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THE MEASUREMENT OF THE CUTTING FORCE AT GRINDING A HELICAL SURFACE

Alexandru MICACIU, Ioan Gheorghe VUŞCAN, Radu Mircea MORARIU-GLIGOR

Abstract: *The sharpening of the cutters with helical profile is conducted by grinding the cutting faces. The sharpening can be conducted on grinding machines especially built for this purpose or on grinding machines with the help of special devices. Knowing the value of the forces that occur in the cutting process is very important. A method for measuring the cutting force at grinding is presented in this paper.*
Key words: *device, cutting force, grinding.*

1. INTRODUCTION

Sharpening mills consists in rectifying the tool face grinding, with the purpose of obtaining an appropriate geometry and smoothness of the surface.

The sharpening is performed on universal or special grinding machines or on grinders with the help of special devices.

Universal grinding machines perform the sharpening of a wide variety of cutting tools, such as: mills, drills, taps, reamers, knives. They are manufactured in many constructive versions, but all types have the same components.

Currently, universal grinding machines are used internally in industrial practice, machines that are manufactures at U.M. Cugir Mechanical Plant or at U.M. Plopeni.

The draft of a UAS 200 grinding machine made at Cugir Mechanical Plant is presented in Figure 1.

The universal grinding machine is composed of: 1 - frameworks; 2 – transversal frame; 3 – table support; 4 – machine table; 5 – tilting table; 6 – machine column; 7 – wheel head; 8 – main shaft; 9 - footstock; 10 –splitter; 11 - device for rectifying abrasive bodies [2].

Also, the current trend is to manufacture universal grinding machines with numerical control (CNC).

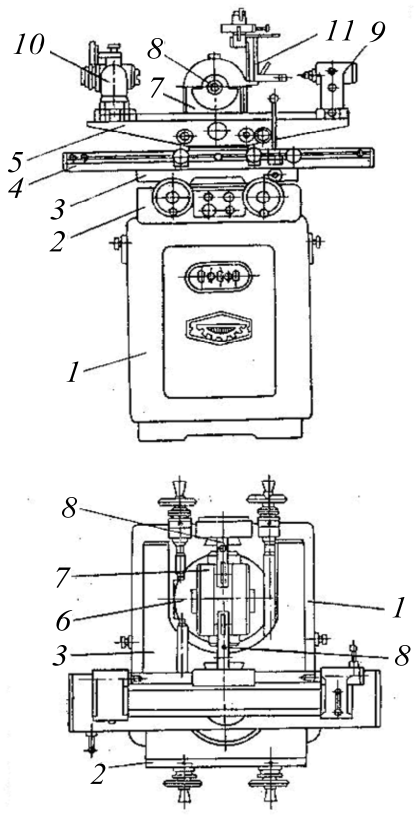

Fig. 1. UAS 200 Universal grinding machine

From the kinematic point of view, these machines are similar to universal grinding machines but with an improved and simplified construction by using the numerical control.

The kinematic couplings of screw and nut type offer the advantage of rigorously keeping the helical parameters constant, but ensures only one value for the helical parameters, and therefore a reduced flexibility, justified only for large scale productions.

Thereby, devices with a high level of flexibility for grinding the helical surfaces, with a large variety of steps common at proper sharpening and smoothing of grinding machines are required.

Companies recognized in the field of machines used for grinding tools have created devices for grinding helical top surfaces, such as the one presented in Figure 2.

Fig. 2. Universal Spiral Grinding Unit UFS 155, made by HALLER GmbH, Werkzeungsschleifmaschinen, Germany.

2. MATHEMATICAL MODEL

During the grinding process due to the contact between the abrasive disc and the surface of the part to be grinded a force called **cutting force** occurs.

The modulus of the cutting force is influenced by the cutting depth, by the displaced volume flow at grinding, by the material hardness and by the abrasive disc characteristics.

A grinding device for helical surfaces adjustable on face grinders made at S.C. U.M Cugir S.A. is presented in what follows.

A high precision concentric jaw chuck was mounted in order to determine the cutting force.

The operating principle of the grinding device for helical surfaces with adjustable step and tilting slider is presented in figure 3.

