MILLS FOR WOODEN CORRECTION PLUGS

Gheorghe Gutt[1], Sonia Amariei[1], Ştefan Beşliu[1], Alexuc Cristian - Florin[2]

[1] Stefan cel Mare University Suceava, e-mail g.gutt@fia.usv.ro
[2] Aquaterm SRL Botosani

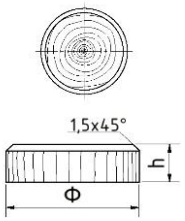
Abstract: *Two wood cutting tools used for milling, in a single step, of the wooden correction plugs intended in turn to replace the black nodes in the timber for the purpose of its increased aesthetic value, are presented. Both milling cutters perform simultaneously in both timber side of the disc, obtained from the branches of trees from the same species of wood with the timber to be ennobled, and the bevel milling at 1x45^0 of a parallel plane side of the disc. First described is a milling cutter with several cutting knives to obtain plugs intended for the correction of a certain diameter, but four different thicknesses of the raw wooden discs with shell. The second milling cutter described is an universal one, with only one cutting knife, intended to obtain the correction plugs of various diameters but with a single thickness of the raw wooden shelled discs.*

Keywords: *mills, black nodes, correction plugs*

1. Introduction

The replacement of black nodes in timber is an increasing in value operation used in the furniture industry and decorative wood elements. After finishing by shaping and grinding, of surfaced timber with plugs correction, it acquires a new quality and a new price. The non-estetic black nodes are removed from one side of the timber by a non-inserted milling, in the remaining place a small amount of adhesive and a wooden disc, generally called a correction plug, are introduced. [1],[2],[3],[4] The correction plugs are standardized and have two parallel plane faces having the geometry and dimensions in Table 1.

Table 1. Geometry, Diameters, and Thickness of Correction Plugs

Correction plugs geometry	Common diameters (F) (Standardized) [mm]	Normal thickness (h) (Non-standardized) [mm]
	15	5
	20	6
	25	7
	30	8
	35	9
	40	10

Beveled side of the wood disc at 45^0 is required for both removing excess adhesive and to facilitate the automatic planting of cylindrical plugs into the sockets correction made by milling. Tolerances of correction plugs refer to the parallelism and the diameter of their two parallel planes. For parallelism, maximum deviations of ± 0.30 are allowed, and for diameters the permissible deviation from the nominal diameter is only positive, having a maximum value of + 0.2 mm. Because the curved drawing of the surrounding lines of the black nodes in the timber to harmonize from the aesthetic point of view perfectly with the inserted correction plugs, the latter are made by the cylindrical

milling of some rough wooden discs obtained in turn from tree branches, with annual growth rings, from the same species of wood as that of the timber to be ennobled. The rough wooden discs are currently obtained by two techniques.

The first technique, used by about 100 years, consists in cutting of raw wooden discs from shelled dry branches. A second new technique, devised and protected by the proposals of inventions and patent of invention of authors [5],[6],[7], consists of the cutting of raw wooden discs from dried branches without shell, the latter being removed by cylindrical milling on branch segments about 1000 mm in length. The diameter of these cylindrical segments has a 2 mm cutting edge tooling allowance to the nominal diameter of the finishing plugs.

Currently, correction plugs are manufactured by the two techniques described using two successive stages by means of vertical wood milling [8],[9], in turn equipped with some special milling cutters. In the first stage the cylindrical surface is processed, and in the second stage one of the plane surfaces is beveled with 1.5mm x 45^0. This two-stages working process leads to low productivity, motivating the team which deals with the conception and design of equipment for the production of auxiliary wood products for the furniture industry, in developing new conceptual and constructive solutions.

In these concerns are also recorded the results obtained and presented in this paper, where a milling cutter is described for the realization of finite correction plugs made of raw wooden discs with shell and a universal milling cutter for the realization of finishing correction plugs from raw shelled wooden discs.

