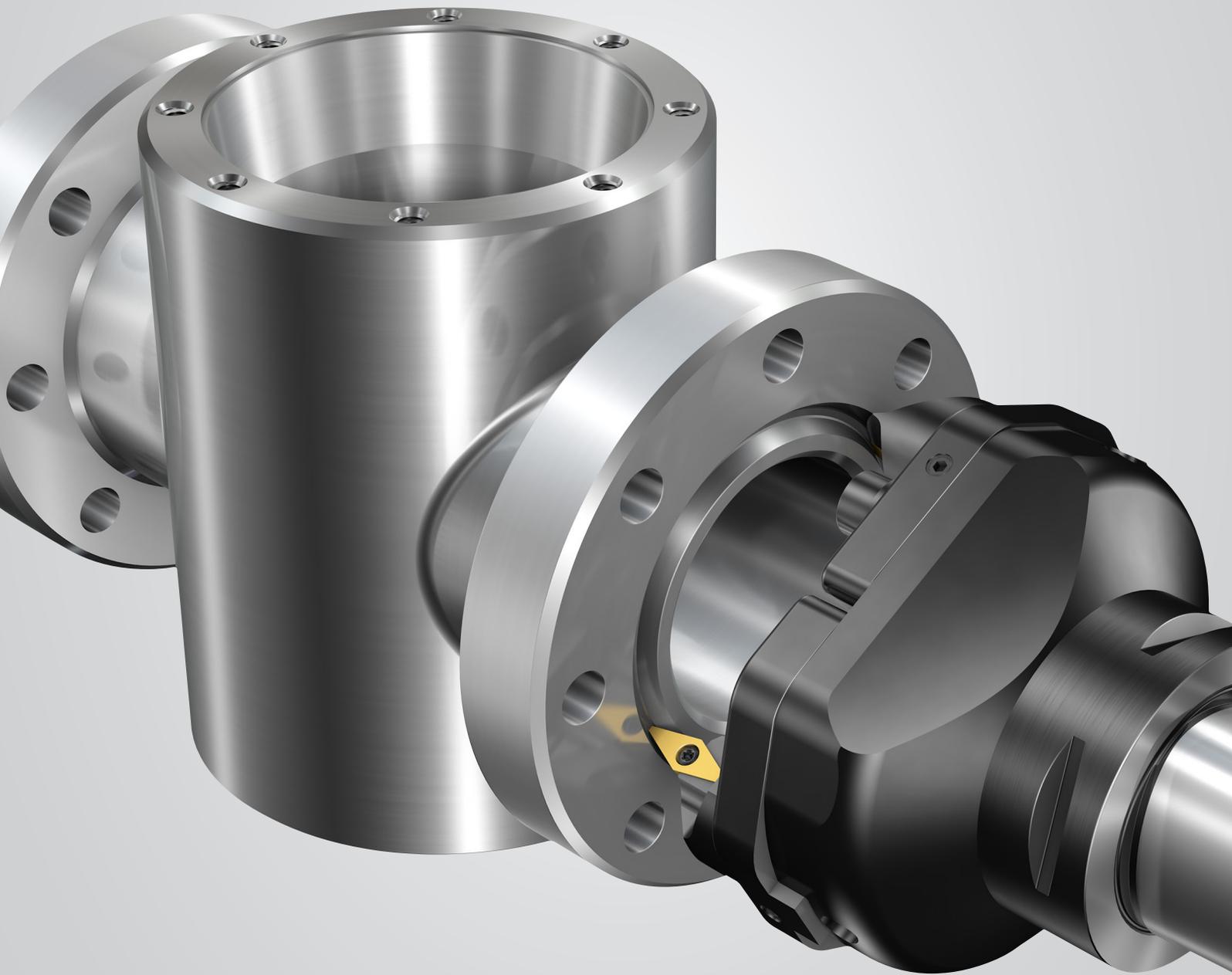


# SpiroGrooving™



# Making API-grooves much more efficiently

One way to provide the very best solution in machining is to develop not only advanced tools but also sophisticated methods to optimize performance, security and results with the focus on individual component features. By focusing on the demands and potential improvements that a feature presents, machining can be lifted to new cost-effective levels. This is the case, not just for complex features but also numerous, relatively uncomplicated but critical features, that need to be made efficiently without the risk of faulty results.

