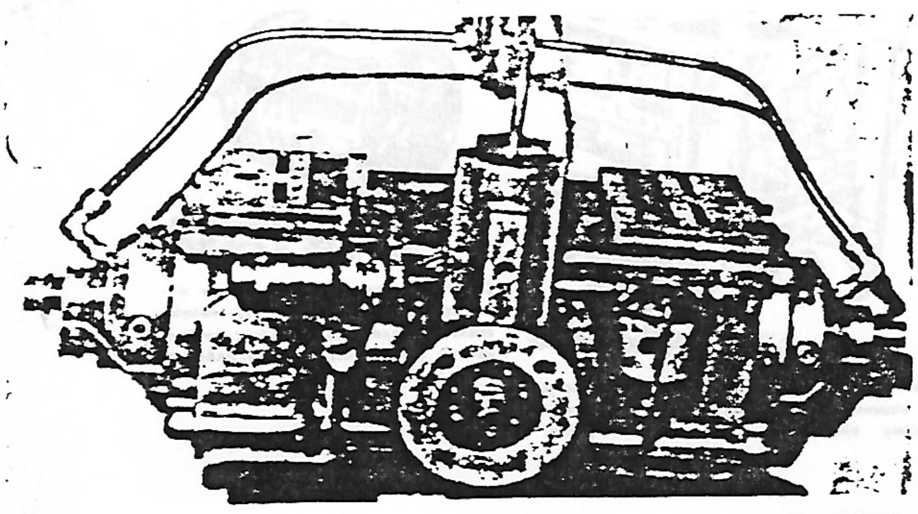


Basic engine, less manifolding, showing tie-rod construction. Injection pump outlet is siamesed to nozzles in heads, removable by unscrewing plugs. Mist lubricator is at left of injection pump above the throttle.

Unique Engine Tested

Engine's low weight-to-power ratio is based on low bmep, very high-speed, 2-cycle operation. Inventor claims that startling performance quoted depends principally on application of new combustion concepts.

WHETHER engines or the new cars, unusual designs take some "getting used to". And this light-weight, *really* high-speed diesel is certainly unusual. Its quoted performance data, particularly in view of its size, is startling.

Seeing the engine, you are impressed with its mechanical simplicity. It also gives evidence of cold, hard practicality, along with ingenuity, in the way that proven mechanical principles have been applied to produce an unusual design. It appears to be an inexpensive engine to produce. This also applies to the injection system, the cost bugaboo of all small diesels.

Mechanical excellence, however, could not account for the performance claims made by the inventor, Max C. Fiedler. He has an extensive background, gained both here and abroad, in internal combustion engine design. Of special importance, his work in the field of fuels and combustion systems for everything from rockets to diesels, lead to the development of the combustion principle upon which performance success of the design depends.

Engine Features

The engine is described as a multi-fuel compression-ignition engine. It is reported that any injectable hydrocarbon can be burned with No. 2 heating oil preferred. For reasons of balance at high rpm, the "Lanchester" system in which reciprocating motion is in balance at all times was selected.

This involves two pistons, horizontally opposed, connected to the crankshaft by one straight rod and a "U"-shaped stirrup rod. Both cylinders fire simultaneously on the 2-stroke cycle. Bore and stroke are 3½-in. by 2-in. giving a displacement of 38½ cu. in. Compression ratio is 25 to 1, figuring effective stroke. Basic engine weight is 75 lb.

Now hold tight. Mr. Fiedler rates the engine at 50 hp turning 8000 rpm. Before you shy away from this speed, remember the 2-in. stroke; it figures out to a 2700-fpm piston speed. Weight-to-horsepower ratio is 1.25 to 1.

Mr. Fiedler puts the fuel consumption to 0.3 lb per bhp hr with excellent part-load efficiency. He credits this phenomenally low fuel consumption to (1) his combustion system and (2) low friction and minimized parasitic loads. Item 1 will be discussed later.

As to Item 2, anti-friction bearings, both ball and roller, are used practically throughout. Two-cycle operation eliminates all valve gear. There's no lube oil pump as a small part of the fuel is fed into the intake air to mist-lubricate all moving parts.

No radiator or water circulating pump are used. Heat rejection to the water is low, in line with quoted fuel consumption, and heat convection from the aluminum cylinder blocks is said to be adequate.

Construction

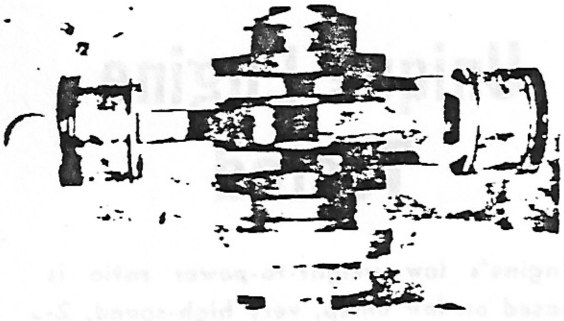
Each cylinder block is an aluminum casting. Shrunk-in, ported cast iron liners are used. These are bored and ground to size. Two mated blocks enclose the crankshaft, eliminating the usual crankcase. They are tied together by alloy steel through-bolts that are stressed to carry cylinder pressures and keep heads and blocks in compression.

