Dec. 26, 1950 K. J. FLECK 2,535,535

INJECTION PLUNGER FOR COMPRESSION IGNITION ENGINES

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Fig. 1.

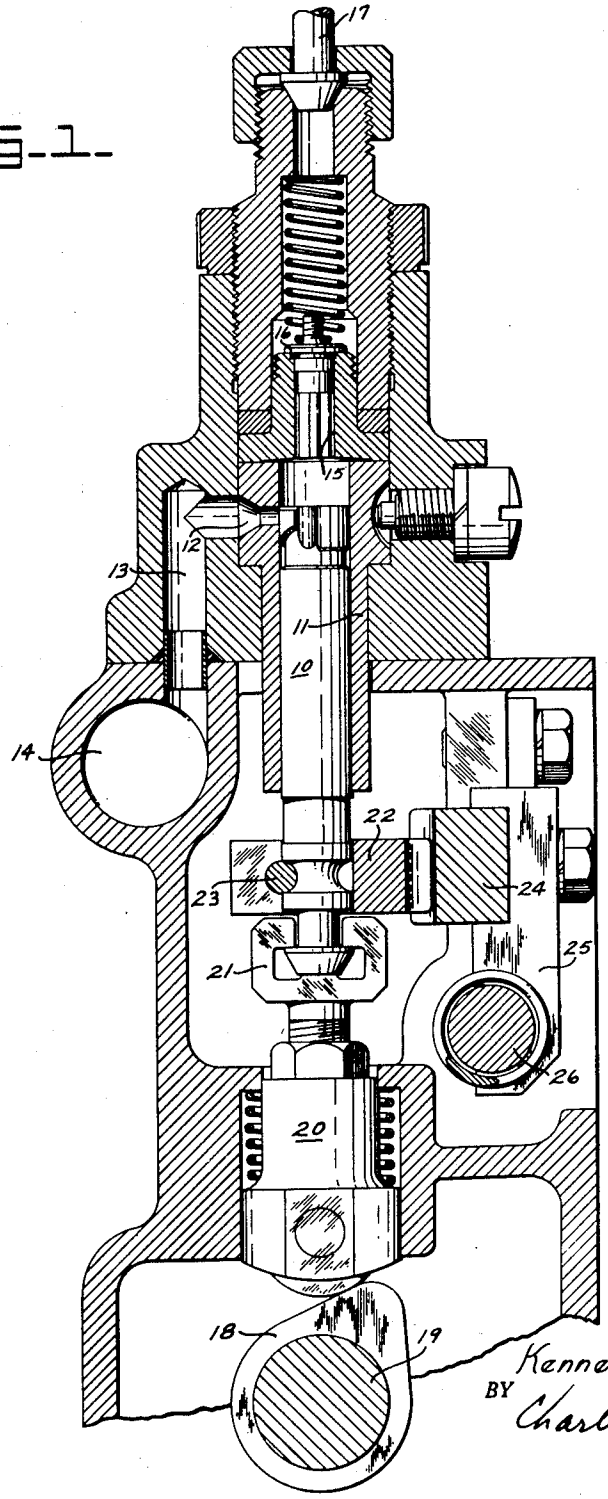

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Fig. 2.

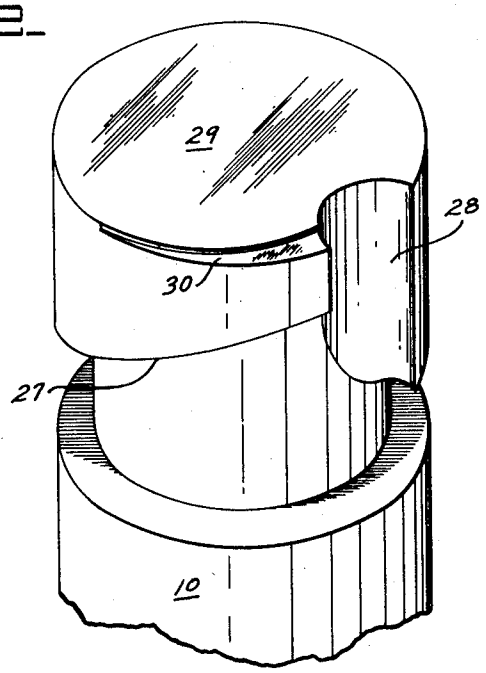


Fig. 3.