In recent years, in line with both machine-tool and software developments, more intricate and sophisticated tool-path methods and tool-engagements have emerged or been refined. This has moved many machining operations on, especially those that include sensitive cuts and loads, to become not only lighter but faster as well as precise and safe. These include various machining methods such as circular-milling and -ramping, slicing, peck machining, predicted cuts, interpolation, orbital, trochoidal machining, InvoMilling™, etc. Above all, the development has been towards lighter tool-loads and more optimal and safer use of the cutting edge at higher feeds and speeds.

## Seal-ring grooves ....

.... as part of spool bodies, valves, pumps, pressure-vessels, etc. is an example of a component-feature. These have to be made frequently and often under time-pressure in Inco-cladding, stainless steel, steel and even solid Inco-alloys to relatively precise dimensional tolerances and surface finish. Often part of hectic production schedules and with high functional security norms, machining seal-ring grooves provided a lot of scope for improvement. Many components, made in expensive materials, have already accumulated manufacturing costs when the time comes to have one or several grooves made – mistakes bring costly consequences.

## The API-style seals ....

.... are of type R, RX or BX – the latter being the high-pressure variant and not interchangeable with the other two. The groove diameters lie mostly within the 75 to 160 mm range and typically the groove height is below 10 mm. The walls of the groove are inclined at the standard of 23 degrees and the surface finish and groove-angle tolerance is Ra 0.4 to Ra 0.8 micron and plus/minus 15 minutes on the BX-groove, which is half the limits compared to those of the R and RX types, at. The sealing areas in API-seals are comparatively small with high contact pressure, providing high reliability in oil-field operations. Manufacturing demands are then, of course, critical to get right : grooves within limits produced on time and cost-effectively. Secure, stable machining, providing a smooth, flexible and efficient process is the objective for manufacturers involved with this component feature.



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In addition to the production pressures, actual metal-cutting challenges of the API-grooves include: machinability of component materials, chip control, consistency and security in fulfilling quality demands, location of grooves on component (accessibility and tool-overhang).

The application requires a dedicated solution to be successful – and today`s new solution is no exception, only that it is considerably better in all ways than before. Existing conventional plunging and radial-turning need to perform rough and finish operations involving high cutting forces with limited tool-life. When secure, these processes are slow and costly with no flexibility as regards groove-diameter size. Both machining- and tool-costs are high by any standards.

#### **Today`s new more sophisticated approach ....**

.... has been developed to really lift the production of seal-ring grooves on whatever parts may be required. A new type of indexable-insert tool and method, based on proven concepts and innovative machining, performs very efficient, light-cutting circular ramping simultaneously on the OD and ID of the groove.

This new process fulfills all the crucial objectives for machining seal-ring grooves in a very efficient and reliable way. The SpiroGrooving solution provides :

- Considerably reduced cutting time through higher cutting data
- Very high process security
- Wide application flexibility with minimized tool inventory
- Easy-to-apply and set-up procedures

## **So what is SpiroGrooving™?**

SpiroGrooving™ is a trade-mark for a patented innovation in machining methods – a simple yet sophisticated manufacturing process of grooves for sealing rings. Clever use is made of a dedicated cutting tool rather than using brute force, making the machining process much more efficient and secure. The process utilizes the capability of modern CNC-machinery and control. The programme, with the relevant values for an application is generated using a proprietary calculator/generator with a user-friendly interface. A post-processor is the brain behind the process related to the machine tool.

Tooling is based on state-of-the art, proven standard-concepts, where modularity provides broad groove-application flexibility. Where conventional methods require a new set of tools for every groove-type or –size, one SpiroGrooving tool covers a range of diameters, providing flexibility in production and a minimized tool inventory. One tool performs both rough and finish machining.

