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H. G. VORHAUER

INTERNAL COMBUSTION ENGINE

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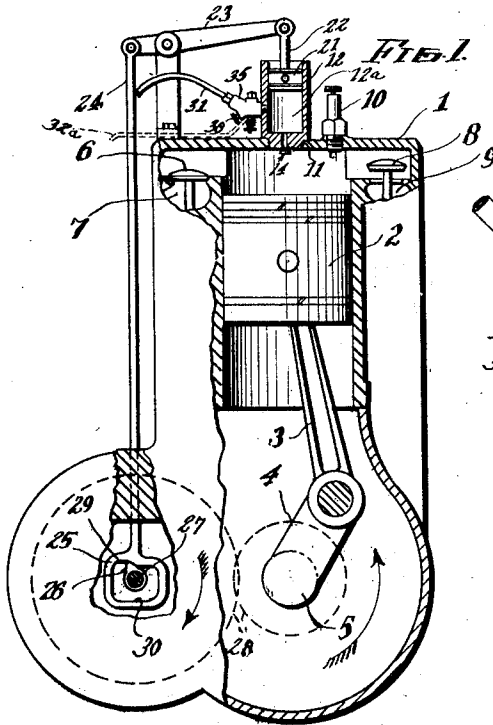
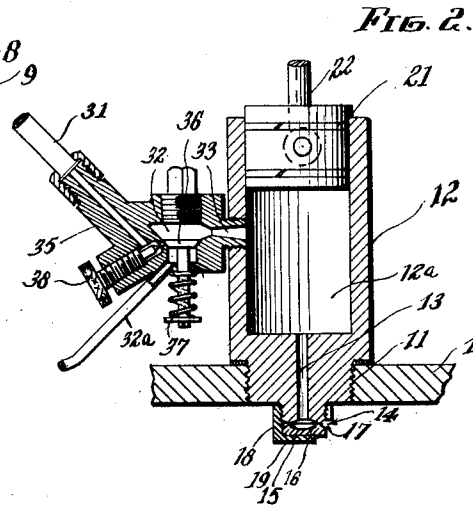
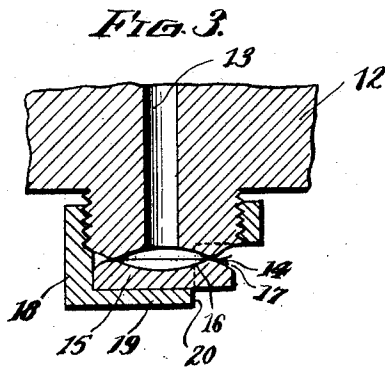
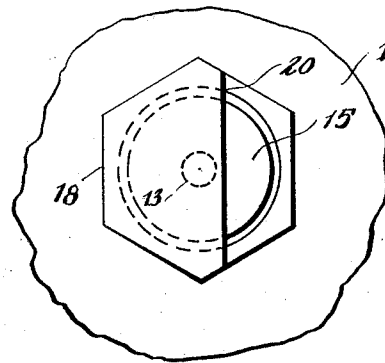


FIG. 4.

Inventor

Harry G. Vorhauer

By

Lyon & Lyon

Attorneys

UNITED STATES PATENT OFFICE.

HARRY G. VORHAUER, OF LONG BEACH, CALIFORNIA.

INTERNAL-COMBUSTION ENGINE.

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This invention relates to the art of internal combustion engines and refers particularly to the manner and means employed for admitting the fuel into the firing chamber of the engine and the manner and means of mixing and measuring out the quantity of charge to be admitted into the firing chamber.

The ordinary internal combustion engine will only operate satisfactorily upon a relatively low boiling point or readily vaporized fuel which must be of high quality and is consequently high in cost. One of the objects of the present invention is to provide such an internal combustion engine as may employ high boiling point fuel which does not have to be highly refined and will operate satisfactorily upon impure fuels of low grade and obtainable at comparatively low cost.

The present invention in its preferred embodiment is intended to operate on somewhat the principle of a Diesel engine in that the engine preferably draws in pure air or other oxidizing gas and partially or entirely compresses the same before the introduction into the firing chamber of the fuel for the combustion; but differs substantially from such customary Diesel engines in that it employs a different method of vaporizing, proportioning, measuring and injecting into the firing chamber the fuel which is to be employed. In the customary Diesel type of internal combustion engine, the fuel for the engine is placed under high pressure and also air or other gas is placed under high pressure and a mixture of these materials in such ratios or proportion that the same is too rich for combustion is injected, mainly in liquid form, into the compressed or partially compressed air or oxidizing gas in the firing chamber. In such customary Diesel engines the turbulence caused by injecting the fuel into the space at the top of the cylinder is relied upon to do the main vaporizing and mixing of the fuel with gas. Such Diesel engines are not entirely satisfactory in that the fuel is not sufficiently vaporized or properly mixed with the gas in the firing chamber and such Diesel engines require a special pressure connection between the pump and cylinder to inject the charge into the cylinder which are expensive in construction and difficult to maintain in proper operative condition.

