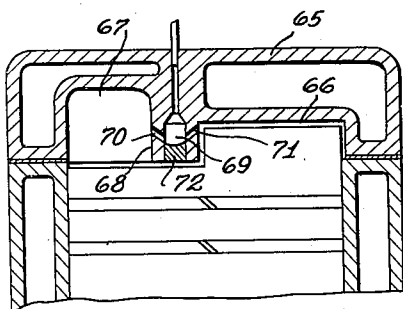


Fig. 8.

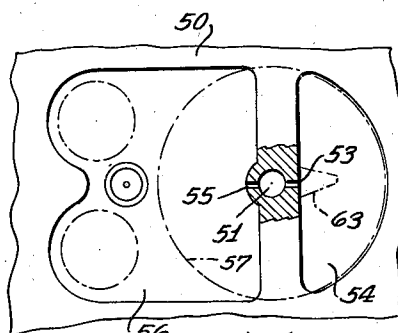


Fig. 7.

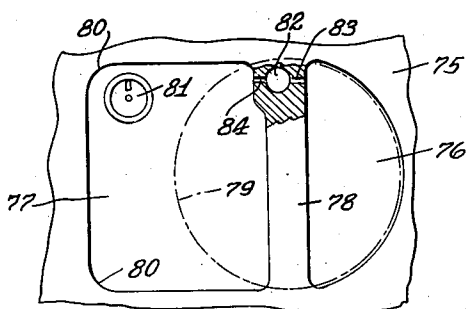


Fig. 9.

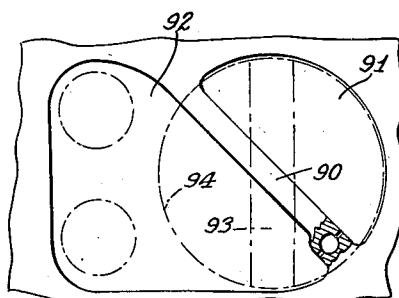


Fig. 10.

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UNITED STATES PATENT OFFICE

2,199,739

FUEL INJECTION HEAD

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Application October 28, 1938, Serial No. 237,420

5 Claims. (Cl. 123—32)

This invention relates to internal combustion engines, and particularly concerns the supply of fuel to and the propagation of combustion in the cylinders of engines. The invention is applicable to engines of the pressure ignited type, and also to engines of the type employing ignition means.

The principal object of the invention is to provide an internal combustion engine wherein the fuel is supplied to the combustion chamber by air pressure developed by piston movement.

In the operation of internal combustion engines of the pressure ignited type, air is supplied to the cylinders and is compressed to a comparatively high degree during the compression stroke of the piston. At or near the time of maximum compression, while the air is under said comparatively high degree of pressure, fuel oil is injected into the cylinder and mixes with the air, and due to the compressed condition of the air, the mixture ignites. A disadvantage present in such an engine is that the injection of fuel is opposed by the high pressure of the air in the cylinder, with the result that intricate and costly injecting mechanisms must be provided. The injection must be accurately timed with respect to the engine cycle, for in pressure ignited engines the injection controls the time of combustion, therefore making it impossible to inject the fuel at other than a definite point in the engine cycle. An important object of the invention is to provide an engine of this type wherein fuel may be supplied to the cylinders over a comparatively wide range in the engine cycle, say, for example, 45° of crankshaft movement, while the piston is at or near its lower limit of movement, and the contents of the cylinder are under a comparatively low pressure. Thus, accurate timing of the fuel supply is unnecessary, as also is the necessity of supplying fuel under high pressure to overcome an existing pressure in the cylinder.

Another object is to provide an engine of the pressure ignited type wherein the fuel is supplied to the combustion chamber slightly before, during, or slightly after the start of the compression stroke of the piston, and wherein the fuel so supplied is mixed with compressed air in the cylinder at a definite stage in the piston cycle, just prior to completion of its compression stroke.

Internal combustion engines of the type employing an ignition means usually have a vaporous fuel supplied thereto, the mixture being controlled by an external means, such as a carburetor, whereby the air and fuel are mixed in proper proportions before they enter the cylinder.

Another and equally important object of the invention is to provide an engine of the type employing an ignition device wherein the fuel, such as gasoline, is supplied to the cylinders in liquid form, and is subsequently mixed with compressed air to provide a combustible mixture. The use of an external means for vaporizing the gasoline and mixing it with air is therefore obviated.

In accomplishing the ends above mentioned, the invention provides a cylinder head with two chamber forming recesses therein and a piston with a stepped portion. One chamber is disposed to receive the step on the piston, whereby said step displaces air therefrom, and the two chambers are connected whereby the air so displaced enters the second chamber. The invention has as a further object to utilize this air flow for the purpose of supplying fuel to the said other chamber.

