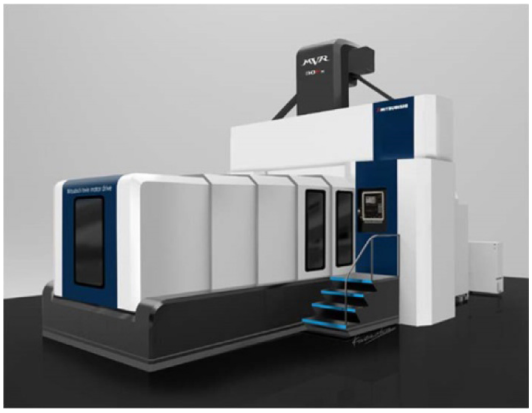
High-Precision Double-Column Machining Center "MVR-Fx" for Die Molds

–Achieves High-Definition, High-Precision Surface Machining–



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The tendency to accumulate machining data as expertise has been increasing in the field of large die molds used for the pressing and injection molding of automotive parts. With such a background and in conjunction with the improvement of three-dimensional high-precision measurement technologies, the realization of even higher-quality and higher-precision cutting surfaces is in demand. However, large die mold processing takes a long time and has the issue of the deterioration of machining accuracy caused by thermal displacement during processing, tool wear, the deviation of the blade tip position after tool changes, etc. Therefore, it is difficult to attain high-precision cutting surfaces. We have developed a large, high-precision machine tool that incorporates the precision improvement technologies and high-precision measurement technologies of our micro milling machine, and realized high-quality and high-precision cutting surfaces to contribute to the reduction of lead time through the elimination of the need for polishing.

1. Advantages and technologies

(1) Precision improvement technologies

For the prevention of accuracy deterioration in die mold machining caused by the thermal deformation of the machine body, a high-rigidity symmetrical machine body structure and a thermally stabilized column (**Figure 1**) that are less subject to changes in temperature were adopted. For the prevention of thermal displacement and the deterioration of the rotational accuracy of the spindle caused by heat generated from the high-speed rotation of the spindle, internal spindle cooling (**Figure 2**) that uses temperature-controlled oil to directly cool the spindle was adopted to eliminate the need for the correction of thermal displacement. A high-rigidity spindle with no rotational deflection was attained by reducing the temperature difference between the inner ring and the outer ring of the spindle bearing. In addition, for the prevention of the deterioration of motion accuracy due to the backlash of the feed drive system, each ball screw of the X, Y, and Z axes was connected directly to the motor, and the X and Y axes, which have a larger range of travel and a long ball screw, had motors on both edges of the ball screw in order to suppress lost motion and enhance high-speed performance.

(2) High-precision measurement technologies

For the prevention of effects of changes in tool length caused by the high-speed rotation of the spindle, an imaging-type tool measurement system (**Figure 3**) was adopted to continuously measure the tool blade tip and automatically determine the stabilization of the thermal displacement of the machine, holder and tool. In addition, the use of a noncontact, three-dimensional workpiece measurement device to check machining accuracy of a three-dimensional shape was made possible. Furthermore, a machine condition measurement and sign diagnostic system utilizing IoT was mounted for the early detection of machine abnormalities.