An object of the present invention is to

provide a method of measuring out the charge to be injected into the cylinder in gas or vapor form so that as injected into the firing chamber at least a substantial part of the fuel to be employed is in gaseous form and in more nearly the desired state for complete combustion within the chamber.

Another object of the present invention is to provide a method of injecting fuel into a firing chamber having a compressed oxidizing gas without requiring high pressure connections between the pump and cylinder with a corresponding elimination of many of the appurtenances necessary for the customary Diesel engine. In the present invention the charge to be injected into the cylinder is compressed after the proper quantity of the same has been measured out and thus compression only applied to such part of the fuel as is to be immediately used in the firing chamber.

Another object of the present invention is to provide an efficient means for creating a turbulent condition in the top space of a firing chamber as the fuel is forced therein, and a more limited object of the invention is to provide such means for producing the turbulent effect in the firing chamber as may handle different quantities of fuel at the same velocity. In other words, to provide means automatically varying with the quantity of fuel to be forced into the chamber for always forcing such fuel into the chamber at a substantially fixed velocity.

Another object of the present invention is to provide a means to eliminate crank case dilution such as is caused by incompletely vaporized fuel being admitted into the firing chamber.

Another object of the present invention is to provide such an internal combustion engine as will eliminate knocking or rapid detonation of the charge, the firing of the charge being slowed down to obtain the proper thrust on the piston in place of a hammer-like blow thereon.

Various other objects and advantages of the present invention will be apparent from a description of a preferred example of an internal engine embodying the invention.

In the accompanying drawings the invention is illustrated in its preferred embodiment, and in such drawings:

Figure 1 is an end elevation partially in vertical section of the preferred type of internal combustion engine.

Fig. 2 is an enlarged elevation mainly in vertical section, of the mixing, measuring and injecting mechanism.

Fig. 3 is a further enlarged section of an orifice and adjacent parts which automatically varies to produce the constant velocity of entering charge.

Fig. 4 is an end view of Figure 3.

Referring to the drawings, the internal combustion engine comprises a firing chamber 1, in which a piston 2 is mounted to reciprocate, the piston 2 being connected by a connecting rod 3 to a crank arm 4 of a crank shaft 5 in the customary or any other preferred manner.

6 indicates an exhaust valve connected with the firing chamber 1 which will permit the spent gases to be expelled from an exhaust line 7, and 8 indicates an inlet valve controlling communication between the firing chamber 1 and a conduit 9 which is employed for introducing air or other oxidizing gas into the firing chamber 1. While the inlet valve 8 is described as admitting only air or oxidizing gas in the firing chamber 1, it may be preferable under certain circumstances to admit a certain quantity of fuel by the valve 9 in which case preferably only such a proportion of fuel to air should be permitted to pass through the valve 8 as is too lean for combustion in the firing chamber 1 or is such as will not be combusted at the high temperature and pressure present at the compression stroke of the piston 2. 10 indicates a spark plug for the firing chamber which, however, is not essential to the operation of an internal combustion engine in all the forms of the invention.

In the example of the invention shown, the top of the firing chamber is provided with a screw threaded opening 11, into which is screwed an auxiliary-fuel measuring and injecting member 12, having a chamber 12^a communicating with the firing chamber 1 through a duct 13 leading through a check valve having a Venturi-shaped discharge orifice 14 formed by a washer 15 and the end of the chamber 12, the parts being provided with confronting faces gradually approaching each other as at 16, and thereafter providing a gradually expanding passage 17. The washer 15 is held against the member 12 by a cap 18 threaded thereto which is provided with an end wall 19 extending partially over the washer 15 but having one side cut away as shown at 20 so that the washer 15 is only partially held to the member 12 by the cap 18. By this construction I have provided a means by which the orifice may be automatically opened and closed to inject the charge into the firing chamber 1, as normally the cap 18 will hold the washer 15 pressed against the member 12, closing the outlet therefrom. Under sufficient pressure of gas in the duct 13, the washer 15

will be forced away from the member 12 particularly at the uncovered section of the washer to permit the passage of gas from the duct 13 into the firing chamber 1. The extent of pressure necessary to open the outlet of the orifice may be governed by the thickness and stiffness of the washer 15, or by cutting away more or less of the cap 18. This arrangement also provides a method or means by which the velocity at which the fuel enters the firing chamber 1 may be made substantially constant, even under varying loads, as where a greater volume of fuel is to be forced into the firing chamber a greater pressure will be exerted against the cap 19 and the size of the discharge orifice varied accordingly.