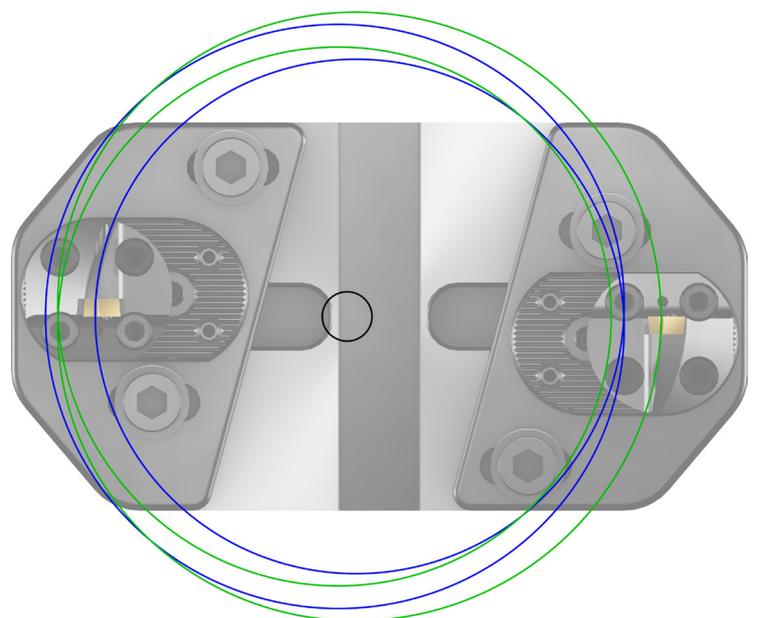
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#### **The tool-path is ....**

...one of tapered, circular ramping where the tool engagement is according to a set ramping-pitch for each revolution. An NC-code generator calculates the SpiroGrooving tool path based on a few input-parameters as part of a complete package. A sophisticated machining process is provided optimizing seal-ring grooves with very limited set-up requirements.

The ramping process – tapered feed movement – is interpolation to continuous levels into the groove. The only tool-setting necessary is that of the tool-diameter to correspond with that of the groove at the top. Based on a few parameters, such as groove-diameter, process-pitch (typically 1 mm for Inco and 2.0 mm for steel) and chosen maximum chip-thickness (typically 0.18 mm), the calculator then establishes the programme. The load on the cutting edge is minimal with chip-thinning effect, allowing high cutting data with short machining times. Chip control is good, as well as the achieved surface finish.

The SpiroGrooving process involves intermittent cutting edge engagements with OD- and ID- oriented inserts of the groove, which according to the spiral, intermittently engages into the programmed cuts. This generates a light cutting action where the load to the insert is no more than the caused by the pitch. The nose-radius of the V-style insert continually goes in and out of cut, taking a light load, leaving a slight top-rest. The 12.5 mm long insert-edge, set at an angle against the 23 degree groove-wall smooths as a wiper on the following revolution, simultaneously as the nose-radius performs the next downward cut. This asymmetrical motion is repeated throughout the ramping-spiral, generating the walls of the groove, until the insert reaches the bottom to generate whatever bottom radius and flat which are well within any surface finish requirements of API-grooves.



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### The tool ...

.... for SpiroGrooving™ is an uncomplicated, clever twin-edge tool with two V-style inserts based on the CoroBore® XL boring system. The tool adaptor has two individual radially-adjustable slides, which have radial adjustability and bolt-locking to achieve flexibility and maximum tool stability. The tooling can be combined with various machine-spindle interfaces, such as Coromant Capto®, HSK, etc. as well as extensions and reductions to suit tool assemblies. Each slide has seats with serrated locking couplings for the two cutting heads. There is full radial adjustability within the groove-diameter ranges for each tool with a grooving range from 50 to 290 mm.

Tool-setting is a simple procedure preparing the tool for the groove diameter at hand where the OD and ID cutting edges are set according to the pitch to be used for a specific groove-diameter.

The circular-ramping tool-path, seen from a groove-shape cross-section, is then in the form of a tapered spiral. At the top of the spiral, where the tool starts its engagement, the inserts are set at the widest part of the groove and the end of the cut, at the groove bottom, sees the insert at the inner, narrowest part of the groove. The combination of method and tool is a unique innovation in machining processes.

### With SpiroGrooving,....

.... manufacturers having to make sealing-ring grooves are looking at substantial benefits. The machining time reduction is considerable – to a half or even quarter of what conventional processes take today – through optimized cutting data and very efficient roughing and finishing cuts.

