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INTERNAL COMBUSTION ENGINE

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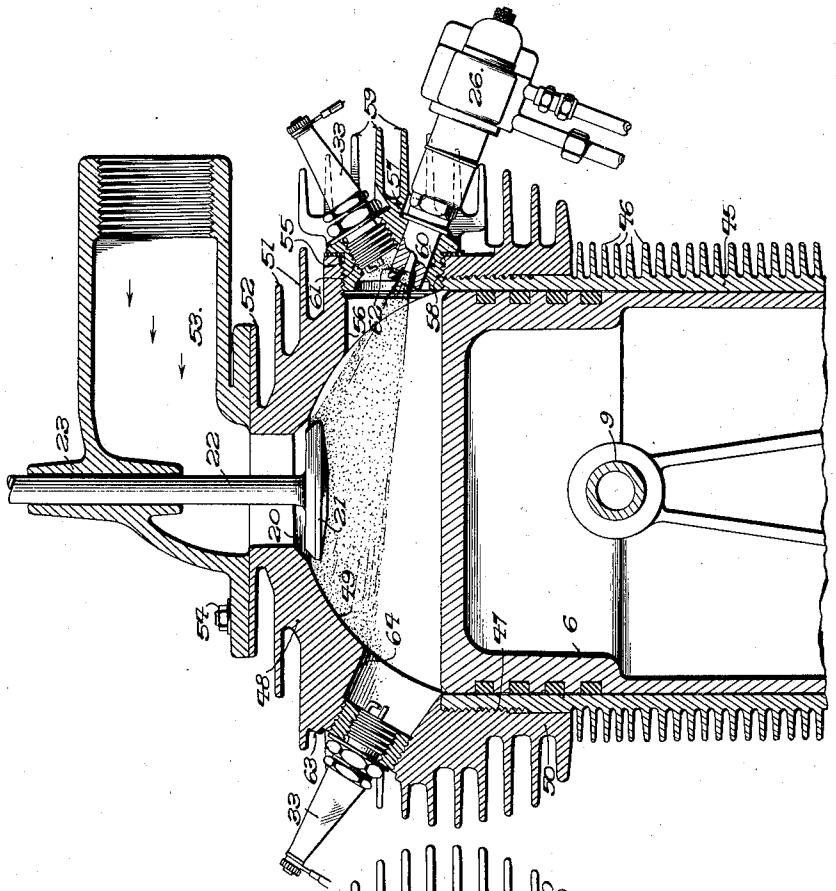


FIG. 2.

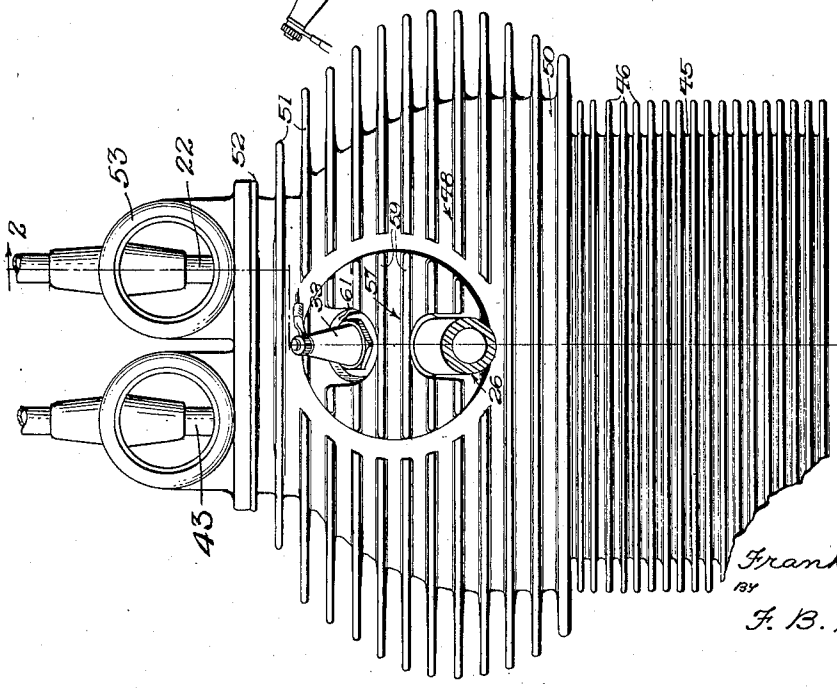


FIG. 1.

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INTERNAL COMBUSTION ENGINE

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12 Claims. (Cl. 123—32)

This invention relates to internal combustion engines and more particularly to the injection of liquid fuel in such engines.

