MEASUREMENT OF PRESSURE IN THE SUCTION MANIFOLD FOR DIAGNOSIS OF VALVE DEFECTS FOR FOUR STROKE SPARK IGNITION ENGINES

THESIS

Submitted for the degree of

MASTER OF SCIENCE

BY

GAMAL MOSAAD HENNES

B.Sc. Mechanical Engineering

Ain Shams University

1986

SUPERVISORS

Prof. Dr. ADEL A. EL'EHWANY
Prof. of Heat Engines
Faculty of Engineering
Ain Shams University

Prof. Dr. TAYSEER A. NOSSEIR
Assist. Prof. of Mech. Eng.
Faculty of Engineering
Ain Shams University

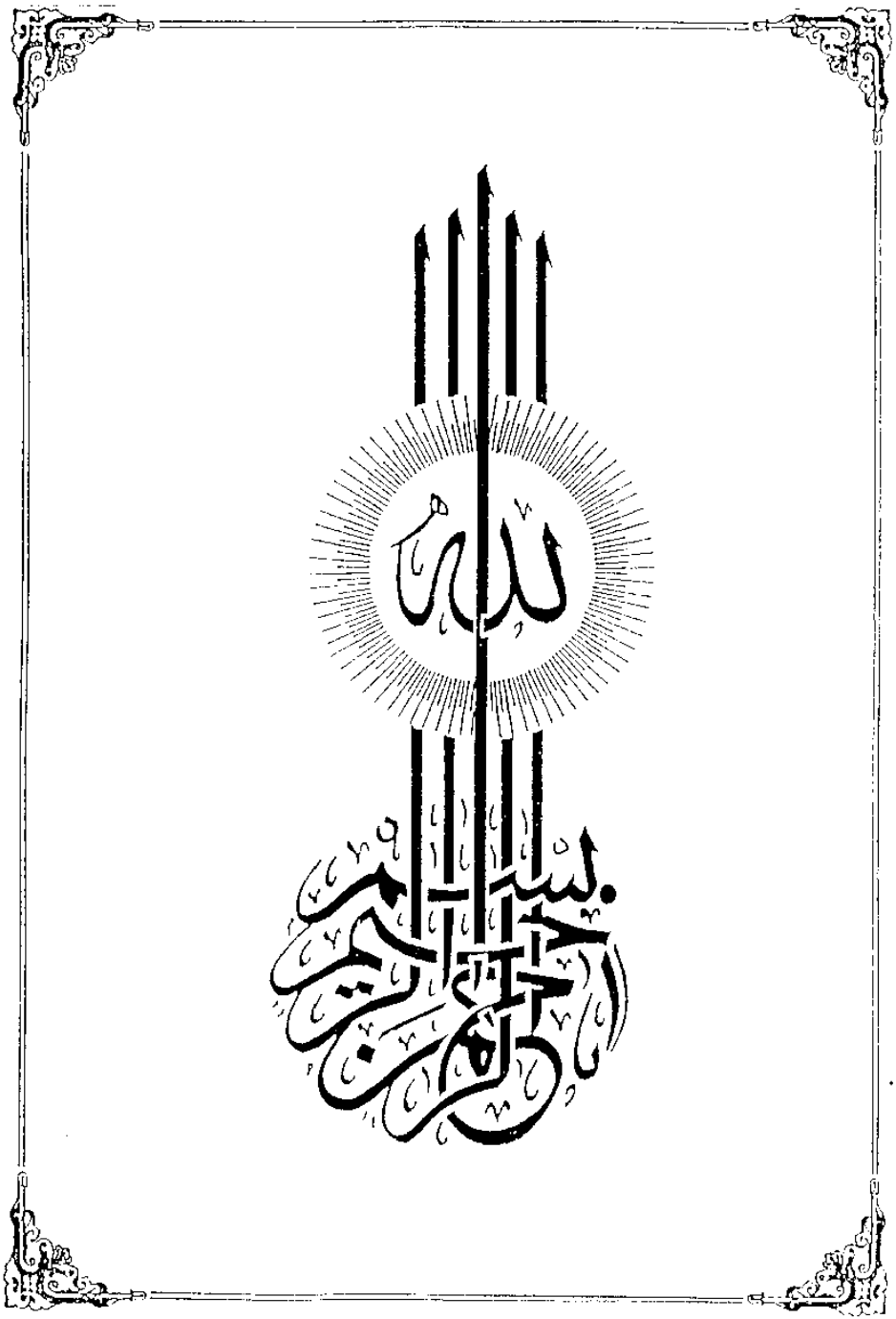
EXAMINERS

Prof. Dr. NASIF M. RAAFAT
Mech. Eng. Dept.
Cairo University.

Prof. Dr. SAMIR M. ABDEL-GHANY
Mech. Eng. Dept.
Ain Shams University

Prof. Dr. ADEL A. EL'EHWANY
Mech. Eng. Dept.
Ain Shams University

Prof. Dr. TAYSEER A. NOSSEIR
Mech. Eng. Dept.
Ain Shams University.



