

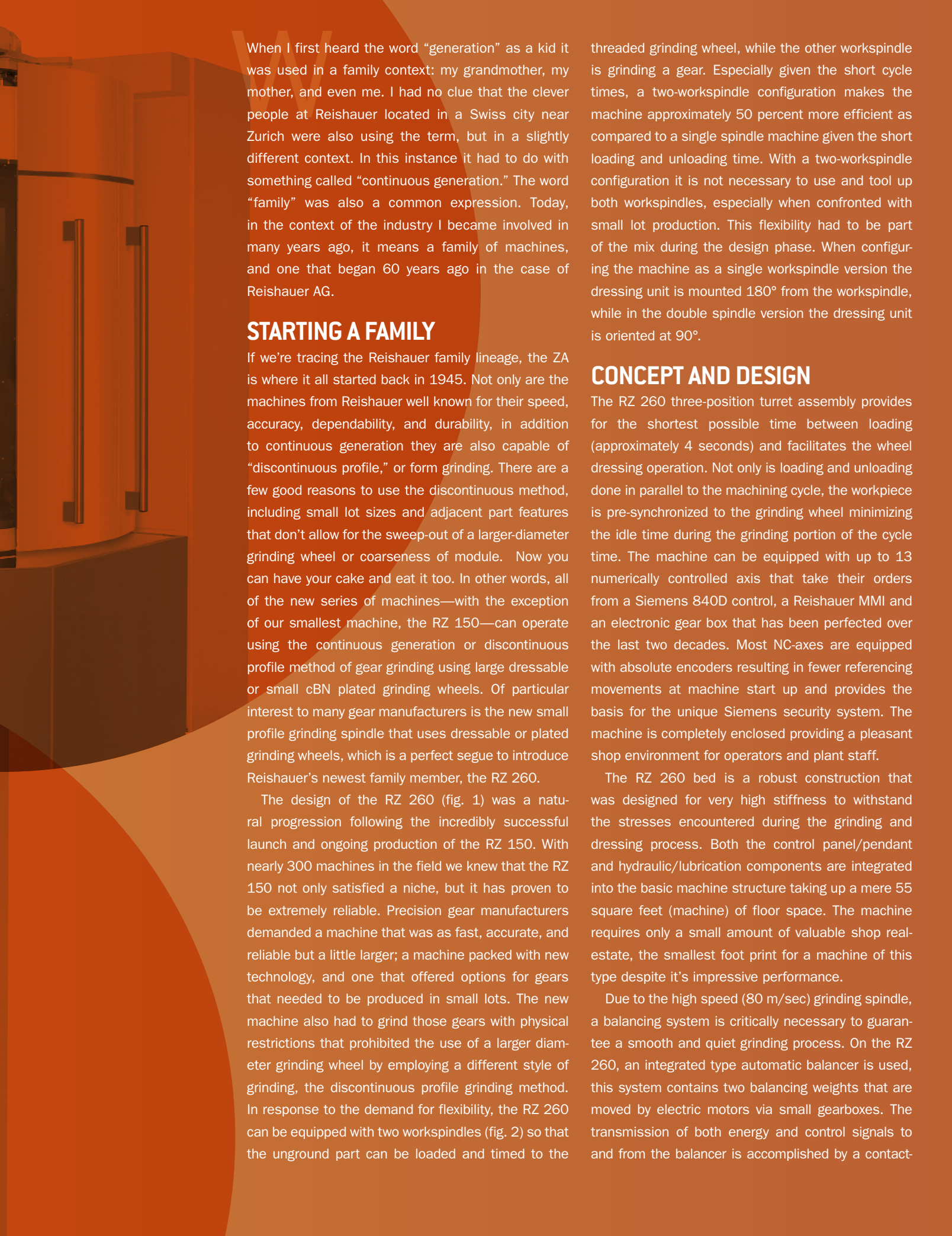
Continuous Generation Grinding



***Precision gear manufacturers
searching for a grinding machine
that's fast, accurate, and reliable
need to know about the RZ 260
from Reishauer.***

By Dennis Richmond

RZ 260



When I first heard the word “generation” as a kid it was used in a family context: my grandmother, my mother, and even me. I had no clue that the clever people at Reishauer located in a Swiss city near Zurich were also using the term, but in a slightly different context. In this instance it had to do with something called “continuous generation.” The word “family” was also a common expression. Today, in the context of the industry I became involved in many years ago, it means a family of machines, and one that began 60 years ago in the case of Reishauer AG.

