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NIKKEN - HIGH PERFORMANCE TOOLING

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Abstract: *The two tooling systems presented in the following paper "3Lock" and "NC5" represents the next generation of tool Interface. This paper tries to point the fact that Lyndex-Nikken offers a wide variety of live tools designed to enhance the performance of a CNC lathe. These highly precise and rigid tools effectively improve milling, drilling and tapping capabilities in turning operations Lyndex-Nikken stocks a range of standardized live tools for CNC turning centers from Mazak and all other major builders.*

Keywords: *Nikken, tools, 3lock, Nc5, system, full contact.*

Nikken tooling range falls into two main categories which one might categorize as either "Standard Technology" or "Advanced Technology"

"Standard Technology" products provide customers with high quality, reliable manufacturing solutions. They represent outstanding value and deliver unrivalled performance to precision manufacturers operating in high added value market sectors i.e. aerospace, medical, motor sport, oil/gas, power engineering, mould tool and die etc.

For ultra-productive manufacturing solutions, including highspeed machining applications, customers should consider our 'Advanced Technology' products. These products represent Nikken's leading edge technology and can be relied upon to deliver the optimum manufacturing solution. In specific applications such as high-speed machining (HSM) or where difficult-to-machine materials are being used – Nikken 'Advanced Technology' products will improve performance [1].

1. 3LOCK SYSTEM

3LOCK Tooling System is one-step-forward triple contact type Tooling Interface with taper & flange contact + internal expansion. The 3LOCK System uses expanding internal pressure to achieve full contact of the toolholder flange to the face of the spindle, therefore producing unsurpassed cutting performance and cutting tool life.

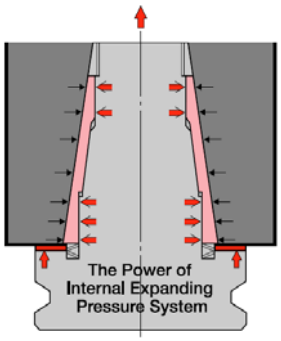


Fig. 1. 3LOCK system.

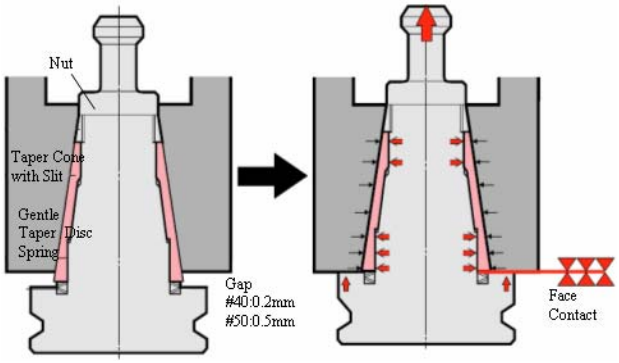


Fig. 2. Before/after clamping.

The 3Lock Holder compensates for centrifugal forces produced by the rotation during high-speed machining. Vibration is eliminated, promoting smooth cutting and longer cutting tool life.

Expanding Internal Locking System. The 3Lock System captures the maximum pulling force generated at the split second of tool clamping.

Dampening Effect. The dampening effect extends the cutting tool life by 3-5 times. Eliminating vibration helps to achieve excellent machining results in aluminum, steel, and alloy steel.

3Lock Technical Information. When a 3Lock Holder is inserted into a 3Lock Spindle (before clamping), the gap between the spindle flange and the tool flange is 0.2mm for a 40 taper, or 0.5mm for a 50 taper.

When the tool is clamped, the taper cone preloaded by the disc springs deforms radially and slides axially to create contact between the spindle face and the tool flange.

Construction of 3LOCK Tooling. 3LOCK System consists of a main body with an internal taper configuration housed inside a taper cone. The taper cone is shaped to conform to a 7/24 external taper. This taper cone is pre-loaded on the body with the disc springs. The combination of the taper cone and disc springs create a dampening effect reducing cutting vibration, thus

extending the cutting tool life. Where the tool is clamped, the taper cone slightly slides in an axial direction to absorb any minute gauge line errors. The internal taper of the main body expands creating a dead lock that results in maximizing the pulling force, when the pulling mechanism clamps the tool, providing contact at the flange. Thus, the triple contact of 7/24 external taper, internal taper of the tool body, and flange can be achieved.

High-Speed and Extended Length The 3Lock Holder is ideal for high-speed and extended length applications (Fig. 3).

It is available in a range of styles and may be compatible with your existing machines [2].

Comparison of cutting capability between the Nikken 3Lock System and BT solid type double face contact tooling (Figs. 4 to 7):

M/C: BT40 solid tipe double face contact spindle

Materials: carbon steel.

