June 26, 1928. 1,674,730

H. M. LEONARD

ENGINE

Filed June 3, 1926

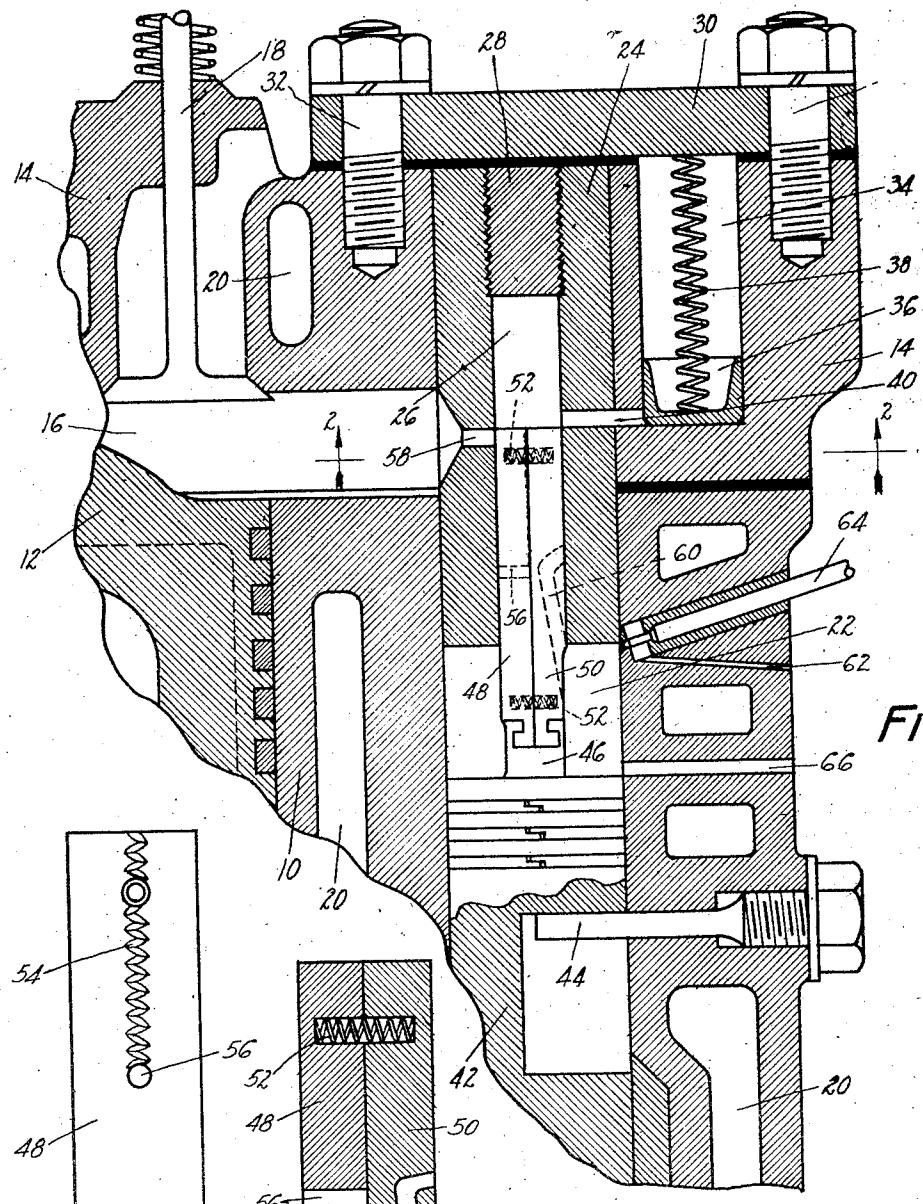


FIG. 1

FIG. 3

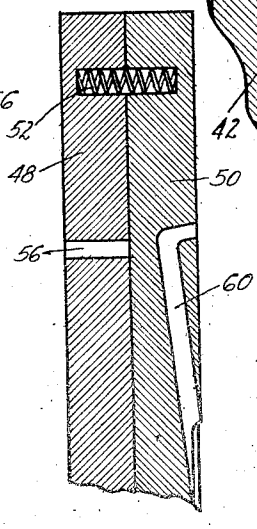


FIG. 4

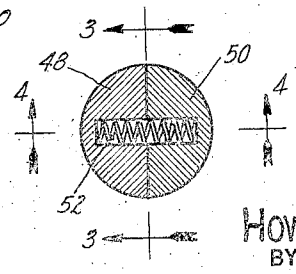


FIG. 2

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UNITED STATES PATENT OFFICE.

