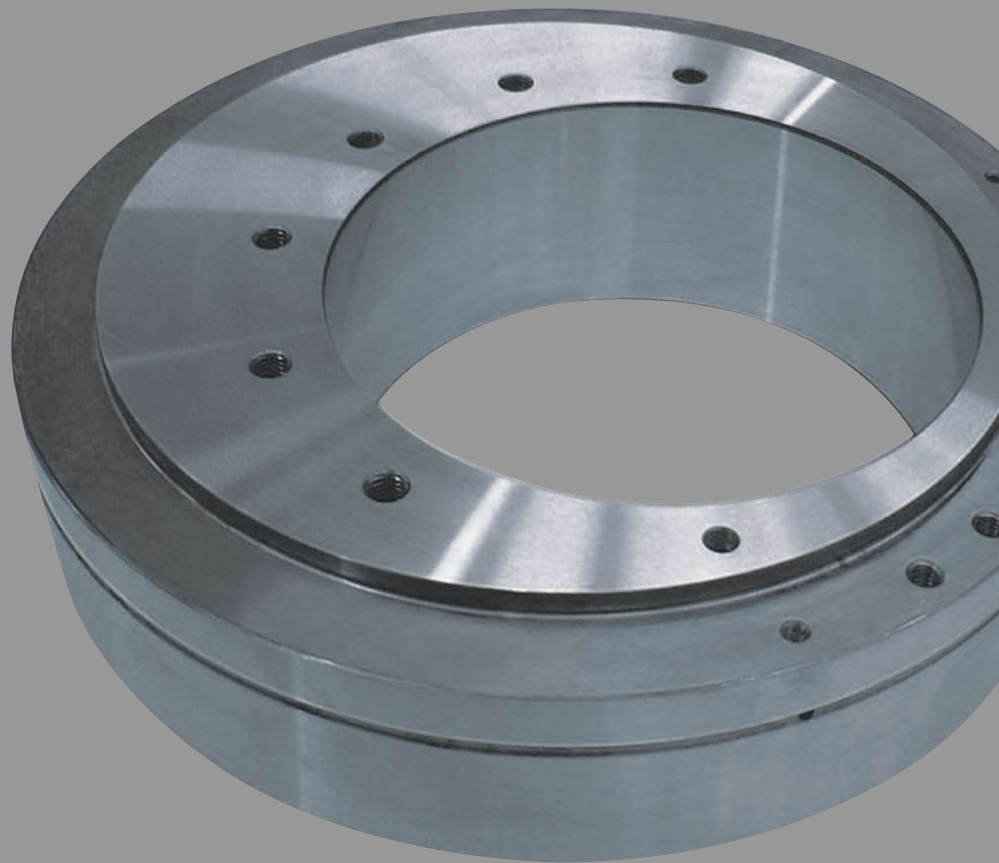


Vertical Grinding Centres

From Grinding to  
complete Machining



Made in Germany

**KEHREN**

Grinding Technology

## From Grinding to complete Machining

Over the past years, grinding operations have become more and more complex, a tendency which will further develop in the future. Here, the driving factor is the complete machining of workpieces in one set-up, resulting in highest precision possible and bringing the wanted rationalization effect.



Picture 1: KEHREN Ri 8-4 *grindturn*

Since 1950, KEHREN GmbH in Hennef/Sieg has built grinding machines. During this time, products have continuously developed to the high-tech machines of today.

With the integration of machining by geometrically defined cutting edges, the range of application of the Ri machine type could be substantially increased. Depending on the machine configuration, the following machining processes can be implemented in only one set-up:

- Surface grinding
- Grinding internal and external diameters
- Grinding taper and radii
- Curve grinding
- Grinding centric and eccentric slots
- Grinding of Hirth and curvic coupling
- Finish drilling of eccentric bore
- Milling and drilling
- Hard turning
- Jig grinding

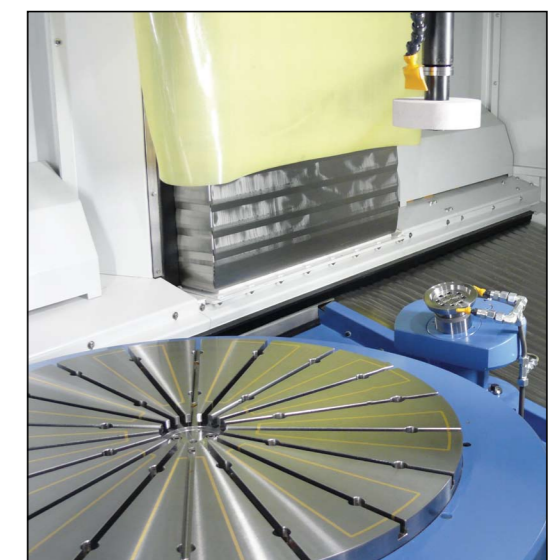
In spite of all these features, grinding is still the main focus. It is not possible to use machining parameters which are used on modern turning or milling machines. With the Ri machines, the turning operation is mainly used for stock removal and the focus is complete finish machining in one set-up.