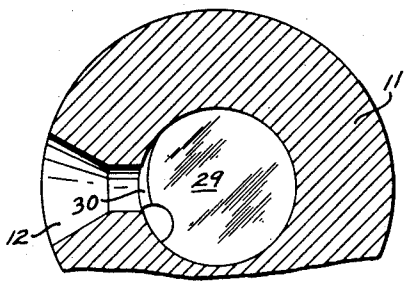
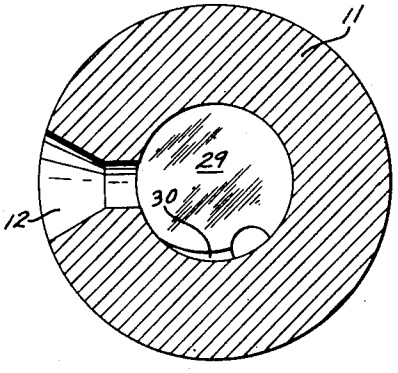


Fig. 4.



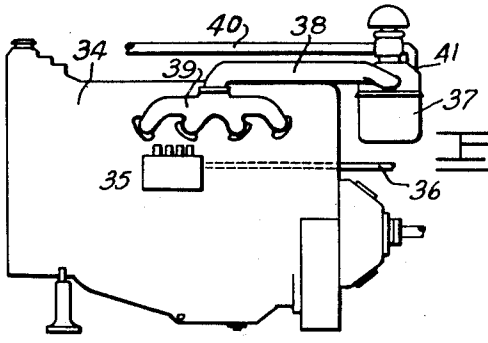


Fig. 5.

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UNITED STATES PATENT OFFICE

2,535,535

INJECTION PLUNGER FOR COMPRESSION IGNITION ENGINES

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1 Claim. (Cl. 123—121)

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This invention relates to fuel injection mechanism for engines of the compression ignition type and more particularly to a fuel injection pump plunger designed to operate with high efficiency on either fuel oil or gas.

Gas, such as natural gas, is commonly employed as a fuel for compression ignition engines. In many instances gas is used as a fuel because of the proximity to the engine installation of quantities of natural gas available at little or no cost. The gas supply is, however, not always constant and it is desirable that the engine be equipped for stand-by or emergency operation with fuel oil in the event of failure of gas supply.

Because of differences in operating characteristics when oil and gas are used as fuels, these engines usually lack efficiency and smoothness of operation with either one fuel or the other. It is known that the injection of oil should take place at an earlier position in the engine cycle when oil is the fuel than when gas is the fuel. For example, one type of engine operates most efficiently when fuel oil is injected approximately 17° before top center position of the crank while, with gas as a fuel in the same engine, injection of the oil used for ignition purposes should occur later or at about 14° before top center position. One theory in explanation of this difference in operating characteristics with different fuels is that natural gas constitutes a highly volatile mixture igniting practically the instant of injection, while fuel oil requires some time to become properly mixed with the air under compression in the combustion chamber.

Variation in injection timing can be accomplished by varying the length or the length of stroke of theinjection plunger, but ordinarily a plunger designed for either oil or gas will result in unsatisfactory, noisy and inefficient operation when the other fuel is used.

It is an object of this invention to provide fuel injection mechanism operable with a high degree of efficiency with either oil or gas as a fuel. Another object of the invention is the provision of a metering type plunger for the injection system of a compression ignition engine in which the injection timing period is automatically changed as the plunger position is varied from its oil operating range to its gas operating range. Further and more specific objects and advantages of the invention and the manner in which these objects are carried out are made apparent in the following specification by reference to the accompanying drawings.

In the drawings:

Fig. 1 is a central, vertical, sectional view through a fuel injection pump and its associated driving and adjusting means;

Fig. 2 is an enlarged perspective view of the head end of the pump plunger shown in Fig. 1;

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Fig. 3 is an enlarged horizontal section through the pump cylinder illustrating the adjusted position of the plunger therein during operation with gas as a fuel;

Fig. 4 is a similar view illustrating the adjusted position of the plunger for a high speed or full load operation with oil as the fuel; and

Fig. 5 is a diagrammatic view of an engine operable either on oil or gas as a fuel.

In Fig. 1 of the drawings, a fuel injection pump of generally conventional design is illustrated as having a plunger 10 reciprocably mounted in a cylinder 11. Fuel is introduced to the upper end of the cylinder through a supply port 12 communicating through a passage 13 with a fuel supply manifold 14. As the plunger is retracted from the position shown in Fig. 1, fuel enters the upper part of the cylinder and upon upward or advancing movement of the plunger, the fuel in the cylinder is subjected to pressure and ejected through a discharge port 15. A conventional spring loaded check valve 16 is associated with the discharge port and the port communicates with a conduit 17 for directing the fuel under pressure from the pump to the combustion chamber of a compression ignition engine, not shown.

