DESIGNING AND FABRICATING A SMALL EDM MACHINE

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ABSTRACT*: The main content of this paper concentrates on studying of designing and manufacturing a small- size electrical discharge machining (EDM) machine in order to meet the domestic demands in the field of machining the geometrically complex shape machine elements, hard materials or in case of severe requirements of precision, surface roughness. These above cases can not be performed with the traditional machining processes. Based on the results of studying the working principle of the EDM method, the solutions for automatically controlling the tool electrode, all necessary materials available in vietnamese market, an EDM machine is successfully constructed. This machine includes the mechanical part, the electrical components (pulse generator), automatic control mechanism of tool electrode, pump system, filter, lighting, etc The initial machining operations have been also realized to determine some important technological parameters as well as to evaluate the obtained machining quality of this machine.*

Keywords: *electrical discharge machining machine, EDM, automatic control mechanism*

1. INTRODUCTION

The main components of an EDM machine is described in figure 1. Both the tool usually made of graphite, copper, Cu- Wo alloy and the workpiece electrodes are connected to a DC pulse generator.The vertical feeding motion of the tool is realized with an automatic control mechanism either with the aid of DC motor, DC servo motor or hydralic cylinder etc. When the gap between the two electrodes is small enough, the materials from both the two electrodes will be removed with the creation of sparks and the flow of the dielectric liquid.

A pump system with filter is necessary to circulate the dielectric mixed with the burning particles. In industry, kerosene is commonly used as the dielectric. This one also plays the role of a coolant for the machined area and is an important factor to determine the sparked gap, the machining precision and the wearness ratio of electrodes etc.

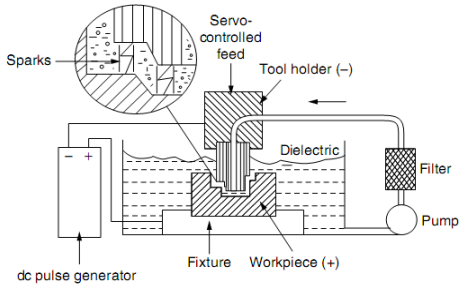

Figure 1. Scheme of EDM method

Electrodes and some other accessories of an EDM machine are represented in figure 2.

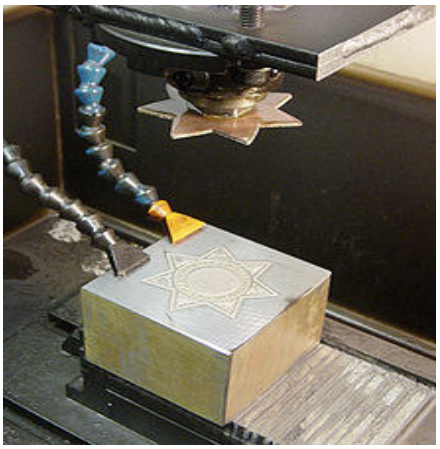

Figure 2. Master at top, badge die workpiece at bottom, oil jets at left (oil has been drained). Initial flat stamping will be "dapped" to give a curved surface. [8]

Nowadays, sinking EDM machines are commonly used all over the world for many industrial applications. Many succesful researches in the field of designing and fabricating EDM machines are continuously obtained.

Some patents form[5] to [12] relating to EDM machines are introduced in references.

Combining with the technique of CNC, rather complex shape can be created on a sinker EDM machine as shown in figure 3

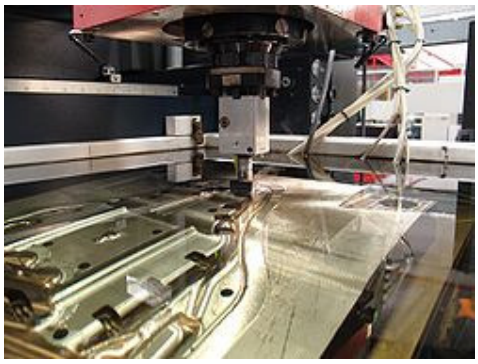

Figure 3. A 3-D complex shaped workpiece machined with a sinker EDM [8]

In Vietnam, many scientific and technical researches have been performed not only in the sector of industry but also in the sector of universities and institutes. Some typical topics can be found in references from [1] to [7].

2. DESIGNS AND OBTAINED RESULTS

2.1. Mechanical Design

The main features of the fabricated EDM machine can be summarized as follows:

- Overall machine dimensions: 800mm x 800 mm x 1500 mm
- Weight: 400 kg, approximatively.
- X x Y x Z = 300 mm x 250 mm x 120 mm

The two translational motions X and Y are manually obtained with the help of a ball screw-nut mechanism. These are motions of the working table that holds the workpieces and fixtures during the machining process.

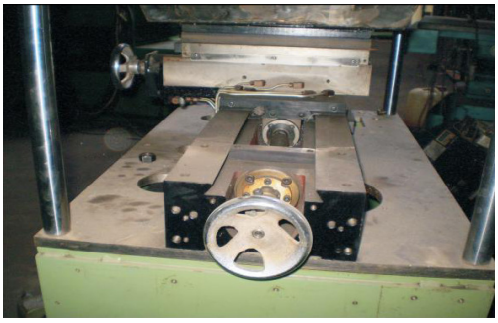

Figure 4 The working table X- Y

The feeding motion or the Z motion of the tool electrode is automatically driven with the presence of a DC print motor and the ball screw-nut mechanism combining with the two linear guides as indicated in figure 5

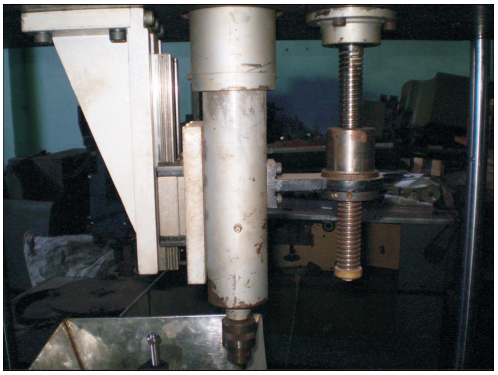

Figure 5 Z-motion mechanism

An additional rotational motion is perform by a DC motor with the belt transmission. This motion is used when necessary. The maximun rotational velocity is of 150 rpm.

