THE STUDY OF DESIGN FACTORS FOR AUTOMATICALLY CONTROLLING SPARK-IGNITION ENGINES

by 500

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ABBREVIATIONS

btc	before top centre
bhp	brake horsepower
bmep	brake mean effective pressure
bsfc	brake specific fuel consumption
psia	pounds per square inch, absolute
rpm	revolutions per minute
r	compression ratio
Fig.	figure
°R	degree Rankine
hr	hour
%	per cent
hp	horsepower
lbm	pound mass
F_R	relative fuel-air ratio
η	efficiency
deg	degree

CHAPTER I

INTRODUCTION

Spark-ignition engines are widely used in automobiles, in aircraft, and as marine engines. As the use of the spark-ignition engines has increased, it has become necessary to make changes in the design of the engine, and in the design of the control systems, so as to get the best possible performance for the entire operation range of the engine.

New developments in the fuel control of the spark-ignition engine include new designs of carburetors and fuel-injection methods. The performance of the engine with a carburetor has been satisfactory except for the problems of air-pollution and efficiency. The main difficulty is to maintain a fuel-air ratio for all load and speed conditions that will give best efficiency and complete combustion.

The fuel-injection system offers a more direct control of fuel-air ratio than the carburetor. If the optimum fuel-air ratio can be maintained for each load condition, the engine will operate at high efficiency and less pollutants in the exhaust gases. Since an automobile engine is required to operate at different speeds, different loads, and different ambient conditions, the problem of control becomes very complex.

The engineers of Volkswagen have designed and have in production a fuel-injection system, automatically controlled through an electronic computer (1). The computer maintains a fully controlled and properly metered flow of fuel and air to the cylinders for best performance at all load conditions, and reduces the emission of unburned hydrocarbons and carbon monoxide to such a low level that other antismog devices are not required. It is the purpose of this report to develop the specifications for an electronically controlled fuel-injection system and to explain the design factors of the electronic control unit.

CHAPTER II

EFFECT OF OPERATING VARIABLES ON PERFORMANCE OF SPARK-IGNITION ENGINE

(1) Effect of fuel-air ratio on performance

Although various ratios of fuel and air can be burned in the engine, it is found that a definite ratio of fuel and air is required to obtain maximum mean effective pressure at a given speed. Fig. 1 and Fig. 2 show the effect of fuel-air ratio on brake mean effective pressure, and on brake specific fuel consumption. As the fuel-air ratio is increased (with best spark-timing), brake mean effective pressure is increased. Brake mean effective pressure goes on increasing as the fuel-air ratio is increased, until a point which is near to chemically correct fuel-air ratio point. Beyond this point if fuel-air ratio is increased, brake-mean effective pressure is decreased because combustion of fuel is not complete due to insufficient amount of air and hence optimum release of chemical energy is not obtained (2).

(2) Effect of engine speed on performance

As the speed of the engine is increased, brake horsepower is also increased. Torque is not strongly dependent on the speed of the engine, but mainly dependent on the size of the engine, but as the brake horse is proportional to the product of torque and speed, horsepower is increased as the speed.

Fig. 3 shows the effect of engine speed on brake horsepower, brake specific fuel consumption, brake mean effective pressure, and brake torque (8).