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RIGID AND PRECISION CNC LATHE NL SERIES

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Abstract: *Additional functions on NL series, such as Y axis, sub-spindle functions, and even milling capabilities integrated into lathes are desired to achieve high productivity. The NL is unparalleled in cutting speed, rigidity, accuracy, tool life and milling ability the milling capability is elevated to a level that no other competitors even come close.*

Key words: *CNC lathes, high speed machining, accuracy.*

1. INTRODUCTION

Today, we are on the threshold of a new beginning in the field of CNC lathes, and we are determined once again to create a lathe that will lead the industry in innovation. After reworking our designs, and incorporating data received from confronting heat related problems and thousands of customer comments, we have improved our products even more.

Our uncompromising development stance has made it possible to deliver unprecedented rigidity, precision, and reliability. Our efforts have created our newest line, the NL Series. These new machines are high-rigidity, high precision CNC lathes and set the new standard in “common sense” machining for a new age.

2. INFORMATION

With the outstanding rigidity offered by the tool spindle, NL series, offers heavy duty cutting without vibration. Also, thanks to a new body construction that strengthens heavy duty cutting ability, wide cutting with no vibration is also possible.

2.1. Ultra-high rigidity structure

We have a new design for the basic structure: the spindle, saddle and tailstock. This new design ensures consistent rigidity (Fig. 1). The result is a level of rigidity that has not been seen before, with increased stability due to the broad bottom face.

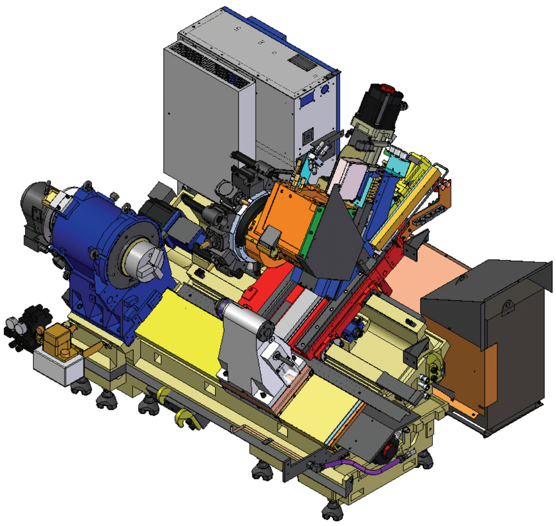


Fig. 1. Machine structure.

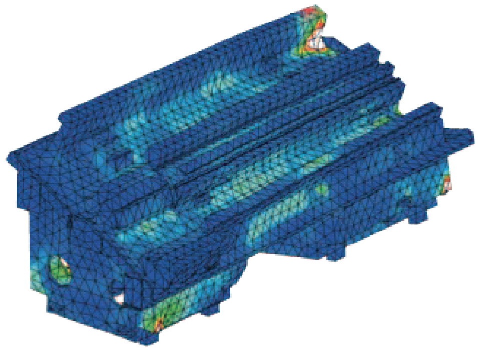


Fig. 2. Bed construction.

The slideways are 30% wider than those of conventional machines and are the largest in the class (Fig. 2). We have achieved an unknown level of stability not only in turning work but also in milling work.

2.2. Highly rigid spindle

The axis rigidity of the headstock and its mounting has been improved by changing the shape of the headstock and increasing the thickness of its parts. The diameter of the bearings has been increased. This allows better spindle rigidity Rigid & Precise while enlarging the through-hole diameter.

Real cutting simulation using dynamic analysis.

2.3. Thermal isolation

The most prominent feature of the NL Series is said to be the elimination of the adverse effects of heat. In order to raise the continuous machining precision of lathes, 95% of which is said to be taken up by cutting time, we at Mori Seiki have come up with the concept of total heat elimination. It is common to find the oil cooler – a major source of heat – located right next to the spindle in conventional machines. As a result, the headstock is affected adversely by that heat.

Placing the oil cooler behind the machine removes that heat source from the headstock. The machine is designed so that the exhaust from the oil cooler doesn’t come in direct contact with the machine (Fig. 3).