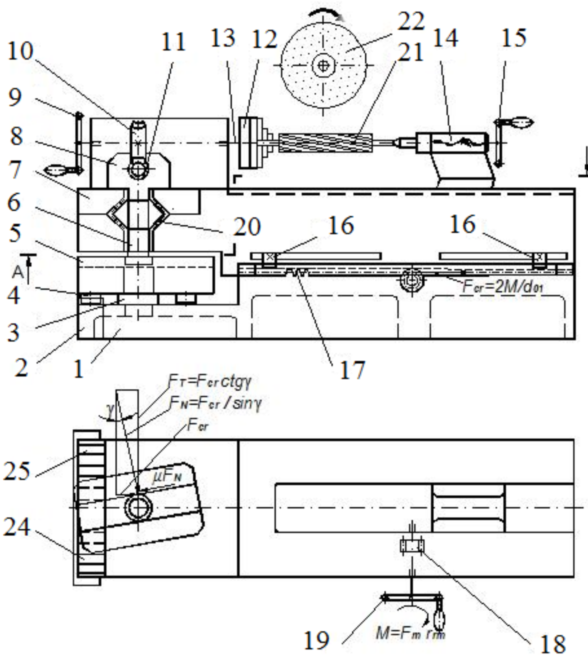

Fig. 3. The operating principle of the grinding device for helical surfaces with adjustable step and tilting slider

The manual moment, developed by the operator for the device actuation, is given by:

$$M = F_m \cdot r_{rm} \quad (1)$$

where: F_m is the manual force of actuating the device; r_{rm} is the radius of the device hand wheel (figure 3).

The force F_{cr} ,that appears in the rack, due to the manual moment *M*, is calculated:

$$F_{cr} = \frac{2 \cdot M}{d_{01}} \quad (2)$$

where, $d_{01} = z \cdot m$ is the index diameter of the pinion that actuates the rack.

The rack drives the tilting slider to a γ angle.

The normal force that acts on the sliding block is given by:

$$F_N = \frac{F_{cr}}{\sin \gamma} \quad (3)$$

with the components: $F_T = F_{cr} \cdot ctg\gamma$, that actuates the spiral wheel and F_{cr}, that actuates the slider.

3. DEVICE PRESENTATION

The grinding device for helical surfaces with adjustable step and tilting slider is illustrated in figure 4.

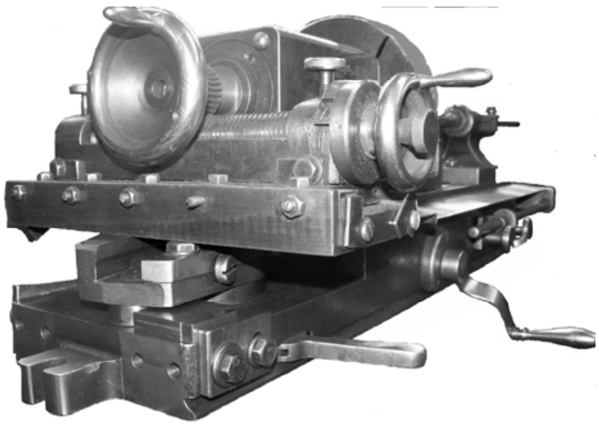

Fig. 4. The grinding device for helical surfaces with adjustable step and tilting slider

The tool that is about to be sharpened is mounted between the tips. Using the handle the displacement of the longitudinal slide of the mechanical system is conducted. The longitudinal slide, actuated in a translation motion also displaces the crosshead slipper guide, adjusted to a γ_w angle . Due to the longitudinal displacement of the crosshead slipper guide, the crosshead slipper joint with the longitudinal slide will displace the transversal slide and also the worm geared with the spiral wheel. Therefore, the worm will spin the spiral wheel and the tool, resulting a helical motion by combining the translation and rotation motion. The indexing may be carried out using the faceplate in order to sharpen all tool teeth. Using the hand wheel the cutting depth can be adjusted when sharpening the tool.

For measuring the cutting force at grinding on the device previously described a measuring system based on a TCRT 5000 optical-electronic transducer (figure 5) was used.

This transducer is made out of an infrared LED combination (940 nm) and a photistor with a visible light filter mounted at a 5 degree tilting angle.

The measuring draft is presented in figure 6.

The LED diode is fed at a constant voltage so that the emitted luminous flow does not have any variations.

The luminous flow reflected on the surface of the elastic part of the transducer is received by the photistor which is placed in the same housing as the LED and transforms the intensity of the luminous flow in electric current proportional to it.

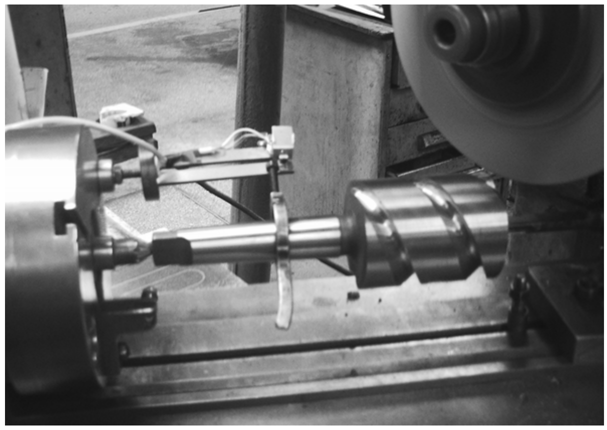

Fig. 5. The use of the TCRT 5000 optical-electronic transducer for measuring the cutting force

