

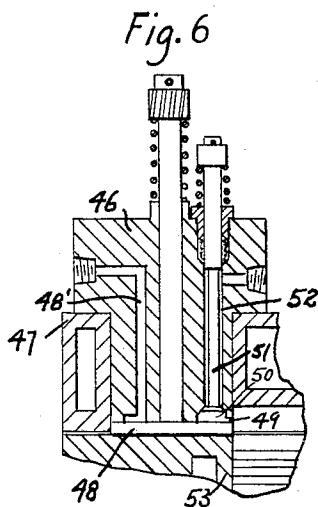
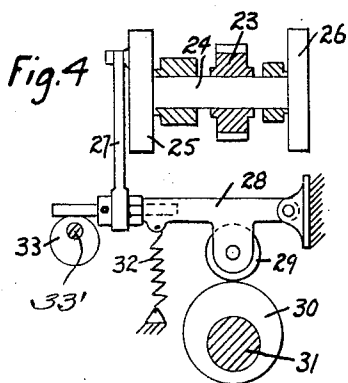
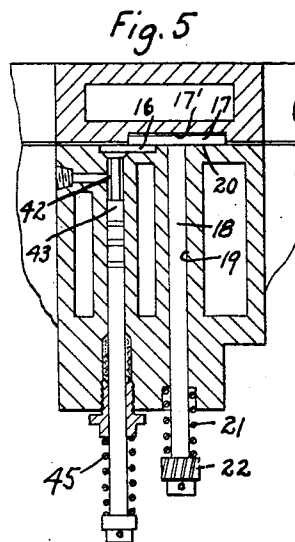
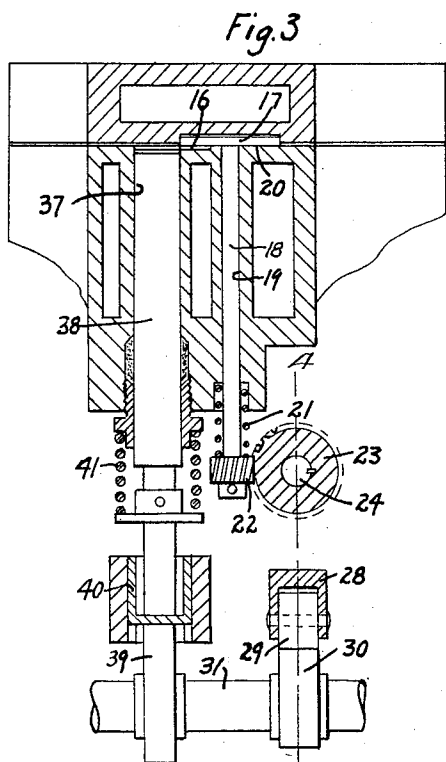
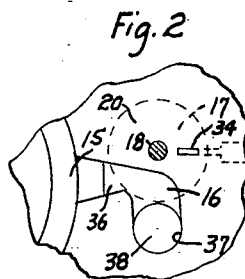
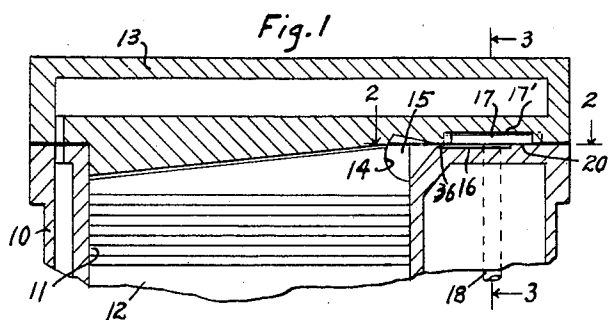
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L. O. FRENCH

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LIQUID FUEL INTERNAL COMBUSTION ENGINE

Filed Jan. 2, 1930



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LIQUID FUEL INTERNAL COMBUSTION ENGINE

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The invention relates to internal combustion engines and more particularly to engines using liquid fuel.

