FORMING CAVITIES IN SAMPLES BY APPLYING A MAGNETIC SHOCK

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Abstract

The papers focuses on the formation of cavities in metal samples. The main parts is the results of experimental work, which are presented in the form of summarized knowledge about the process of forming cavities. Lead plates were used as samples, into which the shapes of punches with apex angles of 60° an 90° were pressed. The experimental work was performed using a magnetic shock application. The actually used experimental equipment for laboratory work is also presented. The aim of the paper was mainly to verify the possibilities of applying a special tool in the formation of cavities in metal samples.

Keywords: Forming, magnetic shock, experimental equipment, indentation

1. INTRODUCTION

For several decades, forming technology has occupied a leading position in engineering technology (production), the main advantage of which is the considerable savings of materials, which, in the current pressure to green production (in general and worldwide), prove to be very suitable and appropriate. Another advantage of forming is its relatively easy automation of processes. The great importance of forming technology is also that it allows a substantial increase in labour productivity. However, the application of new knowledge to production and the use of the advantages of forming technologies depends on the correct design of forming tools. It should be noted that for a long time, ways have been sought that would be able to bring this technology into the sphere of piece and small series production. Forming in this case takes place mainly in the so-called non-rigid tools, by which are meant such forming tools, the construction of which takes into account the use of new solutions based primarily on physical knowledge. This minimizes production costs and shortens production preparation time. The very way of the presented sphere belongs to the spectrum of unconventional technological processes of forming. The necessary knowledge is given in the contribution [1] and monograph [2].

2. THE POSITION OF MAGNETIC FORMING IN THE WORLD

When creating the theoretical part of the paper, I used several stimulating papers in the field of magnetic forming, which, however, I cannot analyze in detail due to lack of space. The most important sources are listed in the bibliography. This concerns in particular the shaping of the sheet by means of a magnetic field, as well as the possibility of creating hemispherical cavities in metal samples [1]. In his monograph [2] he pointed out the shaping of sheet metal in various conditions and in an open magnetic field.

The selection of contributions and publications can be done strictly selectively, which would probably be at the expense of the presented area, but it can also be done taking into account not only the contributions in magazines, but also book publications. I followed this more comprehensive overview. [3-11].

3. DESIGN AND CONSTRUCTION OF EXPERIMENTAL EQUIPMENT

In **Figure 1** is a construction diagram of an experimental apparatus for performing experiments [1].

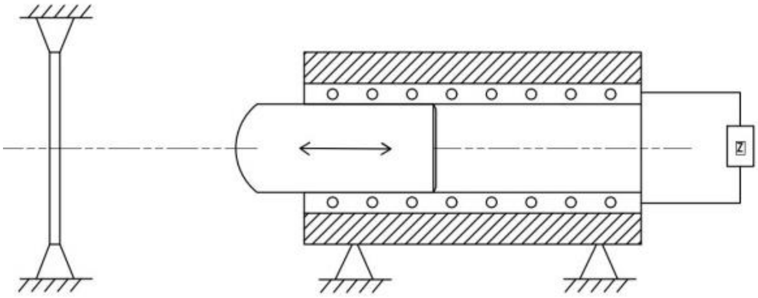

Figure 1 Scheme of free core magnetic field forming

3.1. Electrical circuit

An important part of the experimental equipment is the electrical circuit, where a magnetic field (pulse) is created which forms the experimental material. In **Figure 2** a circuit consisting of a relay, a source and a switch is used. The circuit diagram used in the experiments is shown in **Figure 3** and this has proved its worth in the research carried out [1,2,12].

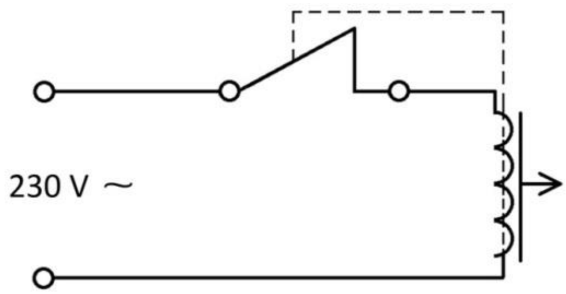

Figure 2 Schematic of magnetic pulse forming

The circuit used is shown in diagram number 2. Calculations of the movement of the punch (core) in the solenoid cavity are described in [12].

3.2. Samples

Lead samples of square shape with dimensions 35x35 mm with a thickness of 7 mm were used as samples. The number of samples was seven for each punch.

4. EXPERIMENTS

Experimental work was performed on the device itself presented in **Figure 3**. Two types of punches with apex angles of 60° and 90° were applied.