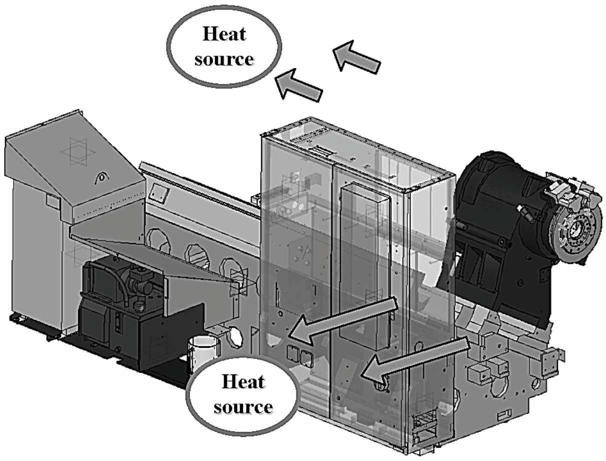


Fig. 3. One piece construction.

2.4. Spindle Cooling

We have redesigned the spindle, which is the greatest source of heat (Fig. 3), to employ a uniform-heat construction that maintains an equal temperature all around the spindle. The main spindle unit is protected from rises in temperature by the spiraling oil jacket located all the way to the back side (Fig. 4).

2.5. Turret with a built-in milling motor TM

The milling mechanism on conventional lathes generates a great deal of heat and vibration due to the large number of parts involved, including the motor and gear belt. The NL Series, however, features the industry's first turret with a built-in milling motor (Fig. 5).

This revolutionary design minimizes heat generation and vibration while eliminating transmission losses. The new design increases both machining accuracy and cutting performance.

The NL Series was designed to create a CNC lathe with true milling capability. For example, the NL2500 can accommodate face mills of up to Ø80 mm. NL Series machines boast milling performance approaching that of No. 40 taper machining centers.

2.6. Accuracy

Conventional machines create a pattern on material due to the amount of vibration the tool tip generates. With the NL Series, there is no pattern on the material, thus eliminating the need for grinding (Fig. 6).

Increasing the rigidity between the spindle and the tool tip has made it possible to achieve high quality machined surfaces (Fig. 7) through turning alone.

2.7. Machining power

By employing a super-rigid construction for the NL Series and equipping it with a turret with a built-in milling motor, it is able to deliver cutting equal to that of machines one class above. This contributes to productivity (Fig. 8).

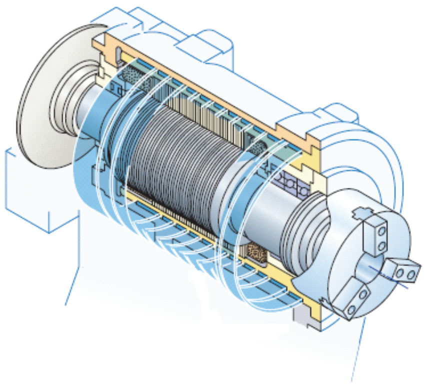


Fig. 4. Spindle cooling.

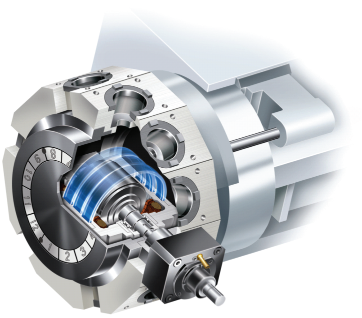


Fig. 5. Built in turret motor TM.

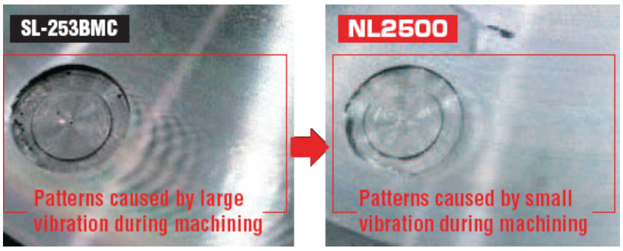


Fig. 6. Comparison between NL 2300 and SL-253BMC.