End Mill: carbide coated 16 mm dia. 4 teeth, dry cutting.

Fig. 3. Extended length.

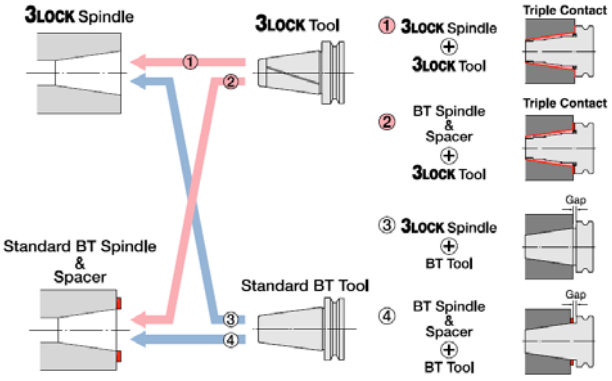


Fig. 4. Comparison 3LOCK –BT system.

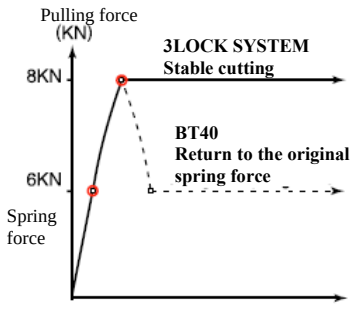


Fig. 5. Comparison 3LOCK –BT system – Cutting stability.

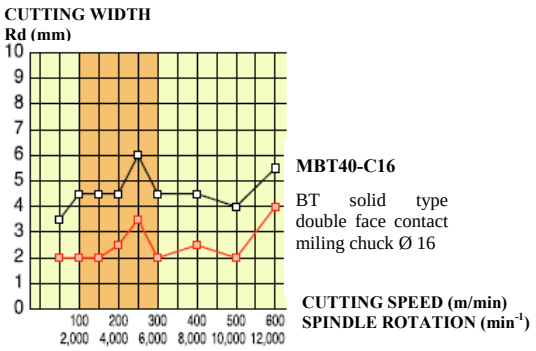


Fig. 6. Comparison 3LOCK –BT system – cutting capability.

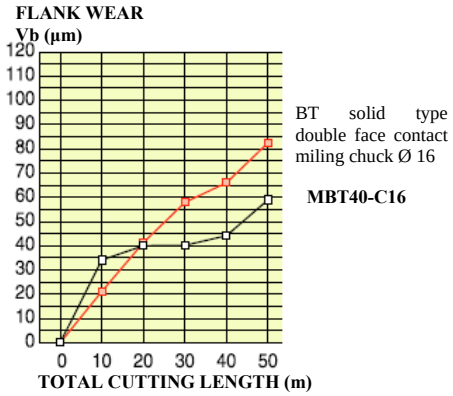


Fig. 7. Comparison 3LOCK –BT system – flank wear.

Condition (1)

V = 50 to 600 m/min S = 1000 to12000 min^{-1}

f_z= 0.125 mm/tooth F = 500 to 6000 mm/min.

Cutting depth A_d = 30mm, carried out as wider R_d as possible until vibration was generated. As in Fig. 6 Nikken 3LOCK SYSTEM provides approximately twice the cutting capability when compared to BT solid type double contact tool.

Condition (2)

V = 400 m/min S = 8000 min^{-1}

f_z = 0.125 mm/tooth F = 4000 mm/min.

Cutting Depth A_d = 30 mm & R_d = 2.5 mm, the flank wear (V_b) is shown on Fig.7. Even the flank wear by BT solid type double face contact tool is increasing in proportion to the total cutting length, the flank wear by Nikken 3LOCK SYSTEM is mostly circulated at the total cutting length = 10m.

2. NC5 TOOLING SYSTEM

The Nikken NC5 toolholder/spindle system (Fig. 8) ofers an alternative to the HSK system. NC5 features a shorter gauge length than HSK because of its solid taper, symmetrical design. As it works on a drawbar mechanism that compresses the split taper, Nikken claims greater taper and flange contact is achieved. Once again, a Belleville washer pushes the split shell upwards as spindle speed increases and bell-mouthing occurs, thus maintaining the full contact with both taper and flange. And because NC5 is solid not hollow like HSK, it has greater static stiffness, like the solid, steep taper BT spindle design [3].

