5-AXIS MACHINING ON LATHE WITH COUNTER SPINDLE

Jozef PETERKA

Author: ***Jozef Peterka, Professor, PhD.***
Workplace: ***Slovak University of Technology in Bratislava***
Faculty of Materials Science and Technology in Trnava
Institute of Production Technologies
Department of Machining and Assembly
Address: ***ul. J.Bottu 25, 91724 Trnava, Slovak Republic***
Email: ***jozef.peterka@stuba.sk***

Abstract

Machining on lathe with counter spindle enables to machine free form surfaces with any intervention during the process. Machining technology on lathes with counter spindle using multiple-axis machining and a description of machining of 5-axis turning centre with the counter spindle CTX - Alpha 500 is briefly mentioned in the article. Machining centre is located in the Centre of excellence of five axis machining at Faculty of Materials Science and Technology in Trnava and it is intended for research on technological possibilities of 5-axis machining and free form surfaces machining.

Key words

lathe, lathe with the counter spindle, machining, 5-axis machining

Introduction

Mostly rotational as well as free form surfaces in engineering, automotive and other industry are machined using the turning technology. This technology has already been dealt with a man in 8th century BC, when he tried to change the shape of objects, which he found in nature to serve him better.

In the Tutankhamune´s tomb in Egypt, there where depicted two men working on a primitive lathe. One of them ensured a rotational movement of machined material and the second one was machining material with a hand-tool.

Development of mechanical machines was very slow, because there was a lack of appropriate construct materials for machines construction. At the end of the 15th and at the beginning of the 16th century, Leonardo da Vinci designed a wooden frame, because cast iron was rare in those times. First cast iron framed machines were built in the 17th century, but they were still powered by human, rarely by animal power. In the 18th century when the first steam engines were invented the power was gradually replaced [4].

The notion of turning means machining method where the main rotational movement is performed by work-piece and feed is performed by tool. At the end of the 20th and at the beginning of the 21st century a connection between turning machines and computers was established. According to that CNC machines have been created and have gradually added

more options (multiple-axis, counter spindle). This offered a possibility to combine more machining methods (turning with milling) on one machine tool.

Application of Technology

Turning centres are numerically controlled machines which have at least one numerically controlled rotational axis and tool holder can clamp at least one driven tool. The axis of main spindle of the machine (work-piece axis), is C axis. Using C axis controlled movement it is possible to positioning a work-piece from 0° to 360 °. Therefore it is possible to machine a work-piece with driven tool using movements of toolholder in longitudinal (Z axis) and transverse (X axis) directions.

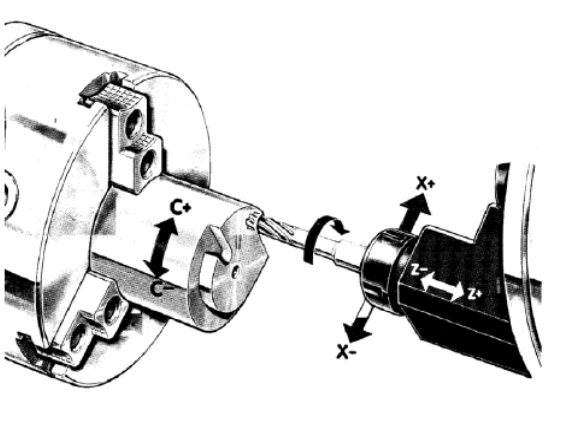

Fig. 1. *Workspace of turning centre [1]*

In this way it is possible to mill grooves for tongues, drill offset holes, drill perpendicularly to the axis of the work-piece. If the machine's control system allow combining axis C with one of the axes X or Z, then it is possible to machine free form surfaces. Working opportunities of turning centre depends on the number of controlled axes and the number of axes, which can be managed simultaneously. In Fig. 2 there is a view into the workspace and the way of marking of the turning centre axes with eight numerically controlled axes.