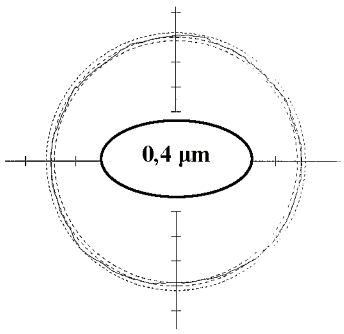


Fig. 7. Roundness.

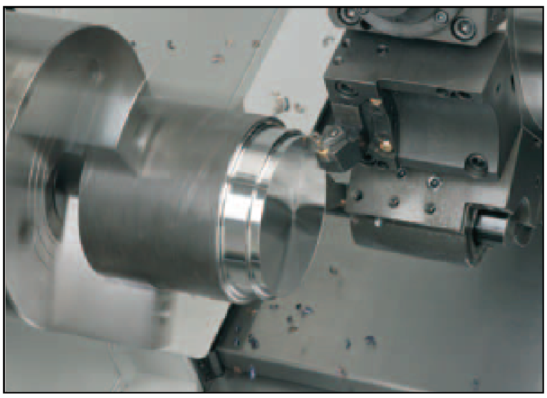


Fig. 8. Heavy duty cutting.

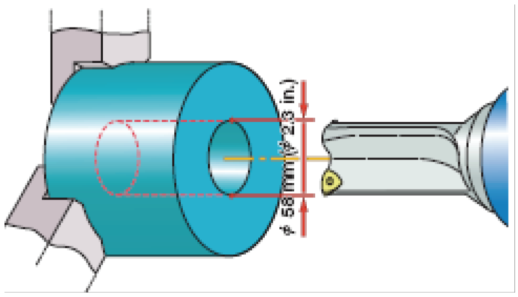


Fig. 9. Throw away drill.

Table 1

Heavy duty cutting

Item	Turning
Machine type	NL2500MC/700
Material	S45C; Ø118×100 mm
Spindle speed	764 min^{-1}
Depth of cut	10 mm
Cutting speed	120 m/min
Federate	0.4 mm/rev
Machining rate per minute	576 mL/min

In Table 1 are presented the cutting condition for Fig. 8.

Table 2

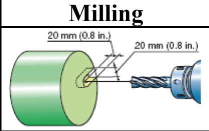
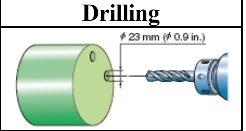
Heavy duty cutting

Item	Drilling
Machine type	NL2500MC/700
Material	S45C; Ø118×50 mm
Spindle speed	549 min^{-1}
Drill diameter	58 mm
Cutting speed	100 m/min
Federate	0.3 mm/rev
Machining rate per minute	435.2 mL/min

In Table 2 are presented the cutting condition for Fig. 9.

Table 3

Machining power

Item	Milling	Drilling
		
Material	S45C	S45C
Machine type	NL2500MC/700	NL2500MC/700
Tool	End mill < Ø 20 mm	Drill < Ø 23 mm
Spindle speed	320 min^{-1}	345 min^{-1}
Cutting speed	20 m/min	25 m/min
Feed rate	64 mm/min	103.5 mm/min
Machining rate per minute	25.6 mL/min	43.0 mL/min

In Table 3 it can see the cutting ability and cutting condition for drilling and milling.

2.8. Tailstock

The NL Series comes standard with a highly rigid digital tailstock driven by a servomotor.

Fig. 10. Tailstock control screen

A digital tailstock with variable feed speed control allows separate speeds to be set for approach and engagement, reducing the operating time of the tailstock spindle by over 20%. Approach position, retract position, re-chucking, and more can be done simply and easily from the MAPPS II screen (Fig. 10). Besides being able to handle a variety of different work piece types, it can also work with M-code thrust selection as a standard feature.

