



NEXT-GENERATION GEAR GRINDING

Reishauer's continuous generating gear grinder, the RZ 1000, provides greater accuracy, faster setups and changeovers, and onboard inspection capabilities.

By Dennis Richmond

What do the gears that end up in trains, wind generators, speed reducers, marine transmissions, off-road equipment, and printing presses have in common? They must run quietly, carry heavy loads, have excellent pitch variation, be very accurate, and offer a long service life. This would normally dictate a post heat-treat process of tooth finishing, the most common being grinding. The solution could be the RZ 1000, Reishauer's newest generation of large continuous generating gear grinders. Making larger gears in smaller lot sizes represents a challenge for all manufacturers, due in part to the hurdles of high material/manufacturing costs, the pressure of a time deadline, and the skill level required to produce such high-speed gears. There has never been any argument that continuous generating tooth grinding results in the lowest cost per piece, highest throughput, and superior index accuracy as compared to single tooth form grinding—although that process has made significant improvements in the last decade. If we identify the key elements a machine must possess in order to grind large gears they are dynamic stiffness, flexibility, short setup and run times, and onboard inspection. Lets break them down to their rudimentary form.

If the control is considered to be the brain of the machine, it's a natural assumption that the workspindle could be considered the heart. In order to transmit smooth motion, high torque, and the necessary workspindle speeds ranging from grinding to inspection, a nontraditional approach was necessary.

The table drive is rather unique and patented for this type of application. A gearless planetary drive provides the static and dynamic rigidity unmatched by any machines of this type. This type of friction drive also eliminates the "ghost" frequencies of past designs, as there are no gear teeth in the drive assembly. The Chart in Fig. 1 illustrates the uniformity of rotation of the workspindle of the RZ 1000. With an acceptable deviation of < 0.3 arc seconds peak to peak, you can understand how accurate the assembly is.

The design also allows for a broader range of workspindle RPMs and is not limited like conventional designs driven by spur/helical gear sets or bronze worm wheels and steel worms. A “direct drive system” (as used by a few manufactures) was given some initial consideration, but it did not achieve the desired results and presented a new set of workspindle speed limitations. A set of high precision rotary encoders keeps this axis in sync with the other rotary axes of the machine.

The control, or “brains,” of the machine is the next vital element in the solution chain. A high-speed, very precise “generation” module in conjunc-

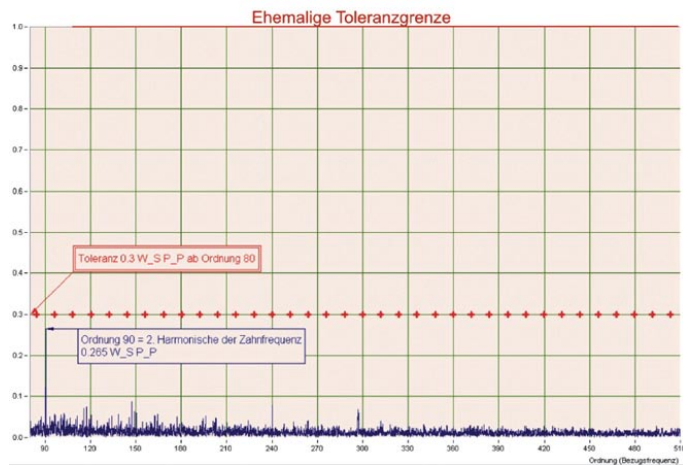