Figure 3 Really used equipment in experimental free core forming

4.1. Experimental results

The results obtained in the experiments with the application of the free core (punch) show that such a shaping method is suitable for several reasons. The first is the speed of the process, when the work itself is a period of time expressed in hundreds of seconds. In this case it is 0.03 s. The second advantage is from the point of view of easy automation when using this type of forming. Analysis of the results in **Table 1** shows that this is a relatively accurate and stable process, as the difference between a maximum value of 1,978 mm and a minimum value of 1.718 mm is 0.26 mm at an indentation diameter. The difference between the maximum value of 1.638 mm and the minimum value of 1.389 mm is 0.249 mm for the penetration parameter. The values can be assessed as balanced and stable. The angle of the cavity is 61.18 ° for all samples. This parameter confirms that the magnetic impact forming process is suitable for this type of work.

Table 1 Experimental results for a 60° apex punch

Sample number	Identation diameter (mm)	Penetration (mm)
1	1.718	1.389
2	1.978	1.606
3	1.966	1.627
4	1.852	1.506
5	1.866	1.576
6	1.820	1.638
7	1.780	1.620
8	1.810	1.546
9	1.840	1.458
10	1.855	1.488

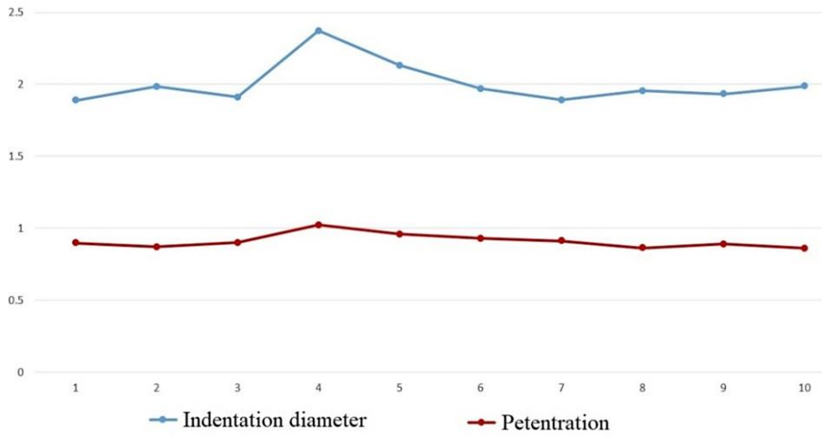

Figure 4 Graph according to **Table 1**

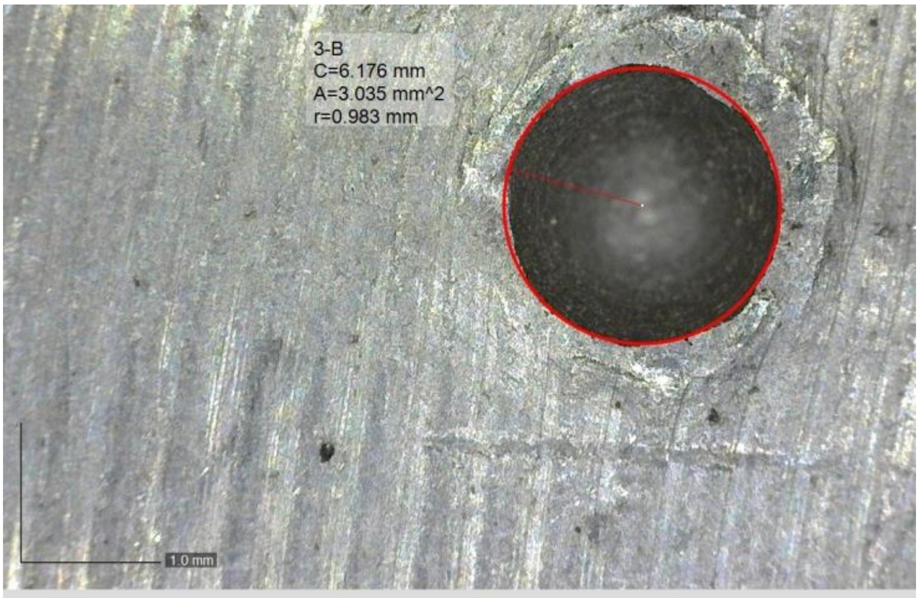

Figure 5 Photograph of the sample with apex angle 60°

Table 2 Experimental results for a 90° apex punch

Sample number	Identation diameter (mm)	Penetration (mm)
1	1.888	0.896
2	1.984	0.869
3	1.910	0.898
4	2.372	1.022
5	2.130	0.958
6	1.968	0.928
7	1.890	0.910
8	1.955	0.862
9	1.931	0.890
10	1.986	0.860