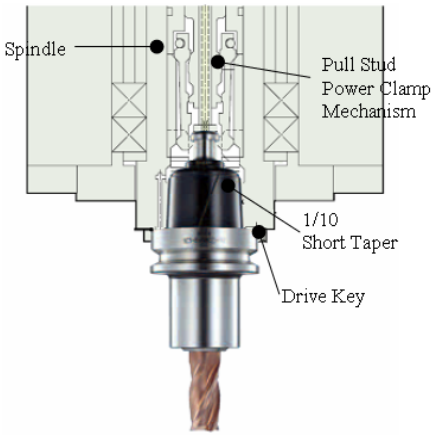


Fig. 8. NC5 tooling system.

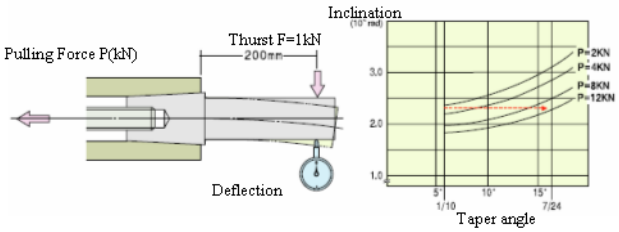


Fig. 9. Correlation between taper angle and static stiffness.

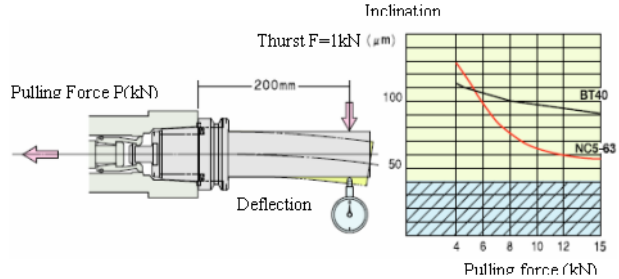


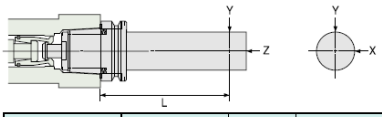
Fig. 10. Correlation between pulling force and static stiffness.

1/10 and 7/24 Taper. The following diagrams show the correlation between *pulling force*/ *taper angle* and their *static stiffness*. As can be seen, using the same *pulling force*, the smaller the *taper angle*, the greater the *static stiffness* it is. Therefore, the larger the *taper angle*, the greater the *pulling force* is required. For example, 12KN of *pulling force* is required for a 7/24 taper to obtain the same value of *static stiffness* as a 1/10 taper using a 4kN *pulling force* (Fig. 9).

Pulling Force and Static Stiffness. The NC5-63 takes advantage of the taper/ *pulling force* to increase its *static stiffness* such that under a force of 5.5 KN the *static stiffness* of an NC5-63 and BT40 are almost the same. But at 12KN the *static stiffness* of an NC5-63 is three times that of a BT40 (Fig. 10) [2].

Repeatability. Higher Repeatability is accomplished due to run-out accuracy of contact flange for taper is within 0.002 mm (Fig. 11).

Cutting examples - Face milling
Tool: NC5-63
Insert: Nikken PRO-END mill PE60H
Material: S53C
V = 180 m/min. constant.



TAPER	Equivalent	L	Repeatability		
			X	Y	Z
NC5- 46	BT30	70	0.003	0.003	0.002
- 63	BT40	120	0.003	0.003	0.002
- 85	BT45	150	0.003	0.003	0.002
-100	BT50	180	0.003	0.003	0.002

Fig. 11. NC5 tooling system.

Fig. 12. Comparison of milling capability using extended cutter.

Comparison between HSK-63, NC5-63 and BT40, (Fig. 12), shows that NC5 tooling is bringing a much more cutting depth that the other tools.

- **End milling**
  (1)Tool Holder: NC5-100 (Fig. 13)
  End mill: Carbide End Mill Ø25.4t
  Material: SCM 415
  V= 300 m/min S = 3800 min^{-1}
  f = 0.3 mm/tooth F = 4600 mm/min.

  (2)Tool Holder: NC5-63
  Insert: Nikken PRO-END mill PE60H
  Material: S53C
  V = 300 m/min S = 3800 min^{-1}
  f = 0.3 mm/tooth F = 4600 mm/min.
  Material: Titan
  V = 75 m/min S = 1500 min^{-1}
  f = 0.18 mm/tooth F = 1700 mm/min.

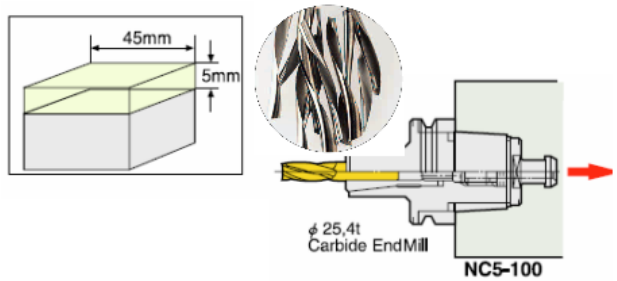


Fig. 13. NC5-100.