STARTING A FAMILY

If we’re tracing the Reishauer family lineage, the ZA is where it all started back in 1945. Not only are the machines from Reishauer well known for their speed, accuracy, dependability, and durability, in addition to continuous generation they are also capable of “discontinuous profile,” or form grinding. There are a few good reasons to use the discontinuous method, including small lot sizes and adjacent part features that don’t allow for the sweep-out of a larger-diameter grinding wheel or coarseness of module. Now you can have your cake and eat it too. In other words, all of the new series of machines—with the exception of our smallest machine, the RZ 150—can operate using the continuous generation or discontinuous profile method of gear grinding using large dressable or small cBN plated grinding wheels. Of particular interest to many gear manufacturers is the new small profile grinding spindle that uses dressable or plated grinding wheels, which is a perfect segue to introduce Reishauer’s newest family member, the RZ 260.

The design of the RZ 260 (fig. 1) was a natural progression following the incredibly successful launch and ongoing production of the RZ 150. With nearly 300 machines in the field we knew that the RZ 150 not only satisfied a niche, but it has proven to be extremely reliable. Precision gear manufacturers demanded a machine that was as fast, accurate, and reliable but a little larger; a machine packed with new technology, and one that offered options for gears that needed to be produced in small lots. The new machine also had to grind those gears with physical restrictions that prohibited the use of a larger diameter grinding wheel by employing a different style of grinding, the discontinuous profile grinding method. In response to the demand for flexibility, the RZ 260 can be equipped with two workspindles (fig. 2) so that the unground part can be loaded and timed to the

threaded grinding wheel, while the other workspindle is grinding a gear. Especially given the short cycle times, a two-workspindle configuration makes the machine approximately 50 percent more efficient as compared to a single spindle machine given the short loading and unloading time. With a two-workspindle configuration it is not necessary to use and tool up both workspindles, especially when confronted with small lot production. This flexibility had to be part of the mix during the design phase. When configuring the machine as a single workspindle version the dressing unit is mounted 180° from the workspindle, while in the double spindle version the dressing unit is oriented at 90°.

CONCEPT AND DESIGN

The RZ 260 three-position turret assembly provides for the shortest possible time between loading (approximately 4 seconds) and facilitates the wheel dressing operation. Not only is loading and unloading done in parallel to the machining cycle, the workpiece is pre-synchronized to the grinding wheel minimizing the idle time during the grinding portion of the cycle time. The machine can be equipped with up to 13 numerically controlled axis that take their orders from a Siemens 840D control, a Reishauer MMI and an electronic gear box that has been perfected over the last two decades. Most NC-axes are equipped with absolute encoders resulting in fewer referencing movements at machine start up and provides the basis for the unique Siemens security system. The machine is completely enclosed providing a pleasant shop environment for operators and plant staff.

The RZ 260 bed is a robust construction that was designed for very high stiffness to withstand the stresses encountered during the grinding and dressing process. Both the control panel/pendant and hydraulic/lubrication components are integrated into the basic machine structure taking up a mere 55 square feet (machine) of floor space. The machine requires only a small amount of valuable shop real-estate, the smallest foot print for a machine of this type despite its impressive performance.

Due to the high speed (80 m/sec) grinding spindle, a balancing system is critically necessary to guarantee a smooth and quiet grinding process. On the RZ 260, an integrated type automatic balancer is used, this system contains two balancing weights that are moved by electric motors via small gearboxes. The transmission of both energy and control signals to and from the balancer is accomplished by a contact-

free transmitter. The balancing unit also contains a sensor to detect small vibrations. This together with an electronic module acts as a touch control system, which enables easier set-up of the dressing tool as well as supervision for both the grinding and dressing process.

The grinder is equally adept at grinding shafts as it is bore type parts. Shafts are usually supported with the optional tailstock/s, while there

is normally no need to support bore type parts with a tailstock due to the inherent design stiffness of the workspindle/s:

- OD \leq 260 mm
- Maximum face width \leq 150 mm
- Maximum length for shafts \leq 490 mm
- Module .5 to 4 mm
- Maximum module for form grinding 6 mm



Fig. 1: The Reishauer RZ 260.