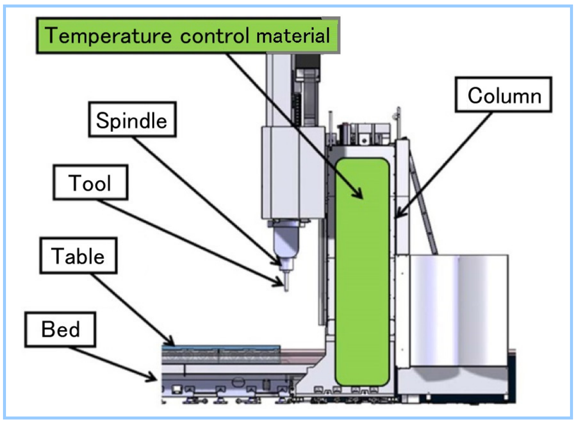

Figure 1 Thermally stabilized column

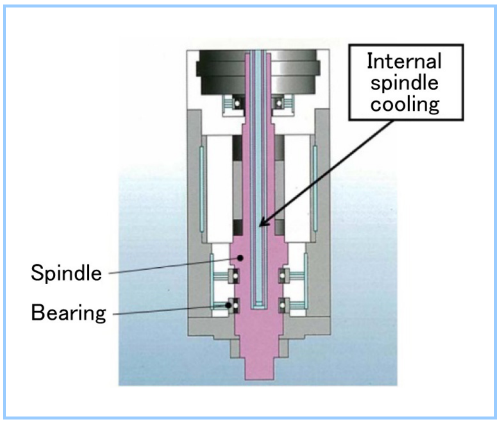

Figure 2 Internal spindle cooling

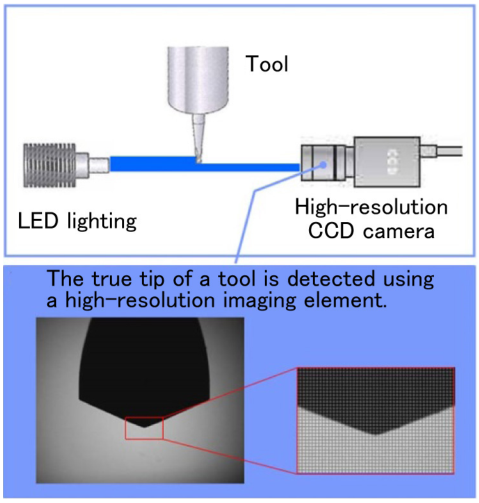

Figure 3 Imaging-type tool measurement system

2. Specifications

Table 1 shows the main specifications. The machine sizes that can handle the machining of various large die mold used for the pressing and injection molding of automotive parts are available. These machines have a full enclosure as standard equipment in consideration of environmental improvement and the safety of the factory, while taking energy saving such as the reduction of air consumption and the adoption of LED lighting into consideration.

Table 1 MVR-Fx main specifications

			MVR30Fx	MVR35Fx
Table work area	Width	mm	2000	2500
	Length	mm	3000 (OP 4000, 5000)	4000 (OP 5000)
Load weight (table)		tons	20	25 (30)
Distance between columns		mm	2550	3050
Distance between spindle end and workpiece mounting surface (EXT spindle end to table surface)		mm	1650 (OP 2000)	
Axis travel	X	mm	Table length + 200	
	Y	mm	3000	3500
	Z	mm	800	
	W	mm	1100 (OP1300)	
Rapid traverse	X, Y	m/min	20	
	Z	m/min	15	
	W	m/min	5	
Cutting feed		m/min	15 (OP 20)	
Spindle head	Ram size	mm	□420	
	Rotation speed	mm^{-1}	20000	
	Output (30 min / continuous)	kW	22/18.5	

3. Benefit of introduction

(1) Improvement of die mold machining surface quality

The enhancement of productivity due to the elimination of the need for polishing is enabled by the realization of high-quality cutting surfaces without a difference in surface step.

(2) Shortening of die mold manufacturing time

A product that accurately reflects the designer's intention can be produced by the accurate reproduction of the machining data onto the die mold. In addition, the creation of a database of expertise and the accumulation of technologies (advanced reverse engineering) in conjunction with three-dimensional workpiece measurement contribute to a reduction in the number of prototypes, resulting in shortened delivery times and fewer man-hours.

(3) Automation and manpower saving at manufacturing site

The biggest obstacles for the automation of processing facilities, the deterioration of the accuracy caused by changes in the outdoor air temperature and the heat generated from the inside of the machine are suppressed to the utmost, and therefore next-generation automation and manpower saving, which were impossible in the past, can be realized.