A most important application for the **Ri** machine is the machine tool industry and their associated part makers with a wide range of various workpieces such as gears and all kind of curves, but also the bearing

and the turbine industry, where fast rotating parts are to be machined, the printing industry, where high precision control curves are to be processed, and the transmission industry for machining gears and bearing bushes or special applications like the grinding of Hirth couplings.

### Machine type **Ri** and **Ri *grindturn***

Vertical grinding centres are available from 500 mm up to 1,600 mm table diameter. The *grindturn* design provides additional equipment for hard turning and hard milling applications. The turrets can be equipped with up to 5 tools. Solid gray cast iron design guarantees a stiff machine with excellent damping properties.



Picture 2: Ri 8-4 interior room, right hand side

### X-axis, Bed saddle movement

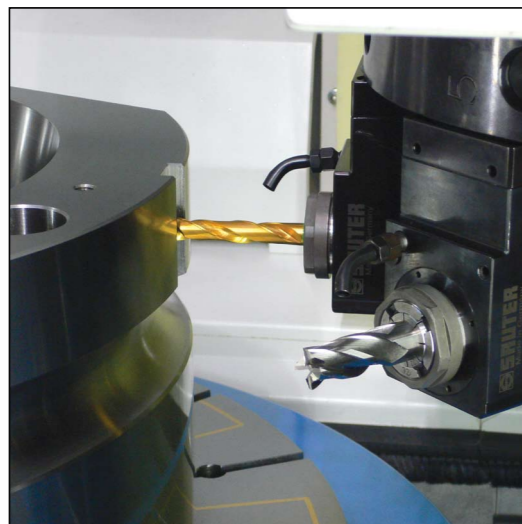
For over 45 years, hydrostatic bearings have been used, and in combination with high precision ball screws as adjusting element, smallest movements of 0.001 mm are possible.

### C-axis, Movement of the rotary table

Also the rotary table bearing is hydrostatic and pre-loaded in axial and radial direction. Thus, radial and axial running accuracies of < 0.001mm mm can be achieved, with a table load of 1,500 up to 7,500 kgs, depending on the machine size.

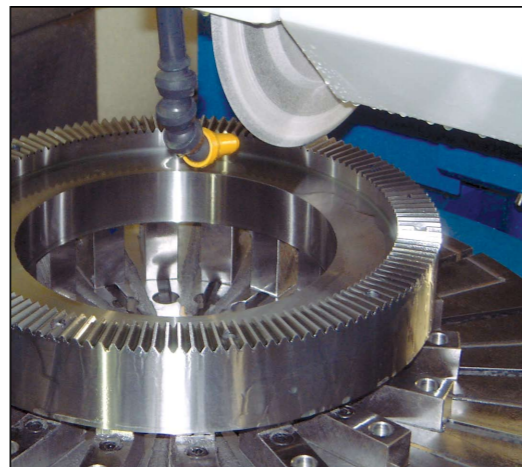
All rotary tables are powered by a backlash free direct drive.

The direct drive provides a positioning accuracy of +/-1.5 seconds of an arc.



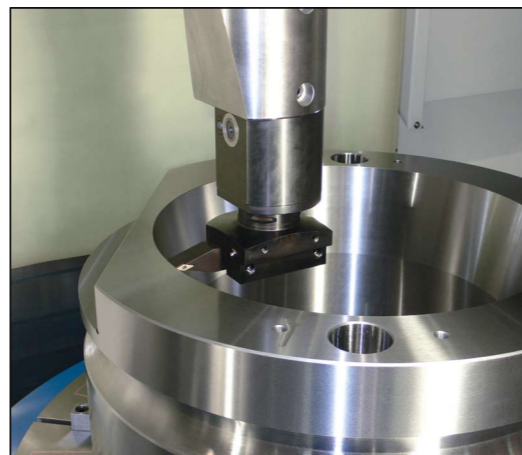
Picture 3: Horizontal drilling

The direct drive has its highest torque when it is at rest, therefore, no further clamping for positioning is necessary, a major advantage for grinding Hirth- and curvic couplings or for drilling eccentric bores.