The connection between the two cylinder head chambers passes through a fuel reservoir, which receives either fuel oil or liquid gasoline according to the type of the engine, the fuel being supplied to the reservoir while the piston is lowered and while there is comparatively low pressure in the cylinder. As the piston rises, and displaces air from the first chamber, the air carries fuel into the second chamber, where ignition takes place either as a result of pressure, or operation of an ignition device.

Another object of the invention is to provide an engine of the semi-Diesel type, or in other words, an engine which operates on fuel oil, but which relies for ignition on an igniting device. In pressure ignited engines the compression pressure usually amounts to around seven hundred pounds, which necessitates a very heavy engine construction in order to withstand the high pressure. So called semi-Diesel engines operate at a much lower compression pressure, say, for example, four hundred pounds, and the engine structure may be made correspondingly lighter.

Another object is to provide an engine with a combustion chamber wherein air is compressed by operation of the pistons, an ignition device in said chamber, and means for directing a stream of vaporous fuel into the chamber and into contact with the ignition device.

Another object is to provide an engine having a head with two chambers, both of which communicate with the cylinder, and means for causing combustion to take place in one chamber to the exclusion of the other. Flame propagation is thus controlled inasmuch as the initial com-

bustion is proportional to the amount of air in the first chamber where ignition takes place, and such combustion is further propagated at the time the air contained in the second chamber becomes available. Control of flame propagation eliminates detonation.

In an arrangement such as here contemplated, two separate chambers are provided in the cylinder head, both of which overlie the piston, and combustion takes place in one in advance of the other. The result is that only a fraction of the head of the piston has pressure exerted thereon, and the normal tendency of this condition is to cause the piston to pivot about the wrist pin of the connecting rod. The tendency of the piston to pivot about the wrist pin results in uneven wear of the cylinder walls, and in "piston slap."

It is a further object of the invention to eliminate the pivoting tendency above mentioned, to eliminate excessive wear and "piston slap." This is accomplished by locating the cylinder head chambers so that their adjacent defining walls extend across and at an angle to the axis of the wrist pin. With this arrangement, the pressure exerted on the head of the piston is exerted on both sides of the wrist pin.

With the above and other ends in view, the invention is more fully disclosed with reference to the accompanying drawings, in which

Fig. 1 is a vertical section of an engine cylinder, illustrating the improved piston and cylinder head construction;

Fig. 2 is a fragmental bottom plan of the cylinder head;

Fig. 3 is a fragmental bottom plan of the cylinder head having one of the chambers modified to accommodate intake and exhaust valves;

Fig. 4 is a vertical section illustrating the novel cylinder head and piston construction in conjunction with an ignition device;

Fig. 5 is a fragmental bottom plan of the head shown in Fig. 4;

Fig. 6 is a vertical section illustrating a modified cylinder head construction;

Fig. 7 is a fragmental bottom plan of the head shown in Fig. 6;

Fig. 8 is a vertical section illustrating another form of cylinder head chamber; and

Figs. 9 and 10 are fragmental bottom plan views illustrating cylinder head chambers of different form.

Referring to Fig. 1, the engine cylinder block 1 has a cylinder 2 with ports 3 in the walls thereof which facilitate the exhaust of burned gases and the charging of the cylinder with clean air. A piston 4 works in the cylinder 2 in the usual manner.

The cylinder head 5, which is secured to the cylinder block in the usual manner, is provided with a recess 6 of substantially semi-circular contour as viewed in bottom plan. The piston 4 has a step or projection 7 thereon which enters the recess 6 as the piston approaches the top of its compression stroke, whereby to compress air in the recess. Referring to Fig. 1, attention is called to the fact that the clearance 8 between the step 7 and the wall of the chamber 6 is exaggerated, as in actual construction it is contemplated that this clearance will amount to approximately one thirty-second of an inch.

A second chamber 9 is also formed in the cylinder head 5 and constitutes the combustion chamber. The chamber 9 has a greater volumetric capacity than the recess 6 when the piston is at the top of its stroke, and is separated from the recess 6, and partly overlies the cylinder 2.

The cylinder head 5 has a reservoir 10 formed therein and closed by a removable plug 11 having a port 12 through which fuel in liquid form may be supplied to the reservoir 10. It will be understood, although it is not here illustrated, that a metering device is employed to supply measured quantities of liquid fuel to the reservoir 10 at timed intervals. A diagrammatic illustration of such a means is given in Fig. 6, which is described later.

The cylinder head 5 is provided with passages 13 extending from the recess 6 to the reservoir 10, and with passages 14 extending from the reservoir 10 to the chamber 9.