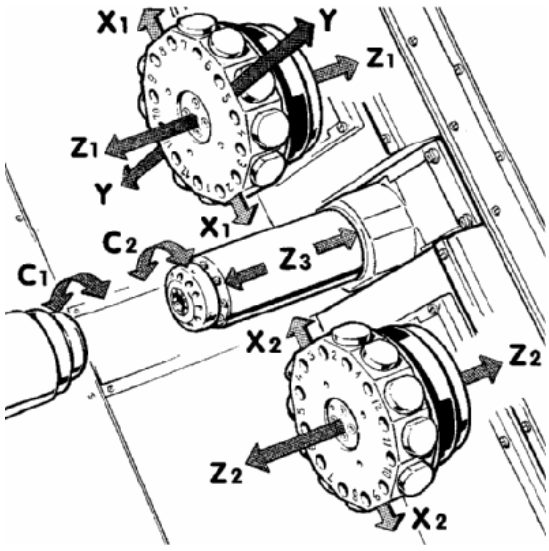

Fig. 2. *Individual axis in turning centre workspace [1]*

On this machine it is also possible to use two tools machining simultaneously. Technology allows to machine second end of the work-piece by upper and lower turning carriage movements (it allowing a second spindle head) and by using of turret head's movements in the Y direction it is allowed to machine the work-piece perpendicularly to its longitudinal axis.

Trend in turning centres design of last years is a construction with at least five axes of which three (X, Y and Z) are linear and the two are rotational (B and C). With controlled B-axis implements tilting of tool spindle, what enables e.g. drilling perpendicularly on the conical surface of the part etc. [1]. Y axis allows performing off-axis drilling and milling operations. Y axis movement is generally realized by the movement of turret and a current movement in the X axis. Combination of these two mutually inclined movements creates movement in the virtual Y axis, however usually with small lift. Some machines have orthogonally axis, it means that Y axis is physically perpendicular to the axis X. It allows bigger lift in this axis [3].

These machines are often equipped by next slide rest with turret for easier mostly turning operation. It enables free form surfaces economically machining. The workspace of this machine is for example in Fig. 3.

Automatically tools' changing in the turret from a tool magazine is obvious for turning centres (also rotational tools). Also automatic work-pieces exchange is allowed [1].

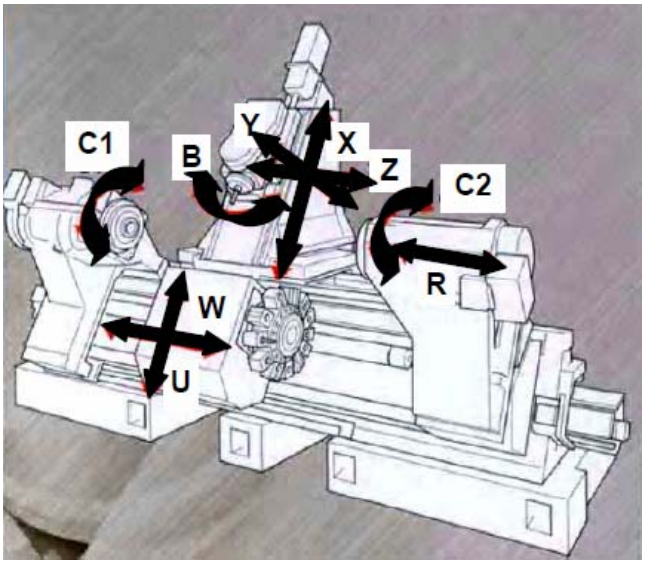

Fig. 3. *Workspace with axes [1]*

These machines enable machining of complex work-piece, especially by turning and milling using multiple technologies [2]. Work-pieces are rotational or free form surfaces for various applications as shown in Fig. 4.

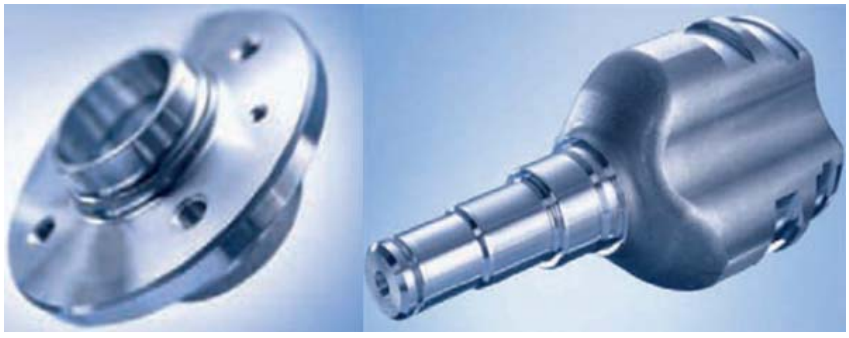

Fig. 4. *Parts witch can be produced on CNC lathes [2]*

DMG CTX-Alpha 500

DMG CTX - Alpha 500 is a machine tool from Gildemeister A.G., or DMG (DeckelMahoGildemeister).