2. Cutting tools for making the correction plugs used for replacing the black nodes of the timber

2.1 Milling cutter for the manufacture of plugs from raw wooden discs with shell.

The cutting tool is a combined frontal milling cutter for the purpose of producing wooden plugs in a single operation and with a single milling cutter, at four different thicknesses and a high quality bevel, using for this purpose wooden rough discs with shell, derived from tree branches belonging to the same species of wood from which the timber to be ennobled [10]. The design and construction of the cutting tool is made in such a way that by milling it is ensured that the wood in excess is removed from each raw disc so that after milling a wooden ring around the milling cutter does not remain, which would mean stopping the machine milling after each milling operation to remove this ring. The milling cutter works vertically from top to bottom and allows both front cylindrical milling for four different thicknesses of the plugs and beveling one side at an angle of 1.5mm x 45^0 of these, Fig. 1, Fig.2. The cutting tool has four non-removable knives of tungsten carbide having a set angle of 11^0 and a clearance angle of 16^0, a removable bevel cut with a set angle of 50^0, with a main attack angle of 45^0. In order to enable with the same milling cutter making four different thicknesses of correcting plugs, in the steel body of the mill are made four holes, perpendicular to the axis of rotation for mounting the knife bevel situated at different distances from the cutting edge of the four knives of milling. In order to milling, the raw wood disc is pneumatically fixed or elastically pressed by a rigid compression spring on a cylindrical paddle, after which the cutter automatically descends from top to bottom, making the cylindrical milling in the first phase, and in the last phase before stopping its movement by a mechanical limiter, milling at 1.5mm x 450. Using the milling cutter the following advantages are achieved:

- it ensures a high degree of universality of the milling cutter by the possibility of using the same cutting tool for four different thicknesses of correction plugs;
- high bevel quality is achieved by removing and sharpening the tungsten carbide bevel knife, in optimum conditions;