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ENGINE.

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This invention relates to engines, more particularly to engines of the injection type, and has for its object to provide novel fuel feeding or injecting means acting in a plurality of stages so as to give the charges of fuel greater opportunity for complete vaporization before they are finally injected into the engine cylinder. It is highly desirable that the successive charges of fuel for an engine of this type be vaporized as completely as possible in a gaseous medium such as air or steam or exhaust gas so that a rich, homogeneous fuel mixture is injected as a vapor rather than as a spray or liquid into the engine cylinder, this being of extremely great importance in engines operating at very high speeds. An important feature of the present invention relates to securing this complete vaporization by compressing the mixture of fluid and fuel several times, preferably with an intermediate stage of expansion, thus not only giving more time for the fuel to vaporize but additionally agitating it and breaking up the liquid to facilitate its vaporization.

In the arrangement shown in the drawing, there is a fuel-injecting device including two pump plungers, preferably connected with each other in the form of a double-diameter piston, one of which initially mixes and compresses the charges of fluid and fuel and ejects them into an auxiliary reservoir and the other of which withdraws the charges from the reservoir and after compressing them again finally injects them into the engine cylinder.

Various other features of novelty relate to the particular construction of the above-described double-diameter piston, and to the relative arrangement of the auxiliary reservoir with respect to the other parts of the fuel-injecting means, and to other novel combinations of parts and desirable particular constructions, which will be apparent from the following description of one illustrative embodiment shown in the accompanying drawings, in which:

Figure 1 is a vertical section through part of the engine cylinder and piston and through the fuel-injecting means;

Figure 2 is a horizontal section through one of the pump plungers on the line 2—2 of Figure 1;

Figure 3 is a side elevation of one half of the fuel-feeding plunger shown in Figure 1, being in effect a section on the line 3—3 of Figure 2; and

Figure 4 is a section through the fuel-feeding plunger of Figure 1 on the line 4—4 of Figure 2.

The novel fuel-feeding means forming the subject-matter of this invention may be used with an engine of any desired type, as for example a two-cycle crank-case compression engine including an engine cylinder 10 and a piston 12, which cooperate with a detachable cylinder head 14 to form a combustion space 16 when the piston 12 is at the upper end of its stroke. A compression-relief valve 18 may be provided if desired to facilitate starting the engine. The cylinder 10 may if desired be provided with the usual water jacket 20.

In the cylinder wall, and in the cylinder head 14, there are formed co-axial openings, the lower part of which forms a pump cylinder 22 and the upper part of which contains a sleeve 24 forming a smaller pump cylinder 26, the upper end of which is here shown closed with a plug 28 held by a detachable head 30 fastened to the cylinder head by bolts or the like 32. Adjacent the smaller pump cylinder 26 the cylinder head 14 is formed with a parallel opening 34 forming a fluid reservoir which may, if desired, contain a smaller piston 36 grooved or otherwise formed on its bottom to permit the entrance of compressed gases beneath it and held by a spring 38 which is compressed as the piston rises when gases are forced into the reservoir 34 below the piston. The bottom end of reservoir 34 communicates by a passage 40 through the cylinder head and through sleeve 24, with the interior of the sleeve 24.