In operation, as the piston 4 is in a lowered position, and comparatively low pressure is present in the cylinder 2, liquid fuel is supplied to the reservoir 10, the amount of fuel so supplied varying according to the size of the cylinder and the degree of richness desired for combustion. As the piston moves upwardly, the air in the cylinder 2 is compressed, and the pressure acts equally through the passages 13 and 14. However, as the step 7 on the piston enters the recess 6 of the cylinder head, air is rapidly displaced from the recess and in flowing through the reservoir 10 to the combustion chamber 9 it carries the fuel from the reservoir into the combustion chamber. The fuel, upon entering the combustion chamber, mixes with the compressed air therein, and due to the compressed condition of the air, combustion takes place. The volumetric capacity of the recess 6 exceeds that which is necessary to transfer the fuel from the reservoir 10 to the combustion chamber, and, therefore, a part of the air therein is displaced through the space 8 and enters the chamber 9. A cross air flow is thus created which sets up a highly turbulent condition in the chamber 9 at the time the fuel enters the same.

As combustion takes place, the pressure within the chamber 9 exceeds that in the recess 6, which will contain pure air. The pressure is transmitted through the passages 14 and 13, and through the clearance 8 to the recess 6 so that pressure is present on the entire head of the piston. As the piston descends and the step 7 is removed from the recess 6, a secondary burning action takes place due to the mixing of the air with the burning gases of the combustion chamber. A continuous or prolonged combustion, therefore, exists, yet pressure acts on the entire area of the piston head throughout the entire stroke. Detonation is thus avoided.

As shown in Figs. 2 and 3, the combustion chamber will take different shapes in different engines. In Fig. 2 the combustion chamber 9 illustrated is the type used in conjunction with intake and exhaust ports in the cylinder walls, as indicated at 3. In Fig. 2, the combustion chamber 9a is shaped to accommodate poppet valves 15, which function in the usual manner to control the intake and exhaust.

Figs. 4 and 5 illustrate an engine which may be considered either a gasoline engine or a semi-Diesel engine. In these views, the engine cylinder block 30 has a cylinder 31 in which the piston 32 reciprocates. The cylinder head 33 has two chambers 34 and 35 therein, the chamber 34 being adapted to receive the step or projection 36 on the piston in such manner that the latter displaces air therefrom.

The two chambers 34 and 35 are separated by a depending portion 37 of the cylinder head and a removable plug 38 is secured in the cylinder head and extends through the portion 37. In the

plug 38 is a fuel container 39 and a passage 40 through which liquid fuel may be supplied thereto. The plug 38 also has two ports 41 and 42, the port 41 extending from the compression chamber 34 to the fuel container 39, and the port 42 extending from the fuel container 39 to the combustion chamber 35.

In the combustion chamber 35 is an ignition device 43, and with liquid fuel supplied to the container 39 during a lower portion of the piston stroke, such fuel is displaced from the container 39 and carried into the combustion chamber 35 by the air which is displaced from the chamber 34 by the piston step 36.

Referring to Fig. 5, it will be noted that the port 42 is disposed whereby the stream of air and fuel discharged therefrom into the combustion chamber is directed at the ignition device 43. The combustion chamber has an inwardly directed projection 44 which divides this stream after it passes the ignition device to set up a high degree of turbulence.

The step 36 is chamfered at 44 so that the step does not close the port 41. The result of this chamfer is that a part of the air displaced from the chamber 34 enters the chamber 35 by passing beneath the depending dividing wall 37, thus setting up a highly turbulent condition in the chamber 35 as the fuel enters the same. After combustion has started, and the piston moves downwardly, the chamfer 44 causes a gradual communication between the air in the chamber 34 and the burning gases in the chamber 35, and thus provides a controlled delay of flame propagation. This enables the use of rapidly burning fuels, such as the less expensive gasolines, without causing detonation, and it also facilitates good combustion conditions in the case of fuel not so finely vaporized as is ordinarily the case. That is, the fuel might be in the form of a multiplicity of small globules, in which case the secondary burning resulting from a secondary supply of air thereto results in complete combustion, with the period of combustion distributed over practically the entire combustion stroke of the piston.

In the case of a semi-Diesel engine, the operation is the same, with the exception that fuel oil instead of gasoline is supplied to the fuel container 39.

Figs. 6 and 7 illustrate an engine which functions in the same manner as the engine shown in Figs. 4 and 5. It comprises a cylinder head 50 having a fuel receiver 51 and a supply passage 52 cast therein. A port 53 connects the fuel receiver 51 with a compression chamber 54, and a port 55 connects the fuel receiver with a combustion chamber 56. As the piston 57 approaches the top of its stroke, the step 58 thereon displaces air from the compression chamber 54 and forces it through the fuel receiver 51.

