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THE „SPRT“ MILLING CUTTER BASED ON SELF-ROTATING BLADES

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Abstract

Attempts to adapt new methods of machining with the use of self-rotating circular knives (SPRT) can also be noted in wood processing. Manufactured by companies such as: Lockheed Corporation, Rotary Technologies Corporation or Pokolm Frästechnik GmbH & Co. KG. and can be used in a variety of applications. Intensive tests have been carried out on the possibility of using such tools for turning wood [9,12,13,14,15]. Currently, American companies have developed tools for metal milling operations based on self-rotating disk tools. The stage of commercial applications of rotary tools began at the turn of twenty and twenty first century - around 2000. Intensification of work on SPRT tools was fostered by the need for efficient and good quality material processing. Adaptation of new rolling methods using self-rotating pulleys (SPRT) can also be noted in wood processing [10, 11, 12, 13]. So far, the use of this type of tools for turning wood has been extensively studied [12,16]. Currently, work is underway on the use of self-rotating blades of heads for leveling wood surface treatment [9,10,16], which is the subject of this report.

Key words: *milling head, SPRT tools*

INTRODUCTION

In the eighties of the twentieth century, the airline company Lockheed Corporation and, the airline company Lockheed Corporation in cooperation with tool companies Rotary Technologies Corporation has developed tools with rotary plates for milling operations. At the same time, the progress in the sciences on structural materials, and the technological capabilities of modern CNC machine tools gave the possibility to produce milling tools for industrial applications, e.g. at Rotary Technologies Corporation or Pokolm Frästechnik GmbH & Co. KG. The working principle of the SPRT tool with the self-rotating blade is illustrated in Fig.1

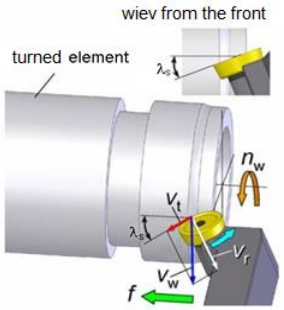

Fig1. Working principle of the SPRT tool with a self-rotating

In recent years, together with the progress in the production of metal materials, increased interest in new tools for their treatment can be observed. This applies to SPRT self-rotating tools: Self Propelled Rotary Tools [2,6,8]. The interest in SPRT tools also gave an impulse for conducting tests, on the possibility of switching to this type of machining in wood

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processing [1,4,5,6,7,9,11]. This is justified because in the woodwork the circular knives have been used for a long time, but fixed. The edges of the blades gave the opportunity to effectively extend the working time - longer cutting edge compared to flat blades [9, 10, 11].

TOOLS WITH SELF-CUTTING BLADES -SPRT

The automatic rotation of the knife during the machining process appears under the influence of friction forces that appear at the point of contact of the side surface of the tool and the surface being worked. In the case where the angle $\lambda = 0°$, the knife does not rotate during machining, but when the angle $\lambda \neq 0°$, a significant contribution to the self-revolving knife has the friction of the mobile chip on the rake face. The dependencies on the form given in the literature [3,6,7,8,9] indicate that the rotational speed of the knife v is directly proportional to the cutting speed v and the inclination of the cutting edge λ.

Thus, when the inclination of the edge λ increases, the rotation speed of the knife v0 also increases. The working principle of the SPRT tool is shown in Fig.1. SPRT - Self-turning tools are characterized by a multiple increase in edge strength compared to fixed edges - blades. They are also characterized by a significant reduction in temperature in the area, by constant change of cutting edge position / blade rotation [2,3,11] and an increase in blade life as compared to tools with fixed blades. Also the possibility of using replaceable blades is a big advantage of this type of solution.

This is particularly evident in the tendencies of constructing tools with blade replacement blades more resistant to blunting [9,10,11,12]. The described features of these tools enable effective solving of problems related to machining, eg [1-3, 7-11]. The principle of SPRT operation is shown in Fig. 1. Research using the SPRT tool was carried out using the experience gained during the research of tools with a self-tapping blade for turning wood. A knife made of steel 45 with a rotating blade with a diameter of 20 mm was used. [Figure 2].