2.2. Electrical design and control circuit

The 2 KW pulse generator is designed and fabricated based on the resistor- capacitor type. By changing and combining the values of resistors and capacitors, we can supply different frequencies. The relationship between the obtained surface quality and the machining frequency is expressed as in the Figure 6. The higher the frequency is, the better the surface quality is.

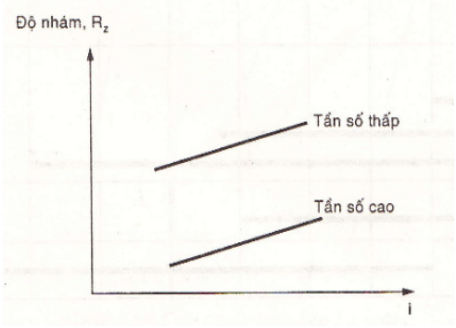

Figure 6 Influence of the machining frequency on the surface roughness [1]

The amplitude of the pulse is also an important parameter.

According to [1], the surface roughness depends on the energy of a pulse and has a profile as illustrated in figure 7

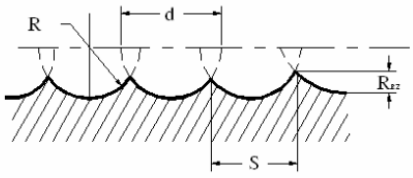

Figure 7. The surface roughness of workpiece obtained by EDM process [1]

A simple solution is chosen for the automatic vertical feeding motion. The tool electrode is driven with the aid of a DC print motor and the OP-AMP circuit illustrated in figure 8

The input signal is the potential between the two electrodes that varies with the spark

gap while machining. This leads to the speed and the rotational direction of the driving motor.

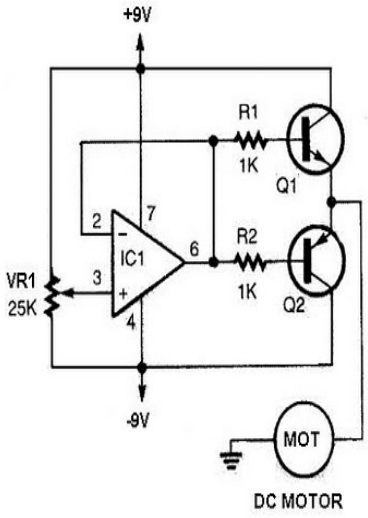

Figure 8. DC motor driving circuit

2.3. Obtained workpieces

Some typical workpieces machined with this EDM machine are presented in figure 9 and figure 10

Figure 9. Copper tool electrodes and machined products

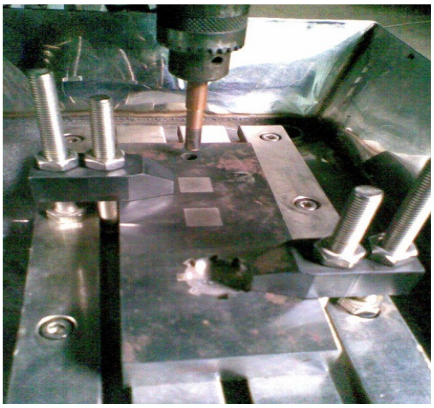

Figure 10. Fixture and the workpieces

3. CONCLUSIONS

A small R-C type EDM machine has been successfully designed and fabricated. Some initial results are obtained to establish the relationship between the surface roughness and the pulse parameters such as frequency, amplitude etc.

Other tests are being performed to investigate the productivity, the wearness ratio of the tool electrode with various materials. The machining precision is also our concern.

In the near future, a transistor type pulse generator will be studied and fabricated.

THIẾT KẾ CHẾ TẠO MÁY TIA LỬA ĐIỆN LOẠI NHỎ

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TÓM TẮT*: Nội dung chính bài báo tập trung vào việc thiết kế chế tạo một máy gia công tia lửa điện nhằm đáp ứng nhu cầu trong nước về lãnh vực gia công các chi tiết máy có hình dáng hình học phức tạp, hoặc độ cứng vật liệu chi tiết cao, hoặc có yêu cầu cao về độ chính xác, về độ nhẵn bề mặt. Với các trường hợp trên, ta không thể gia công bằng các phương pháp gia công cơ truyền thống. Dựa trên các kết quả nghiên cứu về ngyên lý gia công tia lửa điện, các giải pháp điều khiển tự động điện cực dụng cụ, các loại vật tự hiện có ở thị trường Việt nam, một máy gia công tia lửa điện đã được chế tạo thành công.Máy này gồm có phần cơ, phần điện (bộ phát xung), phần điều khiển tự động điện cực, hệ thống bơm, lọc, chiếu sáng v.v…Các quá trình gia công EDM ban đầu cũng đã được thực hiện để xác định vài thông số công nghệ quan trọng cũng như đánh giá chất lượng gia công đạt được của máynày*

Keywords: *electrical discharge machining machine, EDM, automatic control mechanism*

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