One object of the invention is to provide an internal combustion engine wherein fuel is introduced into the combustion chamber of the engine by a fuel film feeding member which is in sealing engagement with the cylinder block or a portion forming a part thereof adjacent one side of the cylinder space and all the operating connections for said member are arranged at one side of the block below the cylinder head, thus eliminating overhead driving connections and making it an easy matter to service the fuel feeding means, if necessary.

Another object of the invention is to provide an internal combustion engine wherein liquid fuel is delivered to a small chamber or passage in restricted communication with the combustion chamber of the engine before the end of the compression stroke in the form of a non-kinetic film and during a portion of said stroke the whole or a portion of said fuel film is subjected to a mixing action with gases forced into said chamber by the piston on its compression stroke and near or at the end of the compression stroke a reversal of flow of the gases with further mixing action with the fuel takes place with the forcing of the mixture into the combustion chamber either by the action of an auxiliary compressor piston associated with each cylinder or by the action of a compressor delivering blast gases, in proper timed relation in the engine cycle, to said mixing chamber at a greater pressure than that then existing in the combustion chamber or cylinder space of the engine.

The invention further consists in the several features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawing Fig. 1 is a vertical, sectional view through an internal combustion engine embodying the invention, parts being broken away;

Fig. 2 is a detail sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail sectional view taken on the line 3—3 of Fig. 1;

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

Fig. 5 is a sectional view similar to Fig. 3, showing certain modifications;

Fig. 6 is a detail sectional view showing another modification.

Referring to Figs. 1 to 5, inclusive, of the drawing, the numeral 10 designates the engine cylinder having a bore in which the piston 12 reciprocates in the usual manner and 13 the head, the particular arrangement here shown being that of the well-known port scavenging, two cycle engine with a deflector wall 14 on the piston for deflecting the scavenging air upwardly into the cylinder, but it is to be noted that this invention may also be used on four cycle engines. It is also to be noted that at the end of the compression stroke the majority of the gases are compressed into a laterally disposed combustion chamber 15, here shown as formed between the cylinder, piston and cylinder head.

Seating on the top of the cylinder block and in sealed engagement therewith, except for a shallow recess or chamber 16 formed in the block, is a movable member 17, here shown as a flat-headed rotatable valve whose upper portion works in a cylindrical recess 17' in the head and whose stem 18 works in a bore 19 formed in the block or parts associated therewith, the lower side of the head of the valve being normally held in sealing engagement with the seat 20 by a spring 21 interposed between the cylinder and a gear 22 mounted on the stem 18. Any suitable mechanism may be used for imparting either a variable, intermittent, oscillatory movement or a variable, intermittent, progressive, rotary movement to the member 17, the latter being preferred.

As one example of a mechanism for this purpose, I show in Figs. 3 and 4 a gear 23 meshing with the gear 22 and mounted on a rotary shaft 24, the ratio of the gears preferably being such as to cause the member 17 to make one complete revolution for a partial revolution of the shaft 24. Mounted on the shaft 24 is a one way clutch 25 of any

well-known or approved construction and also, where said clutch does not release promptly, an automatic brake 26 of any suitable construction. As the particular details of the clutch 25 and brake 26 form no part of the present invention, further reference thereto is deemed unnecessary. One part of the clutch is operatively connected by a link 27 with a suitably pivoted lever 28 carrying a roller 29 actuated by a cam 30 on a shaft 31 driven by the engine in proper cyclic synchronism with the movement of the piston 12, said lever being urged downwardly by a spring 32 connected thereto and to a suitable anchorage. With this construction, at the desired time in the cycle the cam 30 acts to swing the lever 28 upwardly and through the link 27 and the clutch 25 turn the shaft 24 through a partial revolution to in turn rotate the member 17 the desired extent, which may be varied by the extent of movement of the lever 28 by the cam. For varying the extent of movement of the lever 28 an adjustable stop member 33, here shown as an eccentric, mounted on a shaft 33', that may be moved either by manual or governor operation, varies the position of the roller 29 relative to the cam. After the member 17 has been turned to the desired extent the shaft 24 and member 17 remains stationary through the automatic release of the clutch 25, assisted, if necessary, by a brake, such as the brake 26 and the lever and the linkage associated therewith is returned by the spring 32 to their initial position. Thus the member 17 is given an intermittent step-by-step rotation in cyclic timing with the engine, the extent of its rotation being varied to suit the load and speed conditions of the engine.

