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THREE DIMENSIONAL ELECTROCHEMICAL MACHINING

BY

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1990

بسم الله الرحمن الرحيم

بسم الله الرحمن الرحيم

To my wife

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STATEMENT

This dissertation is submitted to Faculty of Engineering, Ain Shams University for the Degree of doctor of Philosophy in Mechanical Engineering.

The work included in this thesis was carried out by the author in the Department of Design and Production Engineering, Ain Shams University, from May 1984 to November 1990.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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ABSTRACT

The present investigation involves a new trend in dealing with three-dimensional shaping in electrochemical machining. This work considers a new concept of a pointed moving tool.

The objective of the present work is to provide a three-dimensional study for shape prediction of electrochemically machined components using a simple pointed tool.

A detailed theoretical analysis is presented for analyzing the component shape produced by a simple pointed cutting tool moving in space under various controlled motions. Since various complicated motions cannot obviously be investigated, partial motions namely, straight, curved and inclined have been considered.

Experimental and theoretical results were found to be in fair agreement which proves the powerfullness of the proposed analytical model. The results regarding the effect of the electrochemical working parameters on three-dimensional shaping were finally presented in the form of charts to help the production engineer to allocate the suitable working conditions.

SUMMARY

Most of the non-conventional machining processes including electrochemical machining are characterized by the fact that each specific tool would produce a component with only one pre-defined shape and size. In order to obtain a different shape or size a new tool should be designed which becomes a cost expensive procedure.

As a new trend in dealing with three-dimensional shaping in ECM, the present work considers a new concept of a pointed moving tool. A simple tool under the condition of three-dimensional manoeuvering can efficiently solve problems of complicated and tedious tool designs.

The objective of the present work is to provide a three-dimensional study for shape prediction of electrochemically machined components using a simple pointed tool.

A complete local test rig was specially designed to perform the experimental tests. The rig allowed for three-dimensional motion of the tool with respect to the workpiece.

A detailed theoretical analysis is presented for analyzing the component shape produced by a simple pointed cutting tool moving in space under various controlled motions. Since various complicated

motions cannot obviously be investigated, partial motions namely, straight, curved and inclined have been considered.

The analytical study was fully computerized in order to provide the production engineer with useful information regarding shape prediction and accuracy.

Experimental and theoretical results were found to be in fair agreement which proves the powerfullness of the proposed analytical model.

The results regarding the effect of the electrochemical working parameters on three-dimensional shaping were finally presented in the form of charts to help the production engineer to allocate the suitable working conditions.

CONTENTS

NOMENCLATURE

A	Profile equation constant	- -
Aw	Atomic mass of atom	- -
B	Profile equation constant	- -
c	Machining constant	mm^2/sec
C	Profile equation constant	- -
CW	Cutting width	mm
ΔCW	Increase of cutting width	mm
D	Tool diameter	mm
DX	Width of tool diameter strip	mm
e	Cam eccentricity (for circular motion)	mm
f	Tool feed rate	mm/min.
F	Faraday's constant	A.sec/gm equiv.
h	Inter-electrode gap	mm
he	Equilibrium gap	mm
ho	Side gap distance at the tool face (y=o)	mm
hy	Side gap distance at any distance y	mm
I	Consumed current	Amp.
J	Current density	A/cm^2
k	Electrical conductivity of electrolyte	1/ohm.mm
OV	Overcut	mm
Q	Electrolyte flow rate	l/min