Picture 4: Grinding of Hirth coupling

Also with the direct drive, a wide range of table rotation speed from  $0,01\text{min}^{-1}$  to  $200\text{min}^{-1}$  (optional up to  $400\text{min}^{-1}$ ) is available, providing the selection of optimum parameters for machining operations.



Picture 5: Hard turning for stock removal

### Z-axis, Vertical movement of the grinding turret

A monorail guidance system is used for the vertical axis. The positioning element is a high-precision ball screw.

### B-axis, Turret

Within the  $280^\circ$  swivel range, the turret can be positioned in  $1^\circ$  increments, in a very precise and also reproducible way.



Picture 6: Revolver with four tool stations and measuring system

The positioning is hydraulically powered, and a Hirth coupling gives repeatability of the highest precision. On request, it is possible to have NC controlled positioning. The turret can be fitted with up to five tool stations, specially equipped for grinding or hard turning and milling application, with the possibility of automatic tool changing.

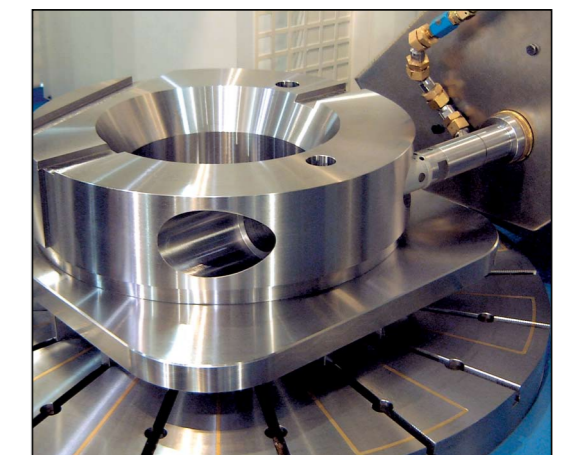
In most cases, grinding spindles with a HSK clamping system or a clamping cone are used. Spindles are always customized, the power of the spindle can range from 9 kW to 30 kW and also the spindle speed can be selected according to customer application.

HSK clamping offers the use of adapters for quick tool change with high repeatability for a wide range of different applications. For the hard turning process, various tool holders can be designed, allowing the use of all common clamping standards.

By means of an integrable disc type tool turret, several turning tools can be used. For an even faster and easier tool change, a customized tool changer with up to 300 tool stations is available as an option.

### Y-axis, Machining in horizontal plane

By means of the optional Y-axis, work pieces can also be machined in the horizontal plane. This flexibility significantly widens the range of application of the Ri machine. Here again, an optional tool changer is available, offering easy tool change.



Picture 7: Drilling of an off-set bore in horizontal plane

### Machine control system

The automatic machining processes are implemented by a Siemens Sinumerik 840 D control.

The standard Siemens software is supplemented by the KEHREN-WOP-Software (Workshop Oriented Programming). This features for example reading of CAD data for contour grinding – ready to use without further corrections.

# Grinding Technology

An adaptive speed control allows grinding process times to be reduced: The feed is controlled by the spindle load; thus process times without work piece contact, for example during jig grinding, can be minimized.



Picture : Grinding of an internal contour

## Dressing of grinding wheels

Dressing cycles can be selected by program or manually at any time. For conventional grinding wheels, single or multiple grain diamonds are normally utilized for dressing. Using a dressing spindle, fitted with diamond wheel, contour dressing is possible for conventional grinding wheels and for CBN wheels. In this process, an axially parallel, orthogonal or angulate position towards the tool axis can be chosen for the driven dressing tool. With all procedures, the required forms and contours can be realized.



Picture 9: Contour dressing

By compensating dressing infeed and wheel wear, parts can be machined in series and without measuring, in repeatable tolerances of less than 0.01 mm.

## Measurement system

However, when implementing the optional Renishaw in process measurement system with probe together with a calibration unit, much closer tolerances can be achieved. The measurement system can be used for gauging all machining surfaces.



Picture 10: In-process calibration of the probe

The measuring data can be read into the NC control and necessary corrections can be realized.