In the larger pump cylinder 22 there is arranged a pump plunger 42 reciprocated by a suitable cam or eccentric mechanism driven by or from the engine crank shaft or otherwise and prevented from turning by a key 44 or otherwise. This plunger 42 is provided at its upper end with a part 46 formed with a dovetailed groove to form a tongue-and-groove joint with the lower ends of two half-plungers 48 and 50 which together form a cylindrical plunger fitting into the smaller pump plunger 26. The half-plungers 48 and 50 are urged apart by means such as coil springs 52 confined between them, into close fitting engagement with the cylinder wall. As best shown in Figure 3, the half-plunger

48 is formed with an axial passage or groove 54 from its upper end, the groove preferably being of zig-zag form (i. e., formed with numerous sharp bends), to provide a tortuous path for the fuel mixture, the more thoroughly to break it up. At its lower end the groove 54 opens into a passage 56 radially through the half-plunger 48, and which registers at the upper end of the stroke of the plunger with a passage 58 through sleeve 24 into the adjacent space 16 of the engine cylinder. The passage 58 is just below the passage 40, and the stroke of the plunger is such that in its lowermost position of the passage 40 is uncovered while the passage 58 is still closed. The half-plunger 50 is shown formed with a longitudinally extending passage 60, the upper end of which communicates with the passage 40 when the plunger is in its uppermost position.

The fuel may be injected into the larger pump cylinder 22 in any desired manner, as for example through a passage 62 controlled by a needle valve 64, the fuel preferably being injected at the top of the cylinder or just below sleeve 24. In its lowermost position the plunger 42 uncovers a passage 66 through which air or steam or exhaust gas or the like may enter the pump cylinder.

In operation, on the downward stroke of the two plungers the larger plunger 42 creates a partial vacuum in the larger pump cylinder 22 which sucks a charge of fuel past the needle valve 64 into the pump cylinder. Near the end of its stroke the passage 66 is uncovered and air or other gaseous fluid is drawn into the partial vacuum to fill the space above the plunger. On the upward stroke of the two plungers the fuel and fluid in the pump cylinder 22 are heavily compressed, thus raising the temperature and agitating the mixture and generally facilitating the vaporization of the fuel in the gaseous fluid, and in the extreme uppermost position of the plunger the passage 60 registers with the passage 40 and the compressed mixture of fluid and fuel is forced into the reservoir 34 below the piston 36 against the resistance of the spring 38. As the plungers again move downwardly, plunger 48—50 creates a partial vacuum in the smaller pump cylinder 26 until it reaches its lowermost position in which the passage 42 is uncovered, whereupon the charge of mixed fuel and fluid in the reservoir 34 rushes into the small pump cylinder 26. As the plungers again come up on the next stroke the charge is heavily compressed in the smaller pump cylinder 26 until at the top of the stroke the passage 58 registers with the passage 56 and the fuel is injected by its own pressure into the combustion space 16. This takes place just before the engine cylinder 12 reaches the top of its compression stroke and as the air in the engine cylinder has been raised by its compression to a temperature above that required to ignite the fuel ignition takes place immediately on the injection of the fuel charge.

While one illustrative embodiment has been described in detail, it is not my intention to limit the scope of the invention to that particular embodiment or otherwise than by the terms of the appended claims.

I claim:

1. An engine of the injection type comprising, in combination with an engine cylinder, means for mixing successive charges of liquid fuel with a gaseous fluid, and means for compressing each of the successive charges of fluid and fuel separately in a plurality of successive stages and then injecting the mixture into the engine cylinder.

2. An engine of the injection type comprising, in combination with an engine cylinder, a fluid reservoir, means for mixing and compressing a charge of fuel in a gaseous fluid and forcing the mixture into said reservoir, and means for withdrawing the mixture of fluid and fuel from the reservoir and injecting it into the engine cylinder, one of said means being arranged to operate the other.

3. An engine of the injection type comprising, in combination with an engine cylinder, a fluid reservoir, means for mixing and compressing a charge of fuel in a gaseous fluid and forcing the mixture into said reservoir, and means for withdrawing the mixture of fluid and fuel from the reservoir and compressing it and finally injecting it into the engine cylinder, said two means including interconnected pump plungers.

4. An engine of the injection type comprising, in combination with an engine cylinder, means for mixing successive charges of fuel with a gaseous fluid and thereafter compressing the mixed charges, and additional means for further compressing the mixed charges and injecting them into the engine cylinder.

5. An engine of the injection type having, in combination with an engine cylinder, a double-diameter pump piston, means including the part of said piston of one diameter for mixing successive charges of fuel with gaseous fluid and compressing them, and means including the part of the cylinder of the other diameter for again compressing the mixed charges and injecting them into the engine cylinder.