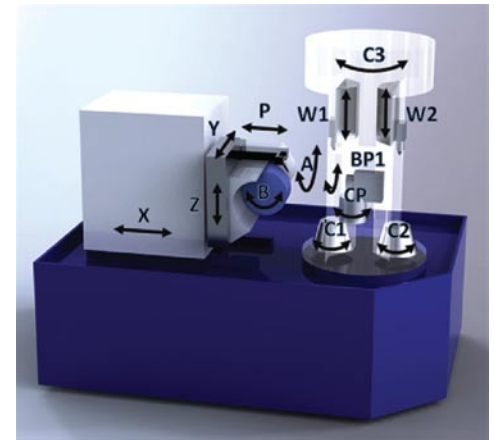


Fig. 2: The RZ 260 can be equipped with two spindles.



Fig. 3: Reishauer's new profile grinding spindle.

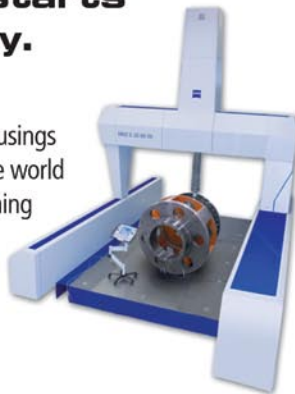


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Flexibility does not take a back seat to productivity as the RZ 260 is available in four versions, in the basic one equipped with a single workspindle, the spindle is automatically moved to an easily accessible position for manual loading. When large lot sizes are called for, the machine is equipped with two work spindles. The machine is configured with a fixed dressing unit if a limited variety of profile modifications are to be produced using workpiece specific dressing diamond tools. When maximum flexibility is called for to produce a large range of different gears, a pivoting dressing unit is the more appropriate choice.

GRINDING PRINCIPLES

As it is on all Reishauer machines, the grinding principle employs the continuous generation method and can be best described as “worm in worm wheel” design. That is to say, a vitrified grinding worm with a rack profile essentially moving tangent to the workpiece while generation of the involute profile occurs. By shifting the wheel tangentially the workpiece is constantly exposed to an unused section, resulting in evenly distributed wear over the face width or usable portion of the wheel. Because a sharp portion of the wheel is present at all times, most gears can be ground in as few as two passes; one roughing, and one finishing. When the usable width of the grinding wheel is exhausted, the diamond roll is rotated into position to renew the wheel by removing approximately .2 mm from the OD and flanks. The size of the gear and resulting center distance between the grinding wheel and gear is automatically maintained through the control of the machine, so no manual intervention is necessary. The grinding principle using the discontinuous profile method is rather straightforward: the shape of the wheel must mirror that of the gear profile to be ground. For obvious reasons the wheel must be dressed a few times per workpiece rather than getting

several gears per dressing operation, as in the continuous generation process. The new small spindle attachment can use either cBN plated or dressable aluminum oxide wheels.

The new profile grinding spindle (fig. 3) is used when grinding gears with space or feature limitations such as small diameter wheels are called for—as small as 60 mm, in fact.

This unit is simply mounted to the standard grinding spindle in place of the larger wheel that is used for the continuous generating process. This spindle was specifically designed for quick changeover between the two grinding processes. In addition to a few physical steps and a couple program inputs, the change is made in minutes rather than hours.

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CONTROLLING THE TWIST

In the past, kinematic deviations caused by surface structure or undulations have often led to the pairing of two gears with different hard

finishing methods such as honing and grinding. In order to change the repetitive microstructure, honing was added in the past as a secondary manufacturing process in some noise-sensitive

applications. The smallest deviations in the rotary axis of the machine manifested themselves onto the surface structure of the ground tooth flank. Thus LNS, or low noise shifting was introduced to avoid destroying the systematic grinding texture. Knowing that it is important to change or destroy systematic grinding texture, LNS was first employed on Reishauer machines nearly a decade ago. This process affects the surface structure in such a way that excitation due to grinding marks can be eliminated. In fig. 4 note the regular pattern or parallel waves in the lead direction of the flank. With LNS activated (fig. 5) the uniform pattern is destroyed leaving a random texture similar to that of honing. Extensive testing on automotive transmissions and on engine balancing gears has confirmed this approach to noise reduction as being both efficient and cost effective.