It has heretofore been proposed to inject a charge of solid liquid fuel into the cylinders of an internal combustion engine in which the maximum compression is below that necessary to cause self-ignition. Such engines have desirable features, particularly for use in vehicles, as they have a large power output and are compact and of less weight than engines operating under the high self-ignition compression, where excessive forces and strains are encountered. However, in such engines much difficulty has been experienced in atomizing, diffusing, and so proportioning the fuel charge that proper ignition and combustion at starting and idling conditions may be had and continuous operation of the engine dependable. It has been found that such engines are extremely sensitive to the proportion of the charge formed, and that a delicate coordination must be made between the air throttle position and amount of fuel injected, particularly under idling conditions where a very small charge of liquid fuel is introduced. If the proper coordination is not maintained, ignition and combustion either fail entirely or become so inefficient that the engine will not overcome its own friction. Because of the difficulty in maintaining the proper coordination under varying conditions, it has been practically impossible to use this type of engine where dependability is a vital factor, such as in aeronautics, even though they are compact, light, and efficient under ideal conditions.

It is one of the objects of the present invention to improve the functioning and dependability, under all conditions, of that type of fuel injection engine in which the maximum compression is below that necessary for self-ignition.

Another object of the present invention is to improve the fuel charge and ignition characteristics of an internal combustion engine in which a solid fuel is injected directly into the cylinders.

Another object of the present invention is to provide a novel cylinder head construction for causing a diffusion of liquid fuel into the air charge and for insuring proper ignition by localizing a rich mixture at the igniter.

Another object of the present invention is to provide a novel cylinder head for an internal combustion engine, which is compact and practical and which increases the efficiency and power output of the engine.

These and other objects will be more apparent from the following description and drawings in which like reference characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and does not define the limits of the invention; reference being had for this purpose to the appended claims.

In the drawing,

Fig. 1 is a side elevation of a modified cylinder head construction of the air cooled type incorporating a novel fuel injector and spark plug unit; and

Fig. 2 is a vertical sectional view of the cylinder head disclosed in Fig. 1.

The cylinder 45 is provided with fins 46 formed integral therewith over the greater part of its area for providing the proper radiating surface, but leaving a threaded portion 47 adjacent the upper end. A head 48 is adapted to cooperate with the cylinder 45 to form a combustion chamber, and has a curved upper wall 49 and a skirt 50 interiorly threaded for engagement with the threaded surface 47 of the cylinder. In the upper surface of the head, apertures are formed which constitute intake and exhaust ports controlled by valves 22 and 43 respectively. A valve is provided in the manifold 53 having a head 21 for cooperating with the seat 20 and a stem 22 extending through a bushing 23 in the wall of the manifold for sliding engagement therewith.

The cylinder head on one side is provided with a boss 55 having an interiorly threaded bore 56 located centrally thereof. A plug 57 having a threaded portion 58 at one end is adapted for engagement with the threaded portion of the bore 56, the other end having fins 59 on its exterior of the same contour as the fins on the cylinder head. This plug 57 is provided with two bores 60 and 61 angularly disposed with respect to the axis of the plug and adapted to hold a fuel injector 26 and an igniter 33 as a unit. The angle at which the fuel injector is positioned is such that the liquid fuel charge will be directed in the form of a hollow spray cone including the valve head 21 and intersecting the path of incoming air. The bore 61 is tapped for threaded engagement by the shell of the igniter 33 so that the hot spot is positioned in the combustion chamber adjacent the nozzle of the fuel injector. A slot 62 is provided in the fuel injector nozzle so that part of the stream of liquid fuel ejected will contact the hot spot of the igniter 33 in the form of a spray. On the wall opposite from the boss 55, a second boss 63 is provided having a bore 64 with internal threads and

adapted to receive a second igniter 33. This second igniter is so positioned with respect to the fuel injector 26 that part of the cone of fuel spray directly contacts this igniter, insuring proper ignition. Preferably, the cone of fuel spray should be located between the intake valve and second igniter 33 so that the inflow of air will carry the spray toward the igniter. In the operation of an engine constructed according to the present invention, liquid fuel is injected into the combustion chamber by any suitable pumping mechanism (not shown) and the fuel injection preferably occurs during the time that the inlet valve 21 is open for the admission of air. The greater portion of the jet of fuel intersects the air stream entering the cylinder through the opening between the valve 21 and its seat 20 and a small portion of fuel will be thrown on each of the spark plugs 33. Each spark plug is shielded from the direct path of the air stream by the upper walls of the bores 56 and 64. The ignition of the mixture is initiated in the bores, but immediately thereafter the flame is communicated to the turbulent mixture in the main combustion chamber.

It will be readily apparent that an engine has been provided in which the main body of fuel and air is thoroughly mixed by causing the fuel to intersect the entering air stream. It will also be apparent that the initiation of the fuel ignition is facilitated by shielding the spark plugs from the direct path of the air stream.

What is claimed is:

1. In an internal combustion engine, a cylinder having a combustion chamber at the head end, an intake port in the wall of the combustion chamber for admitting a stream of air, a valve in said port, a fuel injector so positioned and arranged as to direct a stream of liquid fuel toward the intake port at an angle with respect to its axis, said valve and injector being arranged to admit air and fuel concurrently, a pair of igniters in opposite sides of the combustion chamber one of which is positioned in the path of the stream of the liquid fuel.