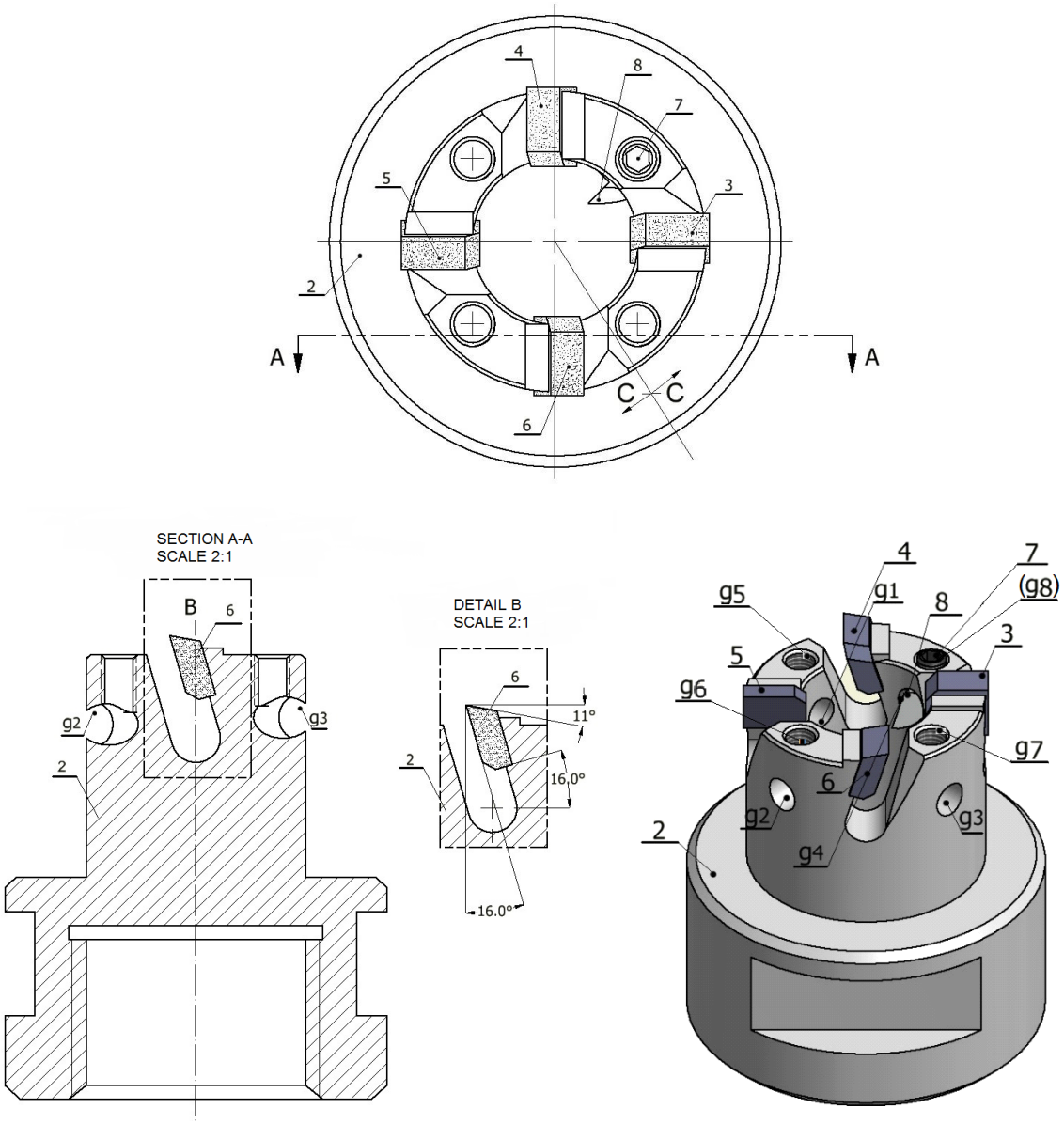


Figure 1 *Overall view and section view of the milling cutter used to obtain the wooden plugs made of raw wooden discs with shell.*

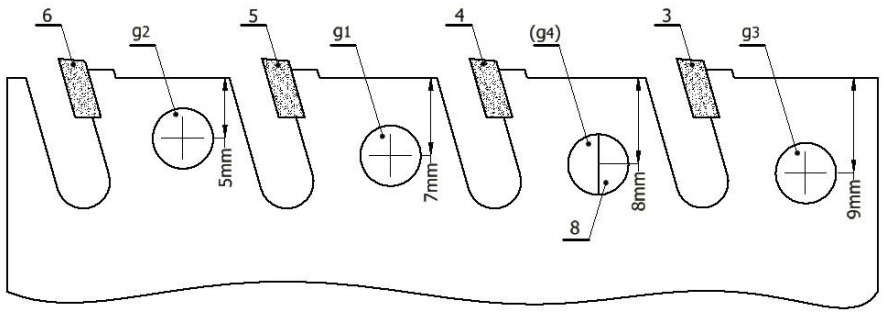


Figure 2 *Surface developed of milling cutter after cutting it on the generators*

The milling cutter used to obtain the wood correction plugs 1, beveled at one side at an angle of 1.5x to 45^0 and of various thicknesses, used in turn for increasing the

value of the timber by replacing the black nodes thereof, consists of steel body 2 having four knives 3,4,5 and 6 (Fig. 1, Fig. 2 and Fig. 3) of tungsten carbide, with a set angle of 11^0 and clearance angle of 16^0.