6. An engine of the injection type having, in combination with an engine cylinder, two pump pistons adjacent said cylinder, a pump plunger in each cylinder, and a reservoir adjacent the pump cylinders and so arranged that one of the plungers in-

jects the successive fuel charges into the reservoir and the other compresses the charges from the reservoir and injects them into the engine cylinder.

7. An engine having, in combination with an engine cylinder and means for forming successive separate fuel charges, a plurality of fuel compressors arranged to act successively on said charges and finally to inject them into said cylinder.

8. An engine having, in combination with an engine cylinder and means for forming successive separate fuel charges, a plurality of fuel compressors arranged to act successively on said charges and finally to inject them into said cylinder, together with means permitting expansion of the charges acted on by one compressor before the action thereon of the next compressor.

9. An engine having, in combination with an engine cylinder, a double-diameter pump cylinder and a double-diameter pump piston therein, and means for receiving charges compressed in the part of the cylinder of larger diameter and delivering them to the part of smaller diameter, the part of the piston of smaller diameter being arranged to inject the charges into the engine cylinder.

10. An engine having, in combination with an engine cylinder, a double-diameter pump cylinder and a double-diameter pump piston therein, and means including a separate cylinder containing a spring-loaded piston for receiving charges compressed in the part of the cylinder of larger diameter and delivering them to the part of smaller diameter, the part of the piston of smaller diameter being arranged to inject the charges into the engine cylinder.

11. An engine having, in combination with an engine cylinder, two compressors and an auxiliary cylinder containing a spring-loaded piston, one compressor forcing compressed fuel charges into said auxiliary cylinder against the resistance of said piston, and the other compressor receiving the charges from the auxiliary cylinder and injecting them into the engine cylinder.

12. An engine having, in combination with an engine cylinder, an adjacent pump cylinder paralleling the engine cylinder, a sleeve fitting into the upper part of the pump cylinder and forming a pump cylinder of smaller diameter and the bottom of which forms a head for an annular lower cylinder space, and a double-diameter piston in the double-diameter pump cylinder so formed, arranged to inject fuel charges into the engine cylinder.

13. An engine having, in combination with an engine cylinder, an adjacent pump cylinder paralleling the engine cylinder, a sleeve fitting into the upper part of the pump cylinder and forming a pump cylinder of smaller diameter and the bottom of which forms a head for an annular lower cylinder space, and a double-diameter piston in the double-diameter pump cylinder so formed, arranged to inject fuel charges into the engine cylinder, together with a reservoir communicating with the upper part of the cylinder when the piston is at the lower end of its stroke and with the lower part of the cylinder when the piston is at the upper end of its stroke.

14. An engine having, in combination with an engine cylinder, a pump cylinder having an upper part of small diameter and a lower part of larger diameter, a double-diameter piston therein, and a reservoir communicating with the small-diameter part of the pump cylinder when the piston is at the bottom of its stroke and with the large-diameter part of the pump cylinder when the piston is at the upper end of its stroke.

15. An engine having, in combination with an engine cylinder, a pump cylinder having an upper part of small diameter and a lower part of larger diameter, a double-diameter piston therein, and a reservoir communicating with the small-diameter part of the pump cylinder above the end of the piston when the piston is at the bottom of its stroke and with the large-diameter part of the pump cylinder through a passage in the piston when the piston is at the upper end of its stroke.

16. A fuel-injecting pump having a double-diameter piston including a lower part of large diameter and an upper part in two separate pieces urged yieldingly apart and connected to the lower part.

17. A fuel-injecting pump having a double-diameter piston including a lower part of large diameter and an upper part in two separate pieces urged yieldingly apart and having tongue-and-groove connection with the lower part.

18. That method of preparing and injecting fuel into an engine which comprises the steps of mixing and compressing each fuel charge with a charge of gaseous medium thereafter, allowing partial expansion of the fuel mixture, and finally additionally compressing the fuel mixture and injecting it into the engine.

19. That method of preparing and injecting fuel into an engine which comprises the steps of mixing each fuel charge with a charge of gaseous medium and thereafter compressing it, and additionally compressing the fuel mixture and injecting it into the engine.

In testimony whereof, I have hereunto signed my name.

HOWARD M. LEONARD.