The cylinder heads are aluminum forgings, symmetrical about a center line. Size of each combustion chamber is 0.7 cu in.

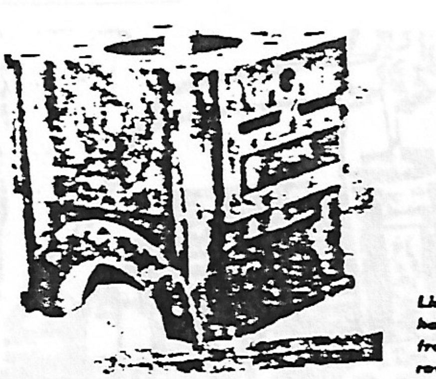
The crankshaft is of alloy steel, heat treated. The shaft and reciprocating elements are inherently in balance without counterweights. The shaft itself is dynamically balanced. Main bearings are deep-grooved ball bearings.

Connecting rods are alloy steel forgings, heat treated. Roller bearings are used at the crank end and needle bearings on the wrist pins.

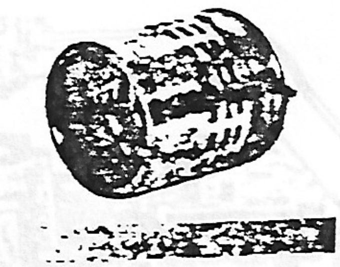
Aluminum alloy pistons are used. They are flat topped, true round, with full skirts free of slots. Wrist pins are fastened by cap screws to the underside of the piston crown.



Rotating and reciprocating assembly of "Lanchester" is always in balance. Bearings are anti-friction type.



One of two aluminum blocks that mate to support and enclose crankshaft, eliminating the conventional-type crankcase.



Liner's top row of ports is for exhaust; middle row is for air intake from crankcase to cylinder; bottom row is for air intake to crankcase.

A fuel injection pump of the utmost simplicity is crank-driven. The nozzles are equally simple and can be removed without disturbing the fuel lines.

Combustion System

Performance of this engine is feasible only by strict adherence to certain principles of combustion expounded by Mr. Fiedler (see "New Theory of Combustion", Journal of the Franklin Institute, Vol. 233, Nos. 1 and 2, 1942). According to this concept, elimination of detonation requires that the injection period be so short that no reaction, with its accompanying temperature rise, takes place before all the fuel is introduced into the combustion air.

Practical injection durations range from 8 to 12-deg crank angle—8 deg being preferable. Fuel must be introduced during this short interval in liquid, widely-separated particles which must be placed in the air in such fashion that a stoichiometric ratio is established. Droplets should be large, otherwise high pressures are needed to make them penetrate the dense, highly-compressed air. Injection pressure should not exceed 1800 psi and duration should be constant for all quantities injected at all speeds.

Low-Cost Injection Equipment

You can see that these injection requirements are considerably different from those commonly accepted. They permitted Mr. Fiedler a whole new approach to the design of injection equipment. An extremely simple pump with equally simple control was built and under test was found capable of producing the desired characteristics at frequencies up to 12,000 per min. It is estimated that in reasonable quantity it can be produced at a cost approximating that of a gasoline engine distributor head.

The nozzle valve must also conform to the required characteristics. To produce the necessary spray, its functions are radically different from present-day valves that depend on a fixed orifice. This gives a different spray characteristic for the same fuel quantity at different speeds or gives different spray characteristics with varying quantities at constant speed. Fiedler's design provides for a "flexible" orifice concept, while the fixed orifice is of such a size that it never offers a fuel restriction. The only function of this orifice is to form a suitable spray pattern.

Again, Mr. Fiedler's practical streak is in evidence. Realizing the importance of cost, he used a new approach in selection of materials and manufacturing methods. All lapping processes are eliminated. The result is a nozzle that can be sold at a price competitive with a spark plug.

Operation

The high output of this engine depends on high-speed operation at a low bmep. There is a definite school of thought favoring this type of 2-cycle operation. Evidence is seen in some foreign engines and at least one other under development in this country.

With low bmep's, the approach to scavenging can be entirely different. Note the porting on the liner shown. There need not be the emphasis on low breathing restriction and complete removal of residual gases. The air required per firing, in view of the modest amount of fuel injected, is low and some heat of residual gases can be retained for future work. This helps on the fuel bill.

This engine is crankcase-scavenged. Design of the porting is such that crankcase compression provides a supercharge of about 8 psi at full speed. Maximum cylinder pressures are about 1000 psi.

The low weight-to-power ratio of such an engine would make practical a great many applications where more conventional diesels cannot be considered. This would apply even at fuel consumption rates currently accepted for engines in this horsepower range. All this, plus the promise of low original cost, presents interesting possibilities for this engine design—should it get to the production stage. Several have been built and extensively tested. And Mr. Fiedler says that there is no reason why horsepower in multiples of the basic unit could not be obtained by adding more pairs of cylinders.