Reishauer's Twist Control Grinding (TCG) technology offers gear manufacturers a new opportunity to profit from the technical advantages of high performance continuous generating grinding without the disadvantage of

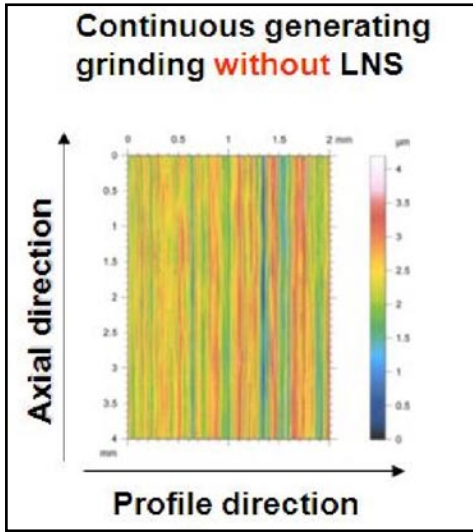


Fig. 4: Without low noise shifting (LNS) activated, note the regular pattern or parallel waves in the lead direction of the flank.

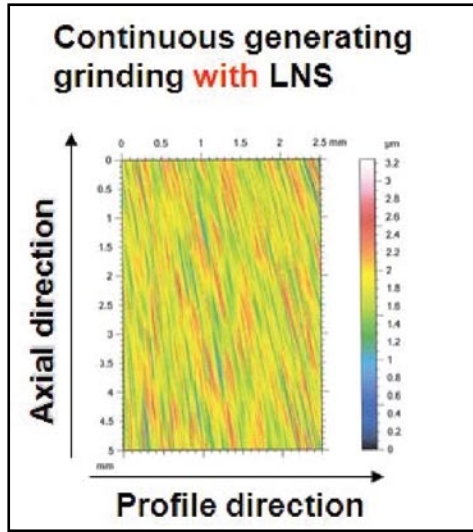


Fig. 5: With LNS activated the uniform pattern is destroyed, leaving a random texture similar to that of honing.



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process related flank twist, which is also known and referred to as bias. This condition occurs on helical gears that have lead modifications, most commonly moderate to heavy crowns. It is created by the geometry and kinematics inherent to the continuous generating process, but it is not limited to this process since the profile or form grinding technique is susceptible to bias or twist as well. Modifications in the lead direction such as crowning or end relief are generally created by changing the center distance between the grinding worm and workpiece during the machining process. The change is generally within acceptable limits in spite of the flank twist. As shown in fig. 6, the contact path between the grinding worm and the workpiece flank does not run along the transverse plane when grinding helical gears that are crowned. The twist is exacerbated by a more-pronounced crown or higher helix angle.

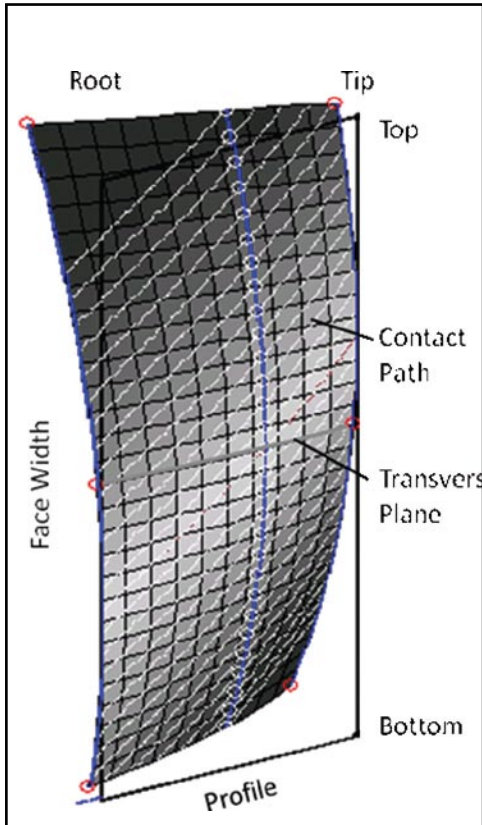


Fig. 6: As shown here, the contact path between the grinding worm and the workpiece flank does not run along the transverse plane when grinding helical gears that are crowned. The twist is exacerbated by a more-pronounced crown or higher helix angle.

Using TCG, manufacturers benefit not only from high productivity, low perishable tool cost, and the unmatched stability that has long been associated with the generating process. TCG can also be used to minimize the affect of flank twist, or to conversely induce a designed specified bias according to a particular application. The technology is currently being practiced successfully in high volume production. 🏆

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