The concept of this machine consists of the following translational axis X, Y, Z and rotational axis C1 and C2. In axis X, Y and Z movements are carried by slide on where is 12 pieces – servo turret with tool drive. Holders, which are clamped in the turret have different shapes respecting the method of machining: turning (for one or more tools), drilling (axial unilateral, bilateral axial and radial) or milling (axial unilateral, bilateral and radial). Tools in holders can be powered and used for milling or drilling.

Fig. 5. *CNC lathe CTX-Alpha 500 [2]*

TECHNICAL PARAMETERS OF CNC LATHES CTX - ALPHA 500 [5] Table 1

Parameters				**Unit**	**Value**
Work area					
x				mm	190
y				mm	±40
z				mm	525
c1				□	360
c2				□	360
Main Spindle					
Spindle head					140h5
Max. bar diameter				mm	51
Power				kW	20
Max. torque				Nm	127
Max. speed				rpm	6000
Counter Spindle					
Spindel head					140h5
Drive power				kW	48
Max. speed				rpm	6000
Tool magazine					
Number of positions					12
Drive power				kW	5,4
Max. torque				Nm	18
Max. speed				rpm	5000

Cooling cutting fluid is used on this machine. Cutting fluid is pumped from the chip conveyor in to the band filtering devices, where it is filtered through filter paper. The filtering device has three pressure pumps (8 bar., 20 bar., and 80 bar.).

Equipment of the machine centre

Heidenhain control system (CNC Pilot 4290) is a major part of this machine through which are carried all operations out on the machine. It allows creation of complete NC - programme, which in the first place begins production by creating assortment of tools with which it work, choosing the semi-product, which can be graphically seen on the display. The next step is creating shape of the work-piece with help of contour lines. Next step programming with codes (G and M) or cycles, which made references to the contour lines. Written programme can be simulated, backward controlled and controlled against collisions.

The control system works on MS Windows XP platform, which allows access to LAN and the Internet. When a problem rises, it can be solved online by technician. Beside network connection there are four USB input slots on the control panel to connect portable devices.

Marposs probe MTE TT30 is a device, which is used for tools measuring. The tool measuring is based on a contact principle. Tools inserted in the turret are gradually measured by touching of the probe. The position is then recorded to the particular tool in table of instruments. This measurement takes place in two axes X and Z.

Chip conveyor is a device that ensures a diversion of chips from the working area into a waste container. It also serves for diversion of the cutting fluid with help of the pump with power of 1.85 kW, pressure of 5 bar. The conveyor has a volume of 170 litres and a filtering device in which the cutting fluid is filtered through a filter paper and flows into the tank with a capacity of 980 litres. From this equipment the cutting fluid is pumped back through three pumps working under the pressure of 8, 20 and 80 bar. Running of the chip conveyor can be adjusted on the control panel. Periods when it is switched on and off and for how long are adjustable from the control panel.

Signal light is located on the machine at the very top and it has four signal colours (red, yellow, green and blue). Every colour has its own function. Red colour signalize when is occurred any disorders and the machine is stopped, the yellow one, when the door is opened into the workspace, the green one, when the program is running in automatic mode and potentiometer adjustment of displacement is set to more than 75% and the blue colour signalize when the tools are clamping into the machine. Another machine's equipments are two pedals for control opening and closing of the chuck on the main spindle or counter spindle. These operations can be realized only when the door is open in to the workspace of the machine and manual mode is switched on.

Conclusion

In the year 2009 a Centre of Excellence 5-axis machining was established at the Faculty of Materials Science and Technology in Trnava of Slovak University of Technology in order to increase the possibilities of research activities in area of machining. On the basis of this project, three DMG 5-axis machines were purchased and one of them is CNC lathe with counter spindle CTX - Alpha 500.

In this article, there is briefly presented this device, its properties and possibilities of its application.

At nowadays the research team is in the stage of installing, testing and starting of machine's operation. First experiences about technological possibilities of CNC turning centre with counter spindle are now acquired in free from surfaces machining.

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Projekt je spolufinancovaný zo zdrojov ES

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