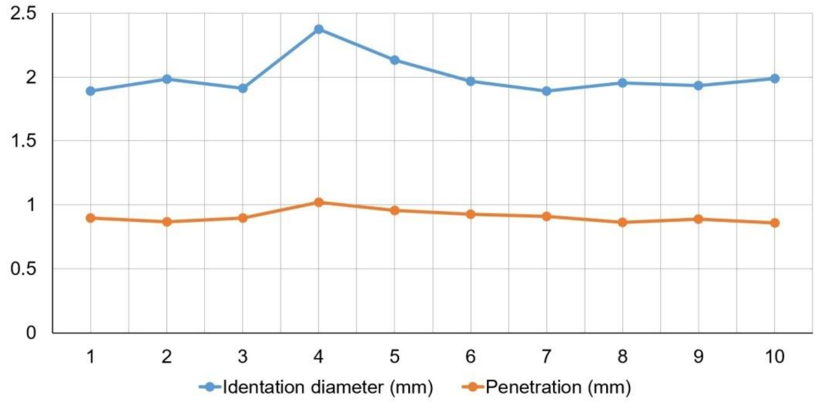

Figure 6 Graph according to **Table 2**

The analysis of the results from **Table 2** also shows in this case that this is a relatively accurate and stable process. The difference between the maximum value of 2.3728 mm and the minimum value of 1.888 mm is 0.484 mm at the indentation diameter. The difference between the maximum value of 1.022 mm and the minimum value of 0.860 mm is 0.162 mm for the penetration parameter. The values are balanced and stable. The cavity angle is 90.92° for all samples, which confirms that the magnetic impact injection process is also suitable at this penetration angle.

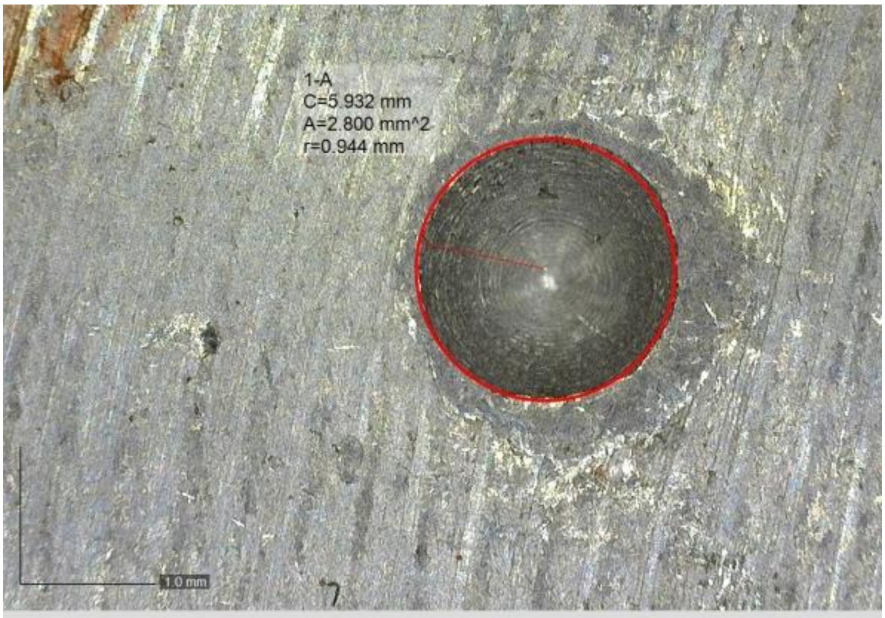

Figure 7 Photograph of the sample with apex angle 90°

Note: The figures in the samples show the radii due to the design of the measuring device, which calculates the diameter. he measuring devices used were: a Dino-Lite measuring microscope and a Micro-Hite 600 3J00 1512 device.

5. CONCLUSION

In the presented paper, attention was focused on the use of magnetic phenomena in the technology of production of cavities in metal samples. The objectives of the paper can be assessed as achieved and met. The published device ensured the performance of experiments on the formation of cavities in samples. The laboratory experimental solution showed the way in which physical knowledge can be conveniently applied in industrial production. It has been confirmed that a relatively simple solution with the application of a magnetic field will ensure accurate, fast and high-quality formation of cavities in metallic materials. The results obtained also confirmed the suitability of this solution for application in the production process. The creation of cavities is one of the most important works in the production of e.g. hollow instruments. The implementation of this type of work combines several advantages: production speed, accuracy, very good final quality of cavities and also good reproducibility of results. The described solution complements and also expands the sphere of volume forming. It can be added that working with a free kernel is simple and reliable. The published results in the text of the paper will certainly be a good basis for further research work in this area.

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