Picture 10: In-process measuring

## Machining applications



Picture 12: Face grinding



Picture 13: Grinding of an external contour



Picture 14: Milling of a horizontal flute



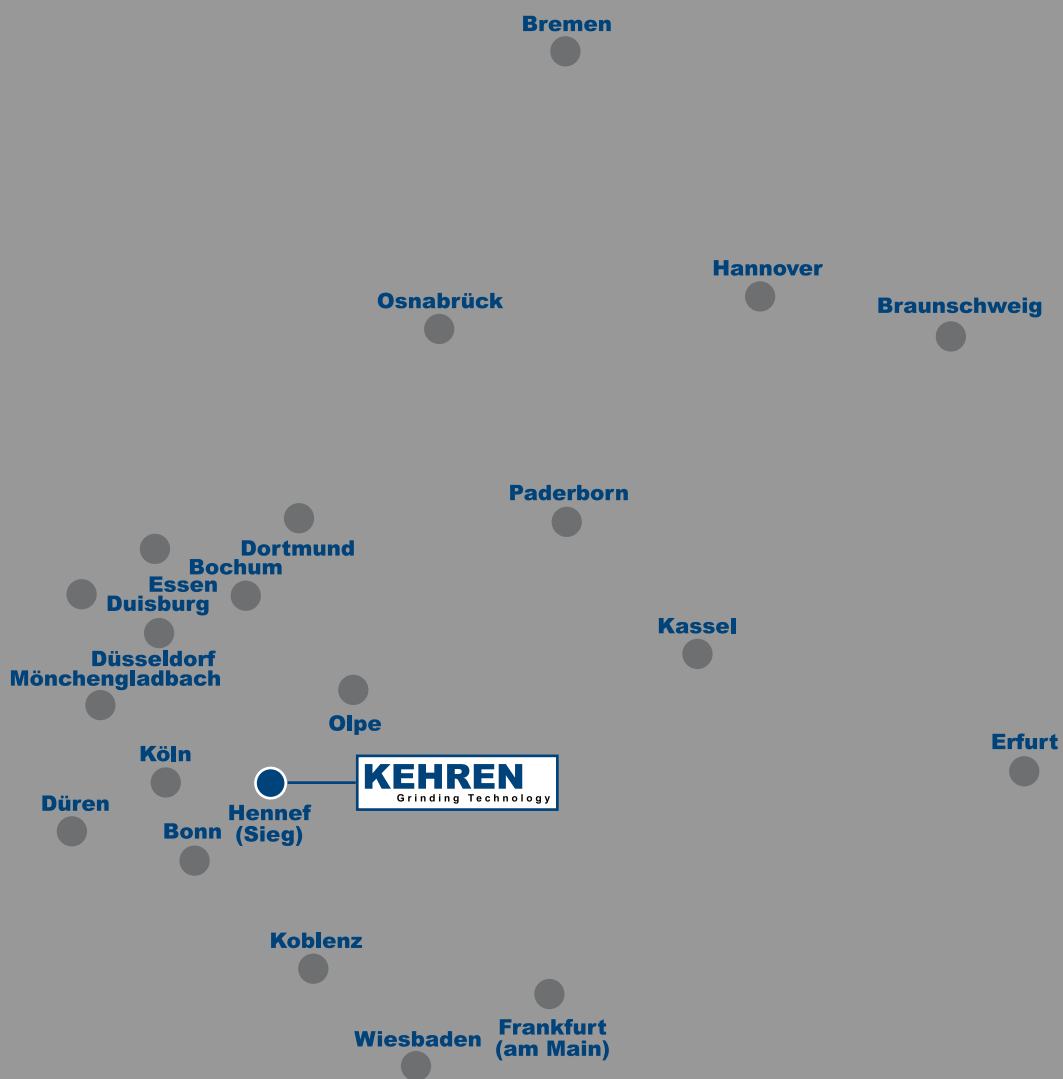
Picture 15: Internal taper grinding

## References

To this day, a large number of **Ri** machines have been delivered to well-established domestic and international customers. Many of our customers use several machines, and some are running even more than 10 **Ri** machines.

## KEHREN General Information

Since 1950, **KEHREN** GmbH has built approximately 2,500 grinding machines of different type. **KEHREN** employs around 80 people. In addition to the introduced **Ri** machine, **KEHREN** builds rotary table surface grinding machines with vertical (**RS** type) and horizontal (**RW** type) grinding spindle as well as surface grinding machines with longitudinal table and vertical grinding spindle (**LS** type). A double column type grinding machine with rotary table or longitudinal table and single spindle or turret is also built. **KEHREN** also produces specially designed **Ri** machines to suit customer's requirements.



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