The measuring and injecting chamber 12^a is provided with a piston 21 which is intended to draw a charge into the chamber 12^a and force the same into the firing chamber 1 at or near the end of the compression stroke of the firing chamber piston 2.

The piston 21 should compress the charge in the chamber 12 at such time that charge will be injected into the firing chamber just before ignition takes place. Various devices, of course, may be employed for properly timing the motion of the piston 21 with the piston 2. In this embodiment of the invention, I have shown the piston 21 connected by a crank 22 with a rocker-arm 23, one end of the rocker-arm 23 being connected by a rod 24 to a cam controlled member 25 engaging with a cam 26 rotated by the cam shaft 27. The cam shaft 27 is connected by gears 28 with the crank shaft 5, in this case a two to one gearing being illustrated. The member 25 is provided with a surface 29 which will engage the cam 26 at the time when the piston 21 should be forced downward to force the charge into the chamber 1. The piston 21 may be forced upward at any time previous to the compression stroke of the piston 2, although in some cases it is preferable to hold the charge in the injection chamber for only a short period of time so as to minimize condensation therein. In this case the upstroke of the piston 21 is effected by the cam 26 engaging the lower surface 30 of the member 25 and will take place at about the time the piston 2 starts upon its intake stroke.

The piston 21 is intended to measure out a charge of at least partially vaporized fuel from a fuel line 31, the fuel being mixed with a quantity of gas passing through ports 32 in the body of a fuel regulating member which gas, together with the fuel from the line 31, is drawn into the chamber 12 through a port 33 near the center of the chamber. In this embodiment of the invention, the ports 32 are shown connected with a line 32^a which may connect directly with the atmosphere so that air

is the gas drawn in through such ports 32. It is understood, however, that when desired, an inert gas may be admitted through the ports 32 so as to mix with the fuel from the line 31, in which case the line 32^a is connected with the exhaust of the engine. In fact, the use of inert gas is to be preferred, as it will tend to eliminate knocking or excessively rapid detonation of the charge in the firing chamber 1. Also the use of an inert gas will permit the introduction into the chamber 12 of a greater proportion of gas to vaporizing fuel with the result that the fuel will be more completely vaporized and the efficiency of the internal combustion engine greatly improved.

The inlet of fuel and gas into the chamber 12 is controlled by a check valve 36 closing both passages in the body 35, as shown in Figure 2, said check valve being yieldingly held in the closed position by some suitable means, such as a coil spring 37. The ratio between the fuel to be admitted and the gas to be admitted into the chamber 12 is controlled by a needle valve 38 in the fuel line 31.

It is not essential to the operation of the internal combustion engine herein described that either the fuel line 31 or gas line 34 be placed under heavy or any pressure, as the upstroke of the piston 21 will draw such materials into the chamber 12 and the downstroke of said piston 21 will produce the necessary compression upon such charge so that it can be forced into the firing chamber 1. It is seen that it is thus necessary to apply the heavy compression necessary to overcome the compression within the firing chamber 1 only to such charge or fuel as is to be immediately employed in the firing chamber 1. The mixture drawn into the chamber 12 should be regulated and proportioned by the needle valve 38, so that in case where an oxidizing material such as air is drawn in the line 32^a, the mixture in the chamber 12 is too rich to combust.

Such an internal combustion engine will permit the use of low grade fuel of high boiling point and will be found to be easy in starting and to substantially eliminate crankcase dilution as the fuel is mixed and

vaporized in the regulating member 35, and in the measuring and injecting chamber 12 prior to its introduction into the firing chamber 1. Moreover, the velocity at which the charge is introduced into the firing chamber 1 can be regulated so that the proper turbulence of the fuel will take place in the top of the firing chamber 1 as the same is admitted.

While the embodiment of the invention herein described is well suited for the purposes of this invention, it is not intended to limit the invention to the details of construction or arrangement of parts as modifications may be made therein without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. In an internal combustion engine, the combination with a firing chamber and a piston mounted to reciprocate therein, of an auxiliary pumping chamber and piston, means for admitting a rich mixture to said pumping chamber, means for regulating the action of the pump piston so that said rich mixture is injected into said firing chamber during the compression stroke thereof, and a Venturi-shaped discharge orifice between the auxiliary pumping chamber and firing chamber, and means separate from the auxiliary pumping chamber and piston for pumping air and fuel into the firing chamber to form a lean mixture in the firing chamber.

2. An internal combustion engine comprising a firing chamber, means for compressing an oxidizing gas therein together with fuel insufficient to support combustion, means for proportioning fuel and gas to produce a rich mixture, an auxiliary chamber connected to discharge into said firing chamber, means for drawing said mixture into said chamber and forcing the same into said firing chamber during the compression cycle thereof, and a Venturi-shaped discharge orifice between the auxiliary pumping chamber and firing chamber.

Signed at Los Angeles, California, this 19th day of March, 1924.

HARRY G. VORHAUER.