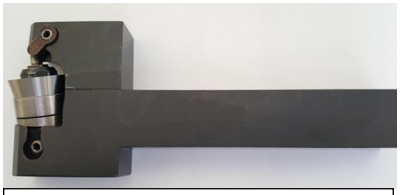

Fig.2. Wood turning knife with self-rotating blade

HEAD "SPRT" FOR ALIGNING FLAT SURFACES

In order to check the possibility of using a tool with self-rotating cutting inserts for milling wood planes, it was decided to use the existing milling cutter head made by Rotary Technologies and adapt it to the cutting conditions of wood.

As part of the unconventional research of cutting tools, it was decided to make a milling head with a set of four self-turning disk tools for leveling planes. Its design was inspired by solutions used in metal cutting tools.

Fig.3. Standard milling head based on self-rotating blades

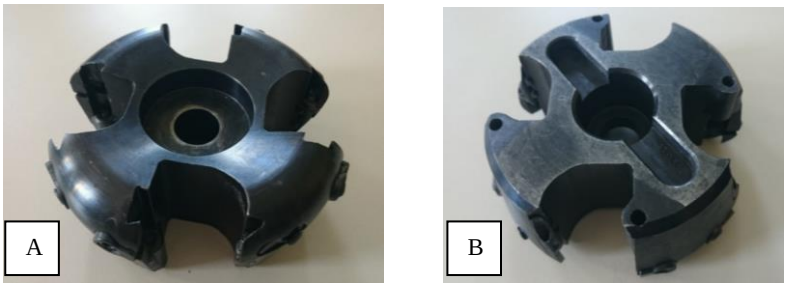

Fig.4. Head body a) top view, b) bottom view

The head body is a thick ring with four sockets to attach the blades. In the middle a hole for fixing the head on the spindle. Trapezoidal grooves leading cartridges with rotating blades are milled in each slot, which need adjustment in order to obtain the appropriate angle "λs". In addition, in the side walls there are mounting elements for the cassettes and fixing their position.

The blade of the circular knife was made in accordance with the dimensional specification of Fig.3. as rolling bearings with adjustable position of the center of the blade by twisting the tool part (blade).

Fig.5. Milling head with self-rotating

Experiments have shown that at selected angles "λs", the tool works in a smooth and stable manner [9,10,11]. The selected angular parameters of the circular knife are shown in Fig.3. SPRT tools are shown in Fig.4.

Fig.6. Construction of self-rotating SPRT tool blades

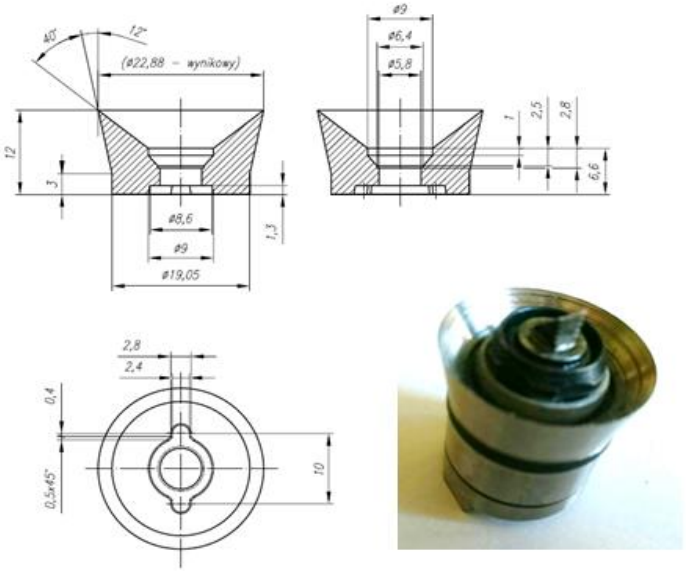

Fig.7. The dimensions of the milling head cutting insert and its view in the toolbox

The cutting inserts are made of a tool steel with a cutting angle adapted to wood processing, i.e. 40 ° in accordance with Fig. 7. Recesses in plates took the form of a bowl which can be seen in the drawings. This resulted in a smooth chip passage through the tool insert. The insert was subjected to a cutting insert, while clamping inserts with needle bearings allowing the movement of the blades. The model of inserts is shown in Fig. 8.