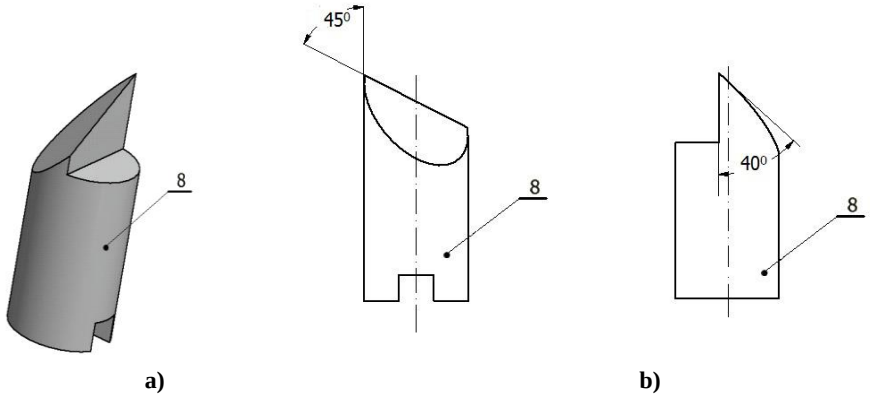


Figure 3. *Overall view 3D of the beveling knife (a) and detail on the geometry of the beveling knife(b)*

In the steel body 2 of the milling cutter are made on the circumference at equal distances between them, but at variable distances of 5, 7,8 and 9 mm from the cutting edge of the knives 6,5,4 and 3, four holes, g1, g2 , G3 and g4, Fig.2, in which can be mounted and rigidized by means of four screwed holes g5, g6, g7 and g8 and a screw 7, beveling knife 8 also made of tungsten carbide, having set angle of 50^0, a main attack angle of 45^0.

2.2. Milling cutter for wooden correction plugs from wood raw shelled discs.

The described cutting tool is a lateral milling cutter designed to obtain, under conditions of high productivity, using milling machines with feed and automatic advance, of finite correction plugs. The raw material used consists in cylindrical wood discs with parallel planes and radial machining addition of about 1-2 mm, [11]. The raw discs are also obtained by milling from cylindrical segments of tree branches belonging to the same species of wood as that of the timber to be ennobled. This technology belongs to the team of authors, [12].

The milling cutter is designed to equip high-productivity automatic milling machines with vertical work, the moving of the semiproduct being made from the bottom up to the milling cutter. The cutting tool is profiled and adjustable cutting knife, and the milling cutter body is made of tool steel, Fig.4.