Liquid fuel is introduced between the sealing surfaces through a conduit 34 whose discharge end leads to surface 20 at a point removed from the recess 16 and is supplied from any suitable source either by gravity or by any suitable pumping system. Then as the member 17 rotates in a clockwise direction the fuel is filmed out between these surfaces and is carried by the member 17 in the form of a non-kinetic film to the recess 16 where it is exposed to gases of the engine. Lubrication of the seating surfaces may be accomplished by adding a small amount of lubricating oil to the fuel where the same does not itself contain constituents having lubricating properties.

The recess 16 is in restricted communication with the chamber 15 as at 36 and constitutes a relatively small volume of the total cylinder volume. Therefore, when fuel is exposed to the gases in said recess a rich mixture is formed. The time at which the fuel film is exposed to the gases in the recess 16 will depend upon the cycle used—whether constant volume or partly constant volume and partly constant pressure—the compres-

sion pressure and the speed. The member may start to deliver its charge at the beginning of compression and continue to the end thereof or it may be delayed until later, or in the case of a four cycle engine may possibly start during the suction stroke. Volatile fuels, such as gasoline or its substitutes, may be used in the engine under higher compression pressures than in carburetor type engines because the introduction of fuel is in the form of a liquid and the fuel air ratio is gradually built up and this introduction may be definitely timed to avoid detonation. Heavier fuels with increased compression may be used, the heat of the air serving to vaporize such fuel and in both instances the thin, filmy condition thereof permit ready vaporization. As the thickness of the fuel film produced as above described may be only about two-thousandths of an inch or less, it will be appreciated that the fuel is in good condition for ready and efficient mixing with gases coming in contact with it. Thus during the compression stroke air under compression is forced from the cylinder and chamber 15 into the recess 16 and across the exposed fuel film and acts thereon to wholly or partially vaporize it and during the power stroke the rich mixture thus formed passes into the engine cylinder.

In order to insure a prompt passage of the mixture into the chamber 15 and the engine cylinder and a positive scavenging of the recess, I have shown in Fig. 3 a bore 37 communicating at its upper end with said recess or shallow chamber 16 in which a piston 38 works. This piston is timed to be moved upwardly near or at the end of the compression stroke by a suitable cam 39 mounted on the shaft 31 and connected with the lower end of the piston through a tappet 40 or any other suitable mechanism, a spring 41 acting to move said piston downwardly and maintain it in proper working relation with said tappet and cam. During the first part of the compression stroke the piston 38 moves downwardly, thus increasing the volume of the chamber formed by said recess and the bore 38 and the action of the mixing of the fuel with the gases takes place as above described. Near the end of the compression stroke the piston 38 is rapidly moved upwardly and the gaseous mixture is then caused to reverse its flow and be forced through the chamber 16 across the exposed face of the member 17, through the restriction 36 into the chamber 15 and the engine cylinder insuring prompt and efficient combustion of the charge during the power stroke.

In Fig. 5 the reversal of flow of the gases is accomplished near or at the end of the compression stroke by the introduction of compressed gases at a higher pressure than the gases in the engine from a suitable source of supply through a passage 42 controlled by a

valve 43 which is properly timed and operated in proper cyclic synchronism with the engine, it being noted that the valve in this instance seats in the cylinder block and opens into the recess or chamber 16. The valve 43 is held to its seat by a spring 45 and opened by any suitable valve gear.