Fig. 14. Types of swarf depending of the material.

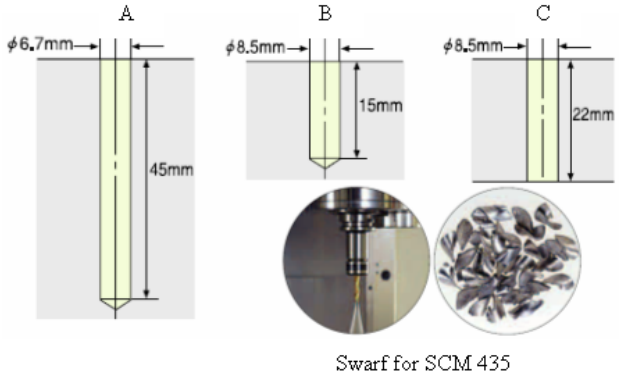


Fig. 15. Examples of drilling.

Drilling (Fig. 15):
A) Deep hole - material: SCM435
V = 100 m/min S = 4770 min^{-1}
f = 0.5 mm/tooth F = 2385 mm/min.
B) Hardened Steel - material: SCM435 (HRC50)
V = 80 m/min S = 3000 min^{-1}
f = 0.15 mm/tooth F = 4500 mm/min.
C) High Speed-High Feed - Material: HRC20~26
V = 134 m/min S = 5000 min^{-1}
f = 1.0 mm/tooth F = 5000 mm/min.

Boring. Current developements in inserts (coated TiAlN and CBN) and their improved capability for high speed cutting is remarkable (Fig. 16). However, the results are based on using these inserts with high-speed cutting conditions (their performance is reduced when used for medium or low cutting speeds). The ZMAC *boring head* has been designed to optimize this new high-speed cutting technology.

Cutting data:
M/C: VC8
Holder : NC5-63-Q26-50
SP26-12-30
12-ZMAC16-45
External coolant
Insert: 3MP-C Nose/R=0.2
Coating (Coated TiAlN)
Material S53C Thermal refined carbon steel
Cutting speed: V = 200 m/min, 350 m/min
f = 0.05 mm/rev for both
Feed: 0.5 mm on dia.

Nikken's NC5 tooling represents a complete system, with compatible end mill holders, tap chucks, drill holders, modular boring tools and so on, with extenders and accessories. The NC5 is available in sizes corresponding to 30-, 40-, 45- or 50-taper Cat style toolholders.

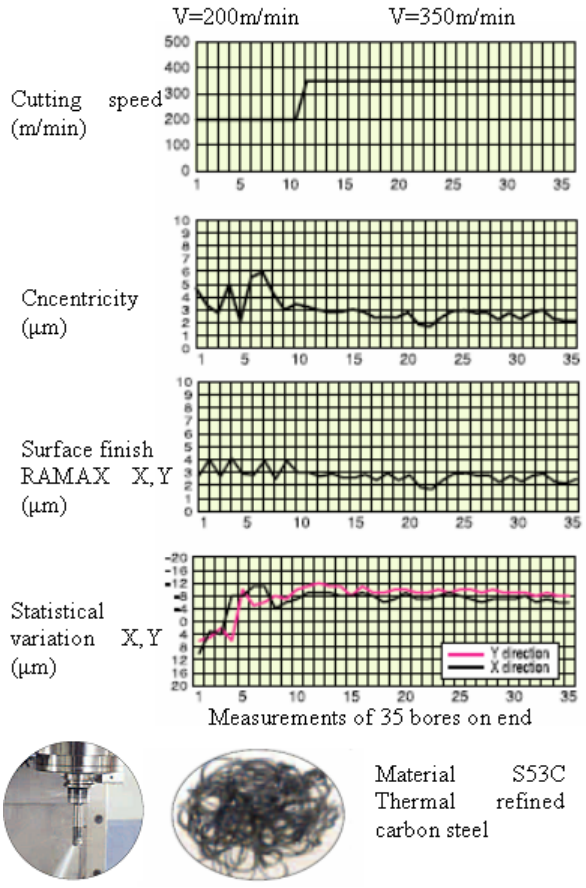


Fig. 16. Improved capability for high speed cutting.

Lyndex-Nikken offers the most comprehensive line of *toolholding products* in the marketplace. This complete range of quality toolholding solutions is designed to meet your strictest requirements to tackle the most complex and demanding applications.

While plenty has been written about the business end of toolholders – the part that actually holds the cutting tool – the other end, the spindle connection, is often overlooked, even though its impact on productivity can be just as great [2].

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