"MVR-Dχ" Vertical Precision Milling Machine A Reliable and Useful Solution at Machine Shops for Railway Equipment Parts

Large Machine Designing Section
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The MVR-Dχ series of portal bridge type, 5-face milling machines are valued by customers as high-speed and high-precision efficient machine tools, in addition to having a high-rigidity structure that enables heavy cutting. Since their release in 2008, Mitsubishi Heavy Industries (MHI) has delivered more than 50 machines in the MVR-Dχ series to customers in all industrial machinery fields including construction machinery, motors and machine tools. In particular, many have been introduced to customers handling railway equipment. This document presents examples of where standard machines in the MVR-Dχ series capable of heavy cutting were modified to meet individual customer needs, and resulted in further improvement of production efficiency.

1. Machine Configuration and Primary Specifications

Figure 1 and **Table 1** show the machine configuration and primary specifications of the MVR-Dχ series. The MVR-Dχ series covers part widths ranging from 2800 to 4300 mm, allowing customers to select a machine that is suitable for their needs. In this lineup, standard specification machines, special specification machines and customized machines tailored for individual customers are separated, and the machine configuration is designed for the modularization and standardization of the unit. The MVR-Dχ series has a wide selection of machine sizes in response to customer needs, including table widths (determinative of the overall machine size) ranging from 2000 to 3500 mm, table lengths from 4000 to 14000 mm, table loading capacities up to 100 tons and column heights of 2050 to 4050 mm. In addition, this series can respond to quick delivery requests. The MVR-Dχ series can cut not only box type parts that consist of 90 degree angled surfaces, but also parts that require the cutting of 30 or 45 degree angled surfaces or free form surfaces. In addition, various cutting demands such as the cutting of deep inside areas or narrow portions can be met. To enable these capabilities, a configuration where an automatic exchange type attachment suitable for the cutting part can be mounted on the ram end is employed. The attachment specifications are determined individually depending on the portion to be cut through a study of cutting based on the part drawing provided by the customer.

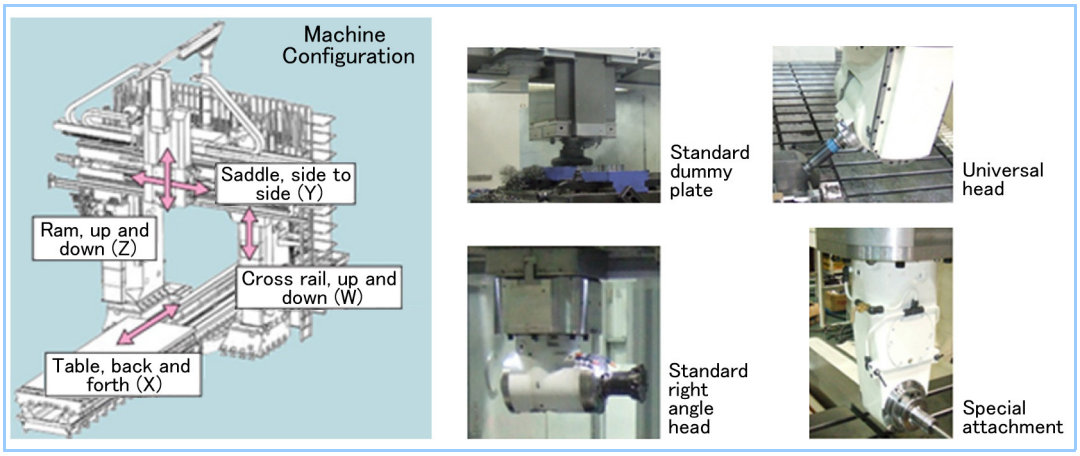

Figure 1 Machine configuration of MVR-Dχ series

Table 1 Primary specifications

					MVR-28/34Dχ	MVR-33/39Dχ	MVR-38/44Dχ	MVR-43/49Dχ
Main body specifications	Maximum size of part to be cut		W	mm	2800	3300	3800	4300
			L		Depending on table back and forth travel			
			H		3550 (depending on column height)		4050 (depending on column height)	
	Dimensions	Table work area	W	mm	2000	2500	3000	3500
			L		4000 to 8000		5000 to 14000	
		Column height			2050 to 3550		2550 to 4050	
	Travel	Table, back and forth	X	mm	Table work surface length +1000			
		Saddle, side to side	Y		3400	3900	4400	4900
		Ram, up and down	Z		Standard 1000/Special 1200			
		Cross rail, up and down	W		1200 to 3200 (depending on column height)		2200 to 3200 (depending on column height)	
	Spindle	Rotation speed		min-1	7 to 4000			
		Power output		kW	Standard 45/Special 55			
	Speed	Table, back and forth	X	m/min	24		20	
		Saddle, side to side	Y		30			
		Ram, up and down	Z		15			
		Cross rail, up and down	W		3		5	
Attachment	Standard attachment				Standard dummy plate			
					Standard right angle head (fixed angle)			
	Special attachment				Universal head (can be indexed to any angle)			
					5-axis head (continuous angle positioning)			
					Special attachments suitable for part to be cut			