The means for supplying liquid fuel to the receiver 51 comprises a pump 59, with its intake and discharge lines controlled by check valves 59a. The pump plunger 60 is reciprocated by a cam 61 and a spring 62, the cam being timed with respect to the engine cycle whereby it supplies fuel to the receiver 51 while the piston 57 is in a lowered position.

In order to prevent the step 58 from closing the port 53 at the upper end of its stroke, the step has a substantially V-shaped groove 63 therein.

Fig. 8 illustrates a further modification in the manner of forming the fuel receiving means. In

this form the cylinder head 65 has a compression chamber 66 and a combustion chamber 67 separated by a transverse wall 68. The transverse wall has a stepped passage 69 cast therein, and ports 70 and 71 connecting it with the combustion and compression chambers respectively. The bottom of the passage 69 is plugged at 72, whereby it functions as a fuel receiver.

Fig. 9 illustrates a cylinder head 75 with a compression chamber 76 and a combustion chamber 77 therein, the two chambers being separated by a transverse wall 78. The combustion chamber 77 is substantially rectangular, with its two parallel sides extending tangentially with respect to the cylinder 79. Both corners of the chamber 77 are rounded at 80 to avoid sharp angles, and an ignition device 81 is mounted in one corner thereof. The transverse wall 78 has a fuel receiving cavity 82 therein disposed at the end of the wall nearest the ignition device 81. Ports 83 and 84 connect the cavity 82 with the two chambers 76 and 77, and the port 84 is directed at the ignition device 81 so that the stream of air displaced from the chamber 76 through the port 83, cavity 82 and port 84 carries fuel into direct contact with the ignition device.

Fig. 10 illustrates an arrangement wherein the wall 90, which separates the compression chamber 91 from the combustion chamber 92, is disposed at an angle whereby it crosses the wrist pin 93 of the piston 94. If pressure is exerted solely in either of the two chambers, or if the pressure is greater in one chamber than in the other, the tendency for the piston to pivot about its wrist pin is minimized due to the fact that pressure in either chamber acts on the head of the piston directly above the wrist pin.

Although specific embodiments of the invention are illustrated and described, it will be understood that various changes may be made within the scope of the appended claims without departing from the spirit of the invention and such changes are contemplated.

What is claimed is:

1. In an engine, a cylinder, a head for said cylinder, said head having a chamber with a wall depending from the roof thereof above the cylinder and dividing the chamber into two compartments, a passage extending through said wall and connecting the two compartments, said wall also having a passage for conveying fuel to the first named passage, a piston having means for displacing air from one compartment, said piston having a wrist pin, and said depending wall being disposed at an angle with respect to the wrist pin whereby it crosses the same.

2. In an internal combustion engine, a cylinder having a piston therein, a cylinder head having a chamber therein overlying the cylinder, a wall depending from the bottom of said chamber and extending substantially diametrically over the cylinder, said depending wall dividing said chamber into two compartments, said wall having a relatively small passage connecting the two compartments and formed with a fuel receiver, and said piston having a step adapted to enter one of said compartments to displace contained fluids therefrom through said passage to the other compartment.

3. In an internal combustion engine, a cylinder having a piston therein, a cylinder head having a chamber therein overlying the cylinder, a wall depending from the bottom of said chamber and extending substantially diametrically over the cylinder, said depending wall dividing said cham-

ber into two compartments, said wall having an opening through the bottom thereof and extending therefrom through the top of the head, a plug in said opening formed with a fuel container and passages extending from opposite sides and opening into respective compartments, and said piston having a step adapted to enter one of said compartments to displace contained fluids through said passages and fuel container to the other compartment.

4. In an internal combustion engine, a cylinder having a piston therein, a cylinder head having a chamber therein overlying the cylinder, a wall depending from the bottom of said chamber and extending substantially diametrically over the cylinder, said depending wall dividing said chamber into two compartments, an ignition device in the first of said compartments, said wall having a relatively small passage connecting the two compartments with its outlet directed at said ignition device, said passage being formed with

a fuel receiver, and said piston having a step adapted to enter the second of said compartments to displace contained fluids therefrom through said passage into the first compartment and into direct contact with said ignition device.

5. In an internal combustion engine, a cylinder having a piston therein, a cylinder head having a chamber therein overlying the cylinder, a wall depending from the bottom of said chamber and extending substantially diametrically over the cylinder, said depending wall dividing said chamber into two compartments, said wall having a relatively small passage connecting the two compartments and formed with a fuel receiver, and said piston having a step adapted to enter one of said compartments to displace contained fluids therefrom through said passage to the other compartment, said step having a groove therein in line with said passage.

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