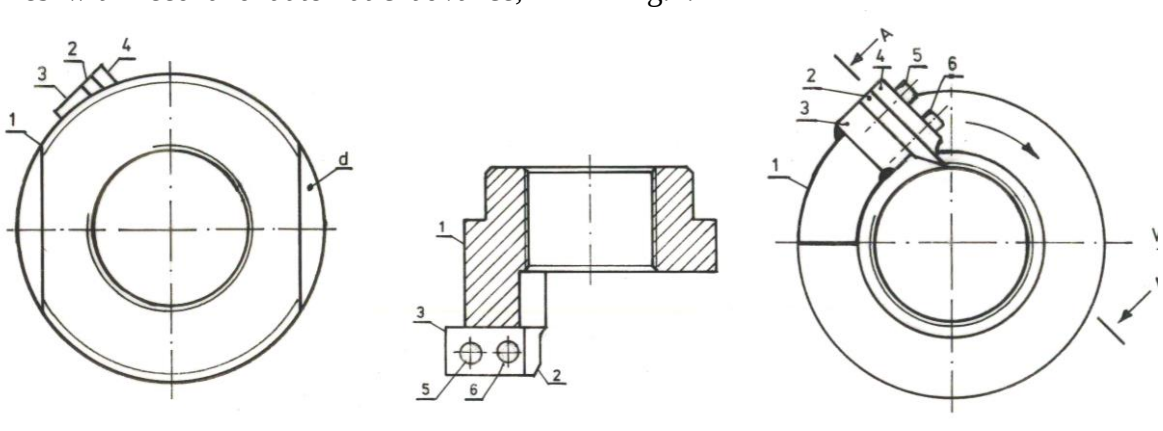
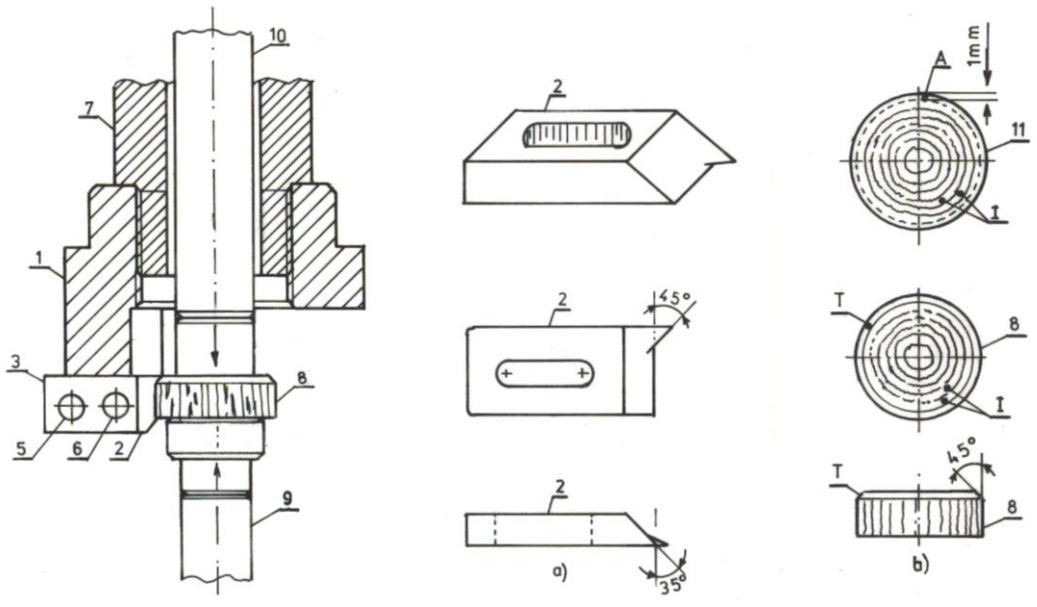


Figure 4. *Views of the mill for the manufacture of wooden correction plugs. a) - Top view, b) - Section view, c) Bottom view. 1-cylindrical body, 2-profiled knife, 3-support, 4-press plate, 5,6-clamping screws.*

The rough wooden cylindrical discs, with a processing tooling alowance of approximately 1-2 mm in diameter, they are automatically pushed by air out of a tubular feeder where the rough wood discs descend gravitationally onto the rod of a lower pneumatic piston, moves vertically to the top of another pneumatic piston, after contact with, it pulls the rough disc into the work between the two rods and at the same time continues moving the rough wooden disc vertically to the rotating mill. In the first phase of the vertical travel of the rough wooden cylindrical disc, the profiled cutter of mill achieves the cylindrical milling of the disc and in the last phase of the travel its bevel with 1.5 x 45^0. After milling, the automatic advances system controls the upward movement of the pneumatic piston and when the displacement of the upper piston and its pressing rod is stopped by a mechanical limiter causing a gap between the finished plug and the upper pneumatic piston rod , the finished plug is removed from the lower pneumatic piston rod by the air jet provided by a pneumatic nozzle controlled by an electrovalve. After the last operation, the milling of another raw wood disc is resuming automatically. By using this type of mill the following advantages are obtained:

- a simple milling tool is designed to equip the automatic milling machines for wooden correction plugs to replace the black nodes from the timber;
- the milling cutter has a single profiled knife, removable and adjustable on revolution diameter, allowing it to be used for two different diameters located at a radius of revolution of 2.5 mm (according to the European standard, the diameters of the correction plugs are increased from 5 to 5 mm in the field of 10 mm - 55mm);
- adjusting the milling cutter on the revolution diameter allows precise compensation of losses due to repeated resharpening thereof so that after resharpening to be kept the tolerated diameter of maximum + 0.2 mm.