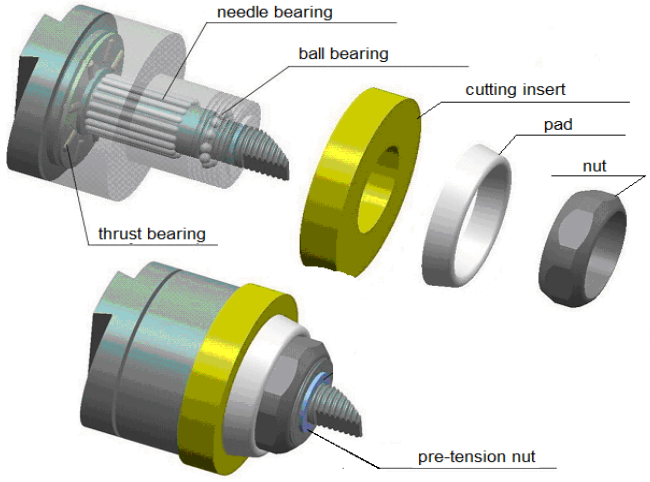

Fig. 8. Insert model used in the construction of SPRT tools

Similar to the Mitsubishi Carbide turning tool [8], the cartridge has a needle and thrust bearing, and the entire system is pre-tensioned by the nut. It presses one more ball bearing against the wall of the rotatable element on which the cutting insert is positioned (Fig.8). The milling cutter was machined into a modified milling head. For the head drive, a metal

milling machine was used on which table, the processed wood samples were fixed, as illustrated in Fig. 9.
Despite the relatively small head revolutions, very good surface alignment was achieved.

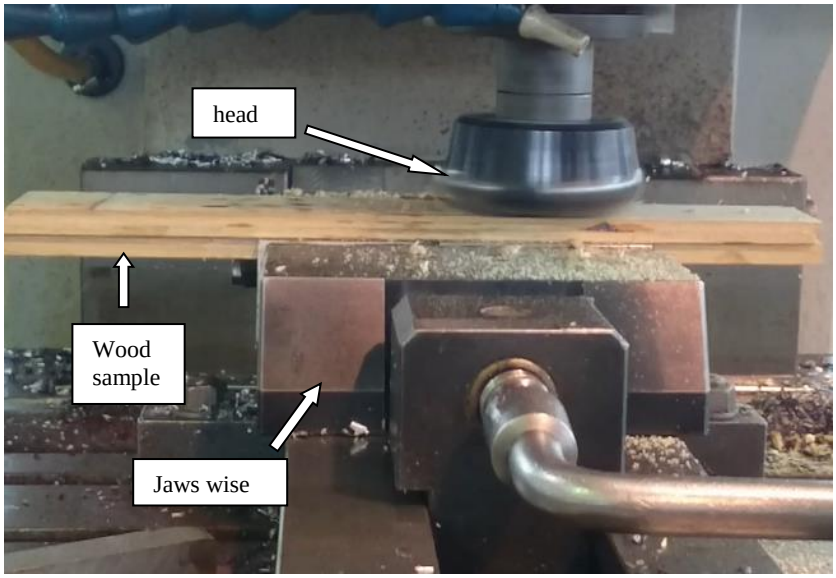

Fig.9. Stand for woodworking trials with a self - rotating blade

CONCLUSIONS

A tool with blades was designed based on the presented head. Typical inserts and body were used. Preliminary tests based on a metal milling machine were performed to obtain satisfactory results. It is planned to use a variety of cutting inserts in terms of geometry and to test their impact on the quality of machining. When machining, it depends on many factors related to the blade geometry, cutting parameters and grade and the moisture status of the wood being processed. It is planned to modify the clamping system of the blades in the cartridge to ensure better flow of chips during machining. The design and manufacturing technology of rotary tools for wood milling is much more difficult than conventional tools. The problems concern especially the bearing nodes, the selection of material for the components of the tool and the accuracy of the individual elements of the tool.