2. Examples of Cutting

For customers in the field of railway equipment, standard MVR-Dχ machines combined with attachments tailored to the customer's specifications have been delivered for the efficient cutting of rail parts, exterior parts of the Shinkansen, railway car bogies and engine cradles. Some examples are shown below.

(1) Cutting of rails (Mi-Ne Seisakusho Co., Ltd)

This is an example of rail cutting that takes advantage of the heavy cutting capability of the MVR-Dχ series (**Figure 2**). Rail steel is very difficult to cut because cutting vibrations tend to occur due to its plasticity and hardness. In this example, however, the high rigidity of the main structural body consisting of the column, the cross rail and the saddle, and the high rigidity of the tool attained by enhancing the cutting tool clamping force to the utmost enable the reduction of cutting vibrations. In addition, custom modifications such as a change of the table top face shape, the addition of a hydraulic supply path for the fixtures and other measures make it possible to mount the rail fixtures on the top face of the table, and this contributes to a reduction of the time period for rail setup change.

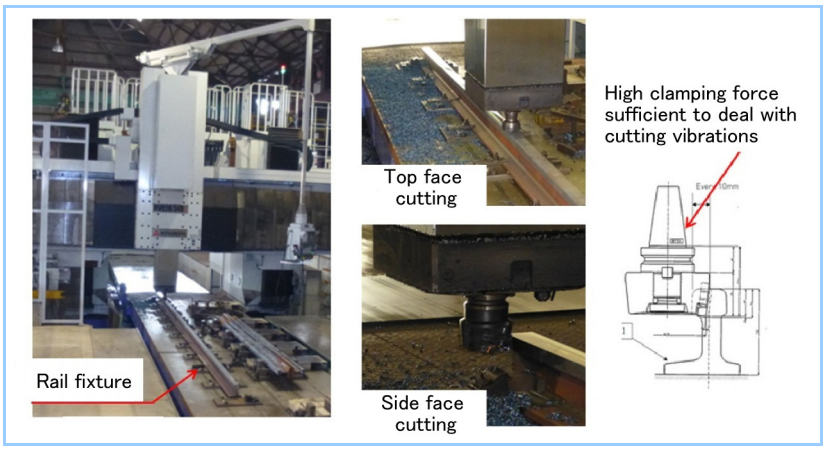

Figure 2 Cutting of rails

(2) Cutting of Shinkansen exterior parts (Akahane Seisakusyo Co., LTD)

This example was provided in response to the needs of the customer, who needed to machine both standard parts cut by the standard spindle and high value-added Shinkansen exterior parts having free form surfaces with a single machine. To meet this need, the machine structure was modified so that the automatic exchange type 5-axis head could be mounted on the standard spindle (**Figure 3**).

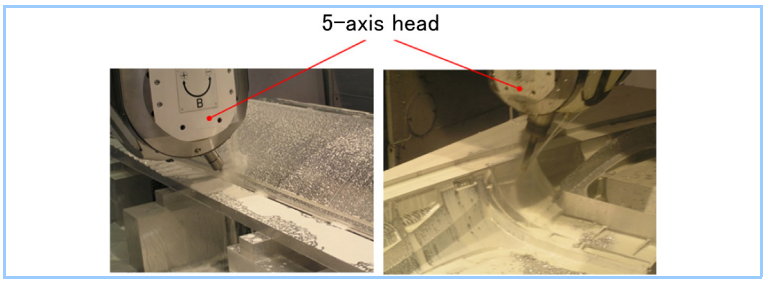

Figure 3 Cutting of Shinkansen exterior parts

(3) Cutting of bogies

For the cutting of railway car bogies, because there are many surfaces that are not 90 degree angles, an attachment that can be indexed to various tilting angles is necessary. In addition, the spindle-through coolant function, which feeds coolant through the center of the tool, has also recently become necessary because of requests for improvement in cutting efficiency. Responding to these requests, a universal head that can feed coolant through the center of the tool even during inclined surface cutting, which was not available in the past, can be provided for the MVR-Dχ series (**Figure 4**).