Reciprocation of the plunger is effected through a cam 18 on a rotating camshaft 19. The cam 18 engages a spring pressed cam follower 20 connected with the lower end of the plunger as by a lifting fork 21. The plunger 10 is of the well known scroll or metering type wherein the quantity of fuel injected upon each stroke is determined by its angular position within the cylinder.

Angular or rotary adjustment is imparted to the plunger through a segment gear 22 split and clamped in a fixed position on the plunger as by a clamping bolt illustrated in section at 23. A rack 24 meshes with the segment gear 22 and is connected as by a fitting 25 with a governor actuated control rod 26. The rod 26 is reciprocated in response to the operation of a governor, not shown, the construction and operation of which is well known. As this reciprocation is imparted to the rack 24, the segment gear 22 and pump plunger to which it is fixed are angularly adjusted. The head end of the plunger is, as best illustrated in Fig. 2, provided with a recess having a scroll edge 27 and a notch 28 communicating between the head or pressure face 29 of the plunger and the recess in which the scroll edge 27 is formed. Consequently, as the plunger is angularly adjusted, the time between closing of the inlet port 12 on upward movement of the plunger and opening of the port when it is uncovered by the scroll edge, and thus the quantity of fuel injected in a single plunger stroke, is varied.

For an understanding of the present invention, it must be known that an engine operating on

natural gas as a fuel has a set metering position considerably below the ordinary operating range employed with fuel oil. This results in injection of oil just sufficient to ignite the gas customarily introduced to the cylinder through the air intake manifold. For example, Fig. 3 of the drawings shows the established position of the plunger with relation to the supply port 12 when the engine is operating on natural gas. In Fig. 4, the plunger is shown between a high idle and full load position for fuel oil and as the governor is set for lower speeds or to deliver less fuel, the plunger would be rotated clockwise from this position. However, even the lowest or low idle position would not be as extreme as that shown in Fig. 3. Therefore, in order to effect a delay in injection timing when natural gas is used as a fuel and oil is injected for ignition purposes, the head of the plunger is relieved or lowered at its edge, as indicated at 30 in Fig. 2, at a position that registers with the supply port 12 in its gas fuel position (see Fig. 3) but does not register with the supply port and is, therefore, ineffective in the ordinary fuel oil operating range (see Fig. 4). Because of the relief 30 in the edge of the plunger head, injection timing is retarded for efficient operation with natural gas when the plunger is in the position shown in Fig. 3 but the normal timing for fuel oil is established when the plunger is in the position illustrated in Fig. 4. It is possible upon adjustment of the plunger from the position shown in Fig. 4 toward the low idle position for fuel oil operation that a portion of the relief 30 might register with the supply port 12. Consequently, this relief is formed eccentrically relative to the center of the plunger so that it diminishes gradually toward the periphery of the plunger, and in the event that its leading end registers with the supply port 12, the effect will be negligible particularly during low idle engine operation.

With the construction shown, the normal adjustment of the pump plunger to its position for operation with natural gas results in an effective shortening of its length and a consequent retarding of injection timing for most efficient operation with gas, while the normal efficient operation of the engine when the plunger is adjusted for fuel oil is not detrimentally effected.

A typical dual fuel engine adapted to operate selectively on oil or gas is shown in Fig. 5. In this figure an engine 34 is shown as having a fuel pump housing 35 containing fuel pumps of the kind illustrated in Fig. 1. There is of course one such pump for each cylinder of the engine. Fuel oil is supplied to the pumps from a source, not shown, through a supply line 36. Air to support combustion passes through an air cleaner 37 of conventional design and then through a pipe 38 to a manifold 39 by means of which it is directed to the several cylinders. When gas is employed as a fuel it is introduced to the cylinders by way of the air intake manifold. This is accomplished by a gas supply line 40 which communicates with the air cleaner as illustrated at 41.

I claim:

In a fuel injection mechanism for an engine adapted to operate alternately on oil and on gas with a pilot flame of oil, a pump plunger with a substantially flat pressure end, said plunger being rotatable in its cylinder to vary the quantity of oil delivered per stroke from a maximum for oil fuel operation to a position for pilot injection for gas fuel operation, said plunger having a relieved portion at the edge of its pressure end for registry with the supply port of the cylinder to vary injection timing when the plunger assumes its gas fuel position, and said relieved portion having an edge parallel to the plane of the pressure end of the plunger whereby the plunger may be rotated to a limited degree for varying the pilot flame size without varying the timing.

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