2.9. Automatic operation support

Automated devices have expanded from the automation and unmanned operation needs of the past to include greater reliability, reduced non-cutting time, and quieter operation. Mori Seiki has poured more resources into design in order to develop automated devices that raise productivity. There has been achieved a new completely automated start-to-finish machining using only one machine, from material supply to discharging the completed work piece. This is a high-speed mass production system that reduces non-cutting time.

3. CASE STUDY

In this study, the machining time calculations are based on the drawing for the work piece: casing covert, material: cat iron (EN-GJL-250) and use of the CNC lathe NL3000MC$_{/700}$ made by Mori Seiki.

3.1. Work piece machining drawing

The machining drawing, for first machining area is shown below (Fig. 11).

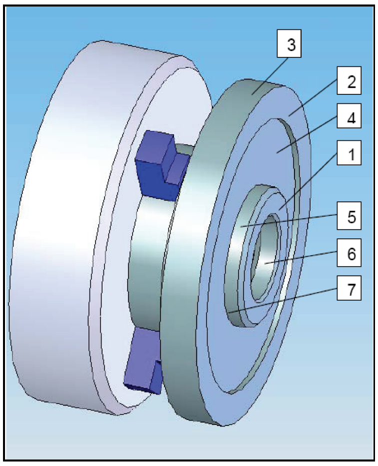


Fig. 11. Machining drawing.

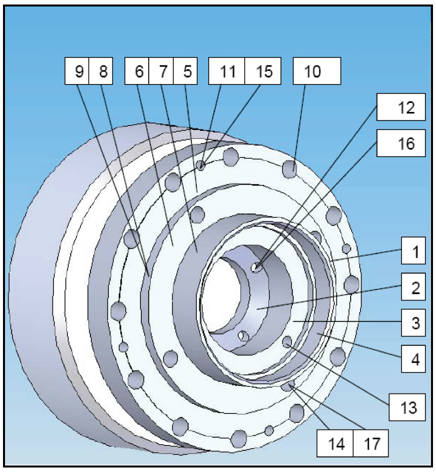


Fig. 12. Machining drawing.

Cutting conditions for machining OP1 are presented in Table 4.

Table 4

Machining OP 1

Machining Type	**Location**	**Diameter**	**Cutting speed**	**Machining time**
		[mm]	[m/min]	[s]
Face turning	1	150	450	36.8
Face turning	2	360	480	106.3
O.D. turning	3	360	450	138.2
O.D. turning	4	152	150	178.2
O.D. turning	5	150,5	430	15
Int. turning	6	90	380	22.8
O.D. turning	7	150	250	14.3
TOTAL				**511.5**

The machining drawing, for second machining area is shown above (Fig. 12).

Cutting condition for machining OP2 are presented in Table 5.

Table 5

Machining OP 2

Machining Type	**Location**	**Diameter**	**Cutting speed**	**Machining time**
		[mm]	[m/min]	[s]
Face turning	1	200	460	26.2
Int. turning	2	130	290	76
Face turning	3	175	450	29.9
Int. turning	4	185	300	76.7
Face turning	5	360	480	113
Face turning	6	270	460	80.4
Machining Type	**Location**	**Diameter**	**Cutting speed**	**Machining time**
O.D. turning	7	200	450	90.4
O.D. turning	8	275,5	460	45
O.D. turning	9	270	250	108.5
Drill	10	22	75	84
Drill	11	10,5	60	41.7
Drill	12	10,5	60	21.2
Drill	13	14	65	12.4
Drill	14	18,5	70	18.4
Tapping	15	12	45	13.9
Tapping	16	12	45	6.7
Tapping	17	20	55	12
TOTAL				**1 030.9**

The machining time for the work piece casing covert is:

- machining time for OP 1: 511.5 s/pc;
- machining time for OP 2: 1 030.9 s/pc;
- total machining time: 1 542.7 s/pc.

The machining time does not include the loading and unloading time.

4. CONCLUSION

Using CNC machines we can observe the increase of precision by using automated cycles and cutting tools with higher tool life.

If we compare the classical machining with CNC machining, for the same part, the time for machining is reduced up to 200%. Another advantage of this technology is that the prices for machining of this part are reduced up to 30%.

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