2. In an internal combustion engine, a cylinder having a combustion chamber at the head end, an intake port in the wall of the combustion chamber, a poppet valve cooperating with the port, a fuel injector so positioned and arranged as to direct a stream of liquid fuel onto the valve and into the stream of incoming air at an angle with respect to the axis of the port and poppet valve, a pair of igniters in the combustion chamber arranged in opposite side walls thereof and one of which is positioned in the path of stream of the liquid fuel, and means for shielding at least one of the igniters from the direct path of air stream.

3. In an internal combustion engine, a cylinder having a series of lateral radiating fins, a cylinder head cooperating with the cylinder to form a combustion chamber and provided on its exterior with lateral radiating fins, an air inlet port in said head, a plug in said head having exterior fins cooperating with the fins on said head, a fuel injector in said plug so positioned and arranged as to direct a stream of liquid fuel across the combustion chamber and into the path of incoming air at an angle, means for directing a second stream of fuel from the injector and an igniter in said plug positioned in the direct path of the second stream of liquid fuel.

4. In an internal combustion engine, a cylinder having a combustion chamber, an air intake valve and an igniter therein at a point below the valve, a fuel nozzle arranged to inject fuel between the igniter and the intake valve and into the path of the air stream whereby the fuel is carried by the air stream to a point adjacent the igniter, a second igniter in the chamber arranged in the side wall opposite the first igniter, said nozzle being adapted to project an auxiliary jet of fuel directly upon the second igniter, and means for shielding the igniter from the path of the air stream.

5. In an internal combustion engine, a cylinder having a combustion chamber, an air intake valve and a pair of igniters therein, said igniters being arranged in a line passing below the valve, a fuel nozzle arranged to inject fuel between the igniters and the intake valve and into the path of the air stream whereby the fuel is carried by the air stream to a point adjacent the igniters, one of said igniters being adjacent said nozzle and the other being remote therefrom, said nozzle being adapted to project small portions of the fuel directly upon both igniters.

6. In an internal combustion engine, a cylinder having a combustion chamber, an air intake valve therein, a pair of igniters having ignition points on opposite sides of said valve arranged in recesses for shielding them from direct air flow through the valve, and a fuel nozzle adapted to inject fuel in the path of the air flow through the valve and small portions of the fuel directly upon the points of both igniters.

7. In an internal combustion engine, a cylinder having a dome shaped combustion chamber, an air intake valve in the outer end of the combustion chamber, an igniter in the chamber side wall, a fuel nozzle in the chamber side wall arranged adjacent the igniter, said nozzle being adapted to inject the main charge of fuel toward the intake valve to intersect the air flow therethrough and to inject a small portion of fuel directly upon the igniter.

8. In an internal combustion engine having a piston, a cylinder having a combustion chamber at the head end thereof, an intake valve in the cylinder head, a pair of spaced igniters in the chamber wall below the valve, and a fuel injector arranged in the side wall of the cylinder adjacent one of the igniters and adapted to inject a main fuel charge across the air stream into the combustion chamber and to direct a small portion of fuel upon each of the igniters, and means for shielding the igniters from the path of the air stream.

9. In an internal combustion engine, a cylinder having a combustion chamber, a pair of spaced igniters therein, and a fuel injector arranged to inject a main fuel charge into the combustion chamber, said injector being positioned with respect to one igniter as to direct only a small portion of the fuel onto the igniter, and said injector being arranged adjacent the other igniter and having an auxiliary opening therein for directing a small portion of fuel onto the second igniter.

10. In an internal combustion engine, a cylinder having a combustion chamber, an air intake valve therein, a piston in said cylinder, a pair of spaced igniters in said chamber positioned in the side wall thereof between the valve and the piston, a fuel injector in said chamber in the side wall arranged to direct a main fuel charge toward said intake valve and a small fuel charge upon each of said igniters, and means for shield-

ing the igniters from the air flow through said valve.

11. In an internal combustion engine, a cylinder having a combustion chamber, an intake valve therein, a pair of spaced igniters in said chamber, and a fuel injector in said chamber arranged to direct a main fuel charge toward said intake valve and a small fuel charge upon each of said igniters, said fuel injector being arranged to inject fuel into the chamber while said intake valve is open for the admission of air, and said injector being in proximity to one of said igniters.

12. In an internal combustion engine, a cylinder having a combustion chamber at the head end thereof, an intake valve in the head of the cylinder movable in a plane parallel to the cylinder axis for admitting a stream of air to the cylinder, a fuel injector so positioned and arranged as to direct a liquid stream of fuel toward said valve, said valve and injector being operated to admit air and fuel concurrently, a pair of spaced electrical ignition means in the combustion chamber one of which is positioned in the path of the stream of liquid fuel, and means for shielding both igniters from the direct path of the air stream.

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