TO

MY WIFE

ACKNOWLEDGEMENT

The auther wishes to express his deepest gratitude to Prof. Dr. Adel El-Ehwany, Prof. of Mech. Eng. Ain Shams Univ., and Prof. Dr. Tayseer A. Nosseir, Assist. Prof. of Mech. Eng. Ain Shams Univ. for their valuable discussion, suggession, supervision and encouragement during the course of the research work of this thesis.

The auther's gratitude is also due to Mr. Abdel-Khalek Hassan and Mr. Wagih L. Azer, for their help in setting up the experimental test rig, as well as all others who have in a way or another, contributed to the successful completion of this work.

The auther wishes to express also his sincere thanks to his parents and his wife whose patience and continuing encouragement contributed a major source of inspiration for him during the whole period of study.

A B S T R A C T

The present work gives a detailed study on the effect of valve tappet clearance and also the state of the valves and valve seats on the performance of the four-stroke spark ignition engines. This was done by measuring the pressure in the suction manifold of the engine by the use of a pressure transducer and a cathode ray oscilloscope. The power of the engine was consumed and measured by a hydraulic dynamometer. The first set of experiments was performed to show the effect of inlet valve tappet clearance on the pressure in the suction manifold. This was made by changing the inlet valve tappet clearance several times. For each value of clearance, the engine was run at different loads and speeds.

A pressure transducer was installed in the suction manifold. The output of the pressure transducer was connected to a cathode ray oscilloscope. The curve which represents the variation of pressure in the suction manifold against crank angle all over the four strokes of the cycle was traced and recorded on photos. By comparing these photographs the effect of inlet valve tappet clearance could be studied.

The second set of experiments was performed when one valve (or both) is defective. This means that leakage occurs through this valve (or valves).

In each case photographs of the pressure trace at various loads and speeds were taken. Again by comparing these photographs, the effect of the state of the valves and the valve seats could be studied. Also, in each case of valve tappet clearance or valve defect, experiments were performed to measure the effective power and torque of the engine as well as its specific fuel consumption at full load.

Mathematical equation which represents the pressure variation with the crank degrees was obtained using the method of curve fitting for the experimental results at the case of standard clearance at certain load and speed.

It is hoped that this equation can predict any malfunction in either valve.

C O N T E N T S

NOMENCLATURE

Symbol	Meaning	Dimensions
A	Area	m^2
A	Constant	-
B	Length	m
C	Valve tappet clearance	mm
D	Diameter	m
K	Constant	-
H	Height	m
N	Engine speed	R.P.M.
n	Constant or ratio	-
p	Pressure	N/m^2
r	Crank radius	m
$(s.f.c.)_e$	Effective specific fuel consumption	kg/kW.hr
u	Velocity	m/s
w	Angular speed	rad/s
V	Volume	m^3
η_v	Volumetric efficiency	-
θ	Crank angle	degree
ϕ	Angle	degree
λ	Angle	degree

Subscripts

m	manifold
s	stroke
i	inlet
p	piston

CHAPTER 1

INTRODUCTION

It is well known that valve tappet clearance in four-stroke engines is an important factor because it directly affects the volumetric efficiency and hence the brake power and fuel consumption of engine. On the other hand, the state of valves and valve seats is also an important phenomena. Any leakage through one valve or more causes a great decrease in power as well as a great increase in fuel consumption. For this reason a periodic check is recommended by all producers of internal combustion engines. As this process is rather difficult and takes a relatively long time, we will try to introduce a modern method to check the valve tappet clearance and how to detect any leakage through any valve of the engine valves.

CHAPTER 2

REVIEW OF PREVIOUS WORK

INTRODUCTION

Little has been reported in the literature concerning the subject of studying the pressure wave in the suction manifold as a means for the malfunctioning prediction of inlet and exhaust valves of engine. All what was reported about valves and manifolds design is concerned with the object of increasing the engine volumetric efficiency and consequently the engine power.

INLET SYSTEM DESIGN

It has long been known that high volumetric efficiencies can be obtained at certain speeds by means of long inlet pipes. The reported effects were due to the inertia and elasticity of the gases in the inlet pipe and the cylinder. According to Taylor[3], the following general characteristics are considered important for inlet system design:

1. Assuming viscosity effects to be negligible, if similar engines have similar inlet systems, the effects of inlet dynamics on volumetric efficiency will

be the same at the same piston speed, other operating variables being held constant.

2. The dynamic pressure at the inlet port at the end of suction stroke is the sum of effects due to standing waves which have been set up in the inlet pipe by previous inlet strokes and the effects of the transient wave set up by the induction process itself.

3. Long inlet pipes with small ratioes of D/B give high volumetric efficiencies at low piston speeds because a high velocity is built up in the pipe toward the end of the induction process and this serves to ram in more air than would be the case with a short pipe. At higher piston speeds, the flow restriction offered by small D/B ratios becomes dominant and volumetric efficiency falls off.

4. Long pipes with large ratios of D/B show max. volumetric efficiencies at intermediate piston speeds because of kinetic energy built up in the pipe. At high piston speeds, the air mass in such pipe is so slow to accelerate, and volumetric efficiency falls off.

5. As pipes become shorter, the maximum gains in volumetric efficiency over the gain with no inlet pipe grow smaller, but the range of piston speeds over which some gain is made tends to grow wider.