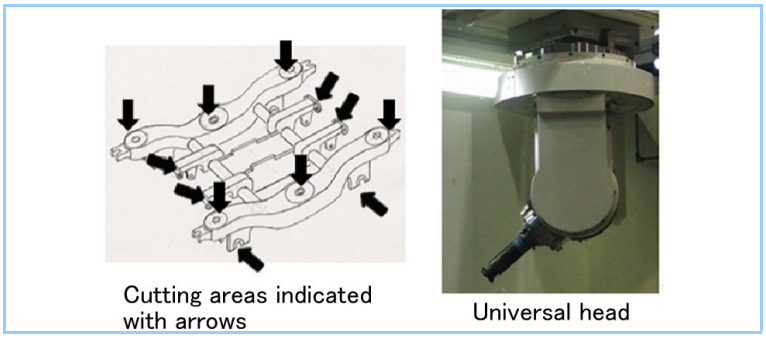

Figure 4 Cutting of bogies

(4) Cutting of diesel engines

To cut diesel engines, an attachment with a special form suitable for the cutting portion is necessary. For crankshaft holes, a thin right angle head for the cutting of deep and narrow portions is needed. For camshaft holes, an L-shaped right angle head is required (**Figure 5**).

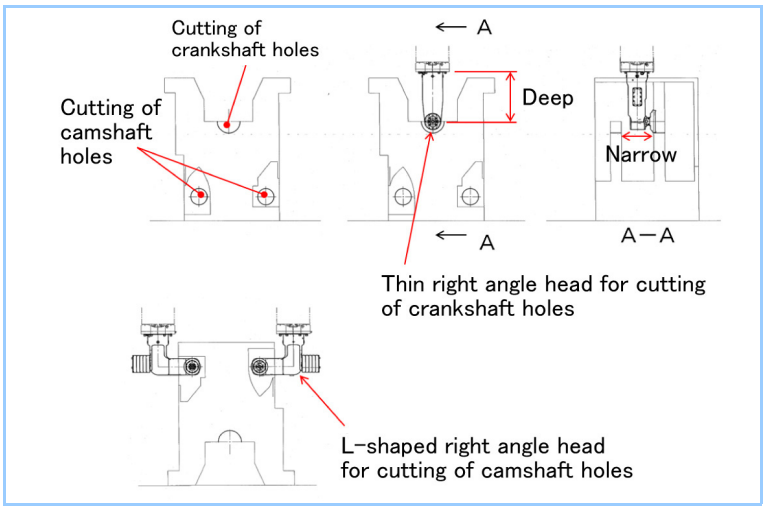

Figure 5 Example of diesel engine cutting

To cut diesel V-engines, a universal head is used for the cutting of inclined surfaces and cylinder bores (**Figure 6**). By employing separate storage in addition to the standard drum type storage for the many attachments necessary for the cutting of engines, automatic exchange of attachments, and as a result unmanned engine cutting operation, have been realized. Furthermore, it is important for the cutting of diesel engines to take measures against thermal displacement because the machine size is bigger in response to the size of the part to be cut. The MVR-Dχ series employs the thermally symmetrical structure of the machine body and uses heat insulating materials to meet the needs for precision engine cutting.

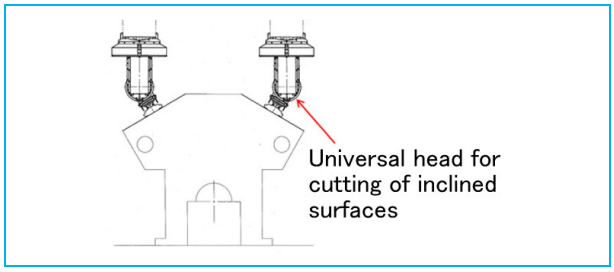

Figure 6 Example of diesel V-engine cutting

3. Conclusion

The destination to which the greatest number of MVR-Dχ series machines have been delivered are customers in the field of railway equipment. At the same time, the MVR-Dχ series machines are valued by customers in all fields including construction machinery, motors and machine tools.

MHI will further enhance the MVR-Dχ series machines by reflecting the opinions of customers in product development, and continue to offer products that meet their needs.