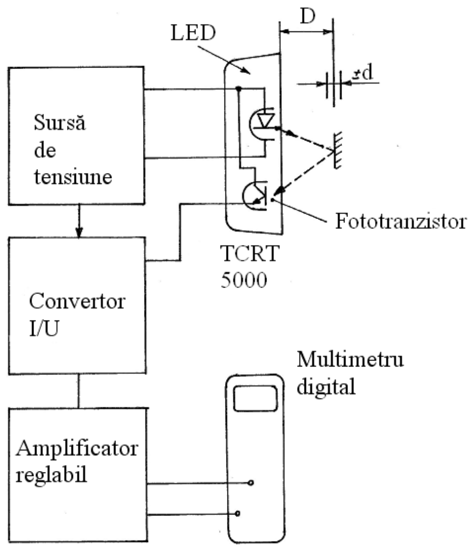

Fig. 6. Measuring draft

The amplified electric current is measured using a digital multimeter previously calibrated in force units. Thus the value of the cutting force is obtained in every moment.

4. RESULTS

After conducting a series of measurements, an optimal positiona has been reached, so that by dimensioning the electronic draft of measurement, a proper sensitivity is acquired in order to obtain conclusive measurements.

This led to conducting the measurements using a sensitivity of 1000 mV/15N.

An example of obtained results is presented in what follows.

	X	Y
1	0	0
2	0.05	1.02
3	0.10	3.04
4	0.15	8.49
5	0.20	14.24

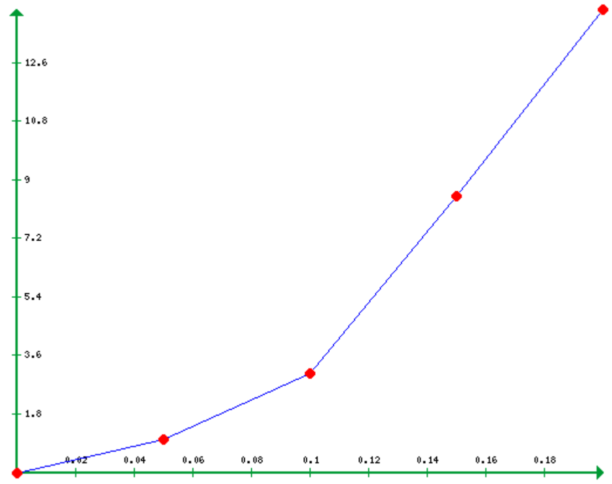

Fig. 7. Measurement results

In figure 7, X represents the cutting depth value measured in **mm**, while Y represents the cutting force measured in **N**.

5. CONCLUSION

The aim of the conducted measurements was to verify the functionality of the device made for grinding the helical surfaces of the cutting tool and also to establish the technological parameters required for its operation.

The device was consistent with the purpose of its manufacturing, but some small constructive changes were required in order to be used.

The values for the feed and the cutting/chipping depth were established in order to identify the optimal working conditions.

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6. REFERENCES

[1] Enache, Ş., Minciu, C. *Tehnologia sculelor aşchietoare, Vol. 1*, Editura Tehnică, Bucureşti, 1987.

[2] Brândaşu, P., Muntean, A., Cenuşă, D., *Scule aşchietoare* – Îndrumar de laborator – Facultatea de Mecanică, Sibiu, 1987.

[3] Hollanda, D., M., Mehidenţeanu, M. ş.a.: *Aşchiere şi scule aşchietoare*. Editura Didactică şi Pedagogică, Bucureşti, 1982.

MĂSURAREA FORŢEI DE AŞCHIERE LA RECTIFICAREA UNEI SUPRAFEŢE ELICOIDALE

Abstract: *Ascuţirea sculelor aşchietoare cu profil elicoidal se realizează prin rectificarea feţelor de aşchiere. Ascuţirea poate fi realizată pe maşini de ascuţit special construite sau pe maşini de rectificat utilizând dispozitive. Cunoaşterea valorii forţelor din procesul de aşchiere este foarte importantă. În lucrare se prezintă o metodă de măsurare a forţei de aşchiere la rectificare.*

Alexandru MICACIU, Eng., amicaciu@yahoo.com, Home Address: Ciocîrliei nr. 8, Cugir, Jud. Alba, Home Phone: 0737030532.

Ioan Gheorghe VUŞCAN, Professor, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, Gheorghe.Vuscan@tcm.utcluj.ro, 0264 - 401600.

Radu Mircea MORARIU-GLIGOR, Lector, Technical University of Cluj-Napoca, Department of Mechanical Engineering Systems, Faculty of Machine Building, rmogli70@yahoo.com, Arieşului 102/107, Cluj-Napoca, 0743 - 120463.