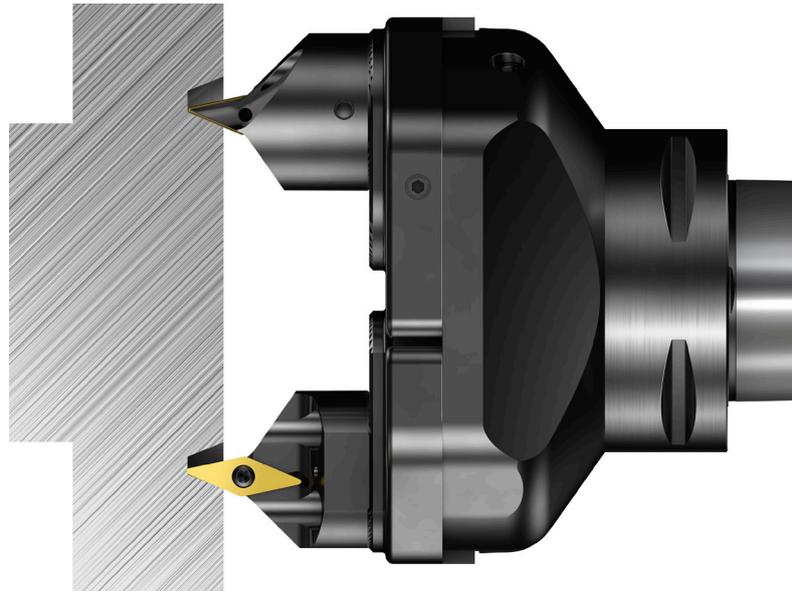
Chip formation is completely controlled through the intermittent cutting edge engagement and chipbreaker insert-geometry.

Tool-life is long and predictable through a machining process that is kind on the cutting edge with the use of the latest in insert-grade technology.

Surface finish and tolerances of any API-ring grooves are easily fulfilled.

Process security is optimal through light, clever machining action using a combination of proven, high-stability, precision tool-concepts. Tooling is standard and modular with very short delivery and specialist backup.

The SpiroGrooving tool is user-friendly, with easy setting and programming employing a dedicated programme and calculator as part of the process. The modularity and generous application range need only minimal tool inventory and tool-costs.



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### An application example ....

.... indicates one typical improvement in machining BX-grooves in a steel Valve body, where groove-diameter is 101 mm, width 16 mm and depth 7.5 mm.

With the previous conventional radial, multi-edge turning concept, for rough and finish operations, the total machining time was two minutes. This employed a cutting speed of 187 m/min, and feeds of 100 mm/min and 50 mm/min, respectively. No diameter flexibility was available and setting was a relatively lengthy procedure.

Switching to SpiroGrooving™, at a cutting speed of 300 m/min and feed of 392 and 50 mm/min the machining time was reduced to 50 seconds. The tool can be used and easily re-set for several other groove applications. The component was moved on in less than half the time with the new method.



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## The tooling components of SpiroGrooving

**CoroBore® XL** is the leading, well-established tool system for large-diameter boring operations. The tool-bridges and -holders have been developed for reliable, efficient at high demands. The system is especially suitable when rigid and reliable performance is sought for larger bores, and to generate good hole quality and tolerances. The tooling has rigid interfaces between tool-head and -cartridge for stable and vibration free boring.

The dedicated cartridges are designed for very high stability. Cartridges are radially adjustable, giving flexibility and stability optimization and coolant is supplied through the tool. There are insert-geometries and -grades for all types of work-materials and the system has a proven record as an advanced, first-preference solution for a majority of large components. Round-insert carriers are an established solution for machining in clad materials such as Inconel 625 welds in oil and gas applications and are now also carriers for V-style inserts for the API seal-groove application in SpiroGrooving.

**CoroTurn® SL** is a leading universal modular system of adaptors with exchangeable cutting heads which enables the building of customized tools for a variety of machining applications. The Serration Lock interface is very robust and allows high tool flexibility through a wide range of tool combinations from a small inventory of adaptors and cutting heads. There is also radial adjustability of heads. This tool system has been widely used for demanding internal and external turning, grooving and threading operations.

**Coromant Capto®** is an ISO-standard, modular quick-change tooling concept offering three systems in one. Quick change tool holders for turning centres reduce set-up and tool change time, leading to significantly increased machine utilization. Coromant Capto® can be directly integrated in the spindle which increases stability and versatility in all machine types for rotating and non-rotating tools. It is ideal as a modular system for machining centres in offering a large variety of extension- and reduction adaptors, enabling assembling of tools with different lengths and design characteristics regardless of the machine interface (SK, HSK, Big Plus). The modularity function means less need for special tools with long delivery times and the same tools can thus be used throughout the entire workshop, providing unique flexibility, optimal rigidity and minimized tool inventory.

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