REFERENCES

[1] CIELOSZYK, J., ZASADA, M.: *The Self-Propelled Rotary Tools-Future Conception In Metal Cutting?* The 15th DAAAM International Symposium Intelligent Manufacturing & Automation: Globalisation - Technology - Men - Nature" 3 - 6th November 2004, Vienna, Austria 2004, pp. 075-077.

[2] CHMIELEWSKI, K., CIELOSZYK, J., ZASADA, M.: *Narzędzia z obrotowymi płytkami skrawającymi – możliwości technologiczne i efekty stosowania,* Konferencja naukowo-techniczna TPP2006, Projektowanie Procesów technologicznych" Komisja

Budowy Maszyn PAN, Politechnika Poznańska, ISBN 978-83-903808-7-2, Poznań 2006, pp. 85-92.
[3] DESSOLY V.: *Modeling and Verification of Cutting Tool Temperatures in Rotary Tool Turning of Hardened Steel*, Georgia. Georgia Institute of Technology, April 2004
[4] DABADE, A., JOSHI, S.S., RAMAKRIHNAN N.: *Analysis of surface roughness and chip cross-sectional area while machining with self-propelled round inserts milling cutter*. Mechanical Engineering Department, Indian Institute of Technology, Vol.132, 2003.
[5] GRZESIK W*.: Podstawy skrawania materiałów konstrukcyjnych.* Warszawa WNT 2010, 527
[6] KARRI, V.*: Fundamental Studium of Rotary Tool Cutting Processes*. Ph.D. Thesis, The University of Melbourne, 1991
[7] KAUSHIKKUMAR, M., PATEL, G., SUHAS, S. Joshi, S.: *Mechanics of machining of face-milling operation performed using a self-propelled round insert milling cutter*, Journal of Materials Processing Technology Vol.171, pp 68–76, 2006.
[8] MITSUBISHI CARBIDE, *Rotary Holder*. LJ383B, Mitsubishi Materials Corporation 2000.
[9] PILC, J., ,MICIETOVA, A.: *Obrabanie kovov autorotujucimi nastrojami*. Žilina 2003.106.
[10] UDAY A., DABADE S., JOSHI S., RAMAKRISHNAN N.: *Analysis of surface roughness and chip cross-sectional area while machining with self-propelled round inserts milling cutter*, Journal of Materials Processing Technology, Vol. 132, No 1-3, pp. 305-312, 2003.
[11] VASILKO: *Teória a prax trieskového obrábania.* Presov. 2003.
[12] WIELOCH G., OSAJDA M.: *Construction of self-propelled rotary tool (SPRT) for wood turning*. Annals of Warsaw Agricultural University – SGGW, Forestry and Wood Technology, Warsow 2007, No 66, 405-408.
[13] WIELOCH G., OSAJDA M., MOSTOWSKI R: *Narzędzia do toczenia z samoobracającymi się płytkami i ich zastosowanie przy skrawaniu drewna*, Obróbka Skrawaniem, Innowacje, IOS Kraków 2008, 408–416.
[14] WIELOCH G., OSAJDA M., JAVOREK L., ZASADA M., CIELOSZYK J., CHMIELEWSKI K.: *New idea in construction and performance of turning rotary knife”*, Annals of Warsaw university of life sciences – SGGW, Forestry and wood technology No 72, 2010, 433-437.
[15] WIELOCH G., OSAJDA M., DZURENDA L.: *Wpływ kąta pochylenia głównej krawędzi skrawającej noża samoobrotowego w toczeniu drewna na wielkość powstających wiórów.* Szkoła Obróbki Skrawaniem, 2011. Nr 5, Opole.
[16] WIELOCH G., PORANKIEWICZ B., CIELOSZYK J., FABISIAK B.: *New solutions of “SPRT” tool constructions for wood surface equalizing by face milling method.* Annals of Warsaw University No 98, 2017, 143-147.
http://www.rotarytech.com/ juni 2017