شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

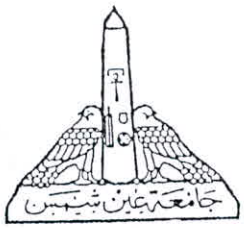
تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

بعض الوثائق الاصلية تالفة

بالرسالة صفحات لم ترد بالاصل



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL POWER DEPARTMENT

DESIGN OF A STIRLING ENGINE USING BLOCK-TYPE HEAT EXCHANGERS

A THESIS

Submitted for the Degree of
Doctor of Philosophy in Mechanical Power
Engineering in The Faculty of Engineering,
Ain Shams University

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Ph.D. Thesis

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Degree	Doctor of philosophy in Mechanical Engineering.
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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Mechanical Power Engineering in the Faculty of Engineering.

The work comprised in this thesis was carried out by the author in the Mechanical Power Engineering Department, Faculty of Engineering, Ain Shams University from April, 1995 to June 1999.

No part of this thesis has been submitted for a degree at any other University

Date 20/11/1999

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ABSTRACT

This dissertation presents the design of a twin-piston, single-cylinder and single-acting Stirling engine. This engine was suggested to be compatible with the alpha-type Stirling machines. A dual bell crank mechanism was suggested to be used in this engine. This mechanism adapted the reciprocation and the synchronization of the two pistons. A kinetic analysis was performed for the mechanism to predict the variation in both expansion and compression spaces with the crank angle. Block-type heat exchangers were introduced as a heater and a cooler. The characteristics of the block-type heat exchangers were found experimentally in terms of heat transfer and pressure drop. A stainless steel woven-screen matrix was introduced as a regenerator.

The engine design rests on a theoretical analysis based mainly on Schmidt theory, where the engine work space was divided into three isothermal regions. The cyclic pressure was calculated from the total mass of the working fluid. The flow rates through the heat exchangers were calculated from the differential equations describing the mass distribution of the fluid in the engine work space. The empirical correlation from the experimental data of the block-type heat exchangers were introduced in the calculations of heat transfer and pressure drop for the fluctuating flow through the heat exchangers.

The main dimensions of the engine were found for its optimum performance. The dimensions of the dual bell crank mechanism were determined to give a stroke length and a phase angle that optimize the engine performance. The optimum phase shift between the two variable spaces is about 100 degrees. The optimum stroke length is about 1.8 times the cylinder bore. The dimensions of the heater, the cooler and the regenerator were selected as well as their materials. The engine power and efficiency were found at different engine speed. Curves showing the variation of the power and the efficiency versus the speed were drawn for four working media, namely, air, nitrogen, hydrogen and helium. The engine speeds for the optimum performance were stated for the four working media.

The dissertation presents also the results of the experimental tests that were carried on a number of block-type heat exchangers. Specimens of different materials (copper, aluminium and stainless steel) and of different diameters were manufactured and tested experimentally. Axial holes of different diameters were drilled and divided either on a single pitch circle or on multiple pitch circles. Air from a blower was heated using an electric heater, and it was cooled by water during its flow through the specimens. Flow rates of both air and water, pressure and temperature measurements were taken by using calibrated measuring instruments. It was found from the experimental tests that, The block-type heat exchangers of small outer diameter are advantageous than the ones of big outer diameter. Empirical correlation for the heat transfer and pressure drop were found to be used in the engine design.