As a modification of the construction shown in Fig. 5, where it is desired to have the feeding mechanism removable, I show a plug or casing 46 mounted in the cylinder head 47 and having the feeding member 48, similar to the member 17, seated at its lower end and supplied with fuel through the passage 48' in said casing, the fuel being formed into a film as in the first-described construction, and exposed on the rotation of member 48 to the gases in the engine cylinder through the restricted passage 49 communicating with a small chamber or recess 50 formed in the casing. A valve 51 controls the passage of blast gas through the passage 52 and into the chamber 50 across the fuel film near or at the end of the compression stroke, said gas acting to blow the fuel in wholly or partly gasified condition into the cylinder at this time to mix with the air compressed in the cylinder 53 and be burned therein during the power stroke.

I am aware that it has been proposed to blast liquid fuel into an engine cylinder, but in all prior constructions with which I am familiar the blast gases as introduced into the engine encounter the liquid fuel in the form of a pool and the fuel is broken up into drops by the action of the air assisted by other parts, such as small orifices or atomizer plates. With the present construction, owing to the fact that the liquid fuel film on exposure to the engine may be but a few thousandths of an inch or a fraction thereof thick, this fuel may be said to be in a pre-atomized condition on its exposure to the cylinder gases, with the result that in the constructions above described I have the fuel charge practically in the form of a rich, gaseous mixture for forcing into the cylinder in the manner above described near or at the end of compression. Also, unlike other devices, the member that carries the liquid fuel into the engine may be a metering member.

Ignition of the charge may be by the heat of compression or where the compression is not high enough to produce autoignition by any suitable ignition device, such as a spark plug or hot wire plug associated with the chamber 15.

I desire it to be understood that this invention is not to be limited to any particular form or arrangement of parts except insofar as such limitations are included in the claims.

What I claim as my invention is:

1. In an internal combustion engine, the combination of a cylinder, a removable cylinder head, a piston working in said cylinder,

a rotary fuel-feeding member seating on the end face of the cylinder wall, a chamber in restricted communication with the cylinder and supplied with fuel in the form of a non-kinetic film on the movement of said member on its seat, means for supplying fuel to the seating face of said member, and means below the top of the cylinder for imparting movement to said member in cyclic synchronism with the engine.

2. In an internal combustion engine, the combination of a cylinder, a piston working in said cylinder, a chamber in restricted communication with said cylinder, means for supplying fuel to said chamber in the form of a non-kinetic film for mixing with the gases from said cylinder during the compression stroke, and means for positively effecting the flow of fuel mixture from said chamber and into the cylinder near the end of the compression stroke.

3. In an internal combustion engine, the combination of a cylinder, a piston working in said cylinder, a chamber in restricted communication with said cylinder, means for supplying fuel to a wall of said chamber in the form of a non-kinetic film for mixing with the gases from said cylinder during the compression stroke, and a compressor for delivering gases to said chamber near the end of the compression stroke for forcing the fuel mixture into the cylinder.

4. In an internal combustion engine, the combination of a cylinder, a removable cylinder head, a piston working in said cylinder, a chamber in restricted communication with said cylinder, a rotary fuel-feeding-and-metering member seating on the end face of the cylinder wall, a chamber in restricted communication with the cylinder and supplied with fuel in the form of a non-kinetic film on the movement of said member on its seat, means for supplying fuel to the seating face of said member, an auxiliary cylinder communicating with said chamber, and a piston working in said last-named cylinder for forcing gases therethrough near the end of the compression stroke.

5. In an internal combustion engine, the combination of a cylinder, a piston working in said cylinder, a chamber in restricted communication with said cylinder, a movable member forming a wall of said chamber for supplying fuel to said chamber in the form of a non-kinetic film for mixing with gases from said cylinder during the compression stroke, and means for delivering compressed gases to said chamber and across said wall near the end of the compression stroke at a greater pressure than the cylinder gases.

6. In an internal combustion engine, fuel introducing means comprising a pair of relatively movable elements normally in seating engagement with each other and between which the fuel is carried in the form of a film

and exposed to the gases in the engine, and
means for delivering blast gases near the end
of the compression stroke at a pressure
greater than that in the cylinder space
5 against said film.

In testimony whereof, I affix my signature.

LOUIS O. FRENCH.

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