f) **a)** **b)**

Figure 5. *Section view (f) of the milling cutter together with the fixation and vertical displacement system of the wooden rough discs and the final correction plugs. 1-cylindrical body, 2- shaped knife, 3-support, 4-press plate, 5,6-bolt clamp, 7-drive shaft, 8- finished plug, 9,10-rods, T-bevel. The geometrical characteristics of the milling knife(b). Geometry of rough discs and finishes plugs(c). 2- profiled knife, 8- finished plugs, 11- raw wooden disc, A-processing addition, T-bevel, I-rings*

Constructively, a milling cutter for the manufacture of wood raw shelled discs(Fig.4, Fig.5) consists of a cylindrical body *1* provided in the upper part with a gap *d* for fixing a clamping key, and in the lower part with a profiled steel knife *2* made of fast steel, which performs both the cylindrical milling and the shelling *T* of a plug edge with $1.5x45^0$, a support *3* welded to the cylindrical body *1*, a pressing plate *4* and two clamping screws *5* and *6*, the milling being mounted on the vertical drive shaft *7* of the milling machine.

In order to bring the rough wooden cylindrical discs *8* with a radial machining addition of about 1 mm in front of the profiled knife 2, as well as the removal from the processing area of the finished plug *9* resulted from the milling and beveling an edge, a pneumatic pressing and vertical displacement system consisting of the piston rods *10* and *11* of two pneumatic cylinders is used.

3. Conclusions

The devices described are able to produce substantial improvements in the production of the plugs used to replace the black nodes in the timber for the furniture industry and decorative wooden elements

Acknowledgments

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation , CNCS/CCCDI-UEFISCDI, project number PN-III-P2-2.1-BG-2016-0031, within PNCDI III.

References

[1]. Kucera L., J., Trends in Wood Research Springer Verlag, 1985, p.85/110

[2]. Wolfgang Nutsch s.a, Fachkunde für Schreiner, 12.Auflage, Verlag Europa-Lehrmittel OHG, Wuppertal 1981, p. 60-96

[3]. Johannes Tröger , Marco Schneider , Grundlagen und verfahren der Holzbearbeitung, Lagos Verlag, Berlin, 2015, p. 180- 225 5.

[4]. Etele Csanady, Endre Magoss, Mechanics of Wood Machining, second edition, Springer Verlag, 2013, p.45-67

[5]. Gheorghe Gutt, Process and automatic machine for manufacturing correction plugs, Patent RO127737/2012, http://worldwide.espacenet.com

[6]. Amariei Sonia, Alexuc Cristian-Florin, Vertical boring and turning mill for manufacturing cylindrical wooden disks, Patent RO 128987/2013 http://worldwide.espacenet.com

[7]. Gheorghe Gutt, Sonia Gutt, Andrei Gutt, Florin-Cristian Alexuc, Milling process and lathe for obtaining the corrective plugs of the falling nodes and the black nodes of the timber, Patent RO 128.019 /2012, http://worldwide.espacenet.com

[8]. XXX Das Leitz Lexikon , Edition 6, Leitz GmbH & CoKg, 2011

[9]. Guido Henn, Handbuch der Oberfräse. Auswählen Bedienen, Beherschen, 3 Edition, Vincent Network, 2011, p.1-67

[10]. Gutt Gheorghe, Amariei Sonia, Alexuc Cristian-Florin, Todirica Florin-Sorin, Horodnic Sergiu-Andrei, Milling device, Patent Proposals, OSIM, A00979/2016

[11]. Gutt Gheorghe, Amariei Sonia, Todirica Florin-Sorin, Alexuc Cristian-Florin, Horodnic Sergiu-Andrei, Round milling device, Patent Proposals, OSIM, A00976/2016

[12]. Gutt Gheorghe, Amariei Sonia, Andrei Gutt, Technology for manufacturing plugs correction from branches softwood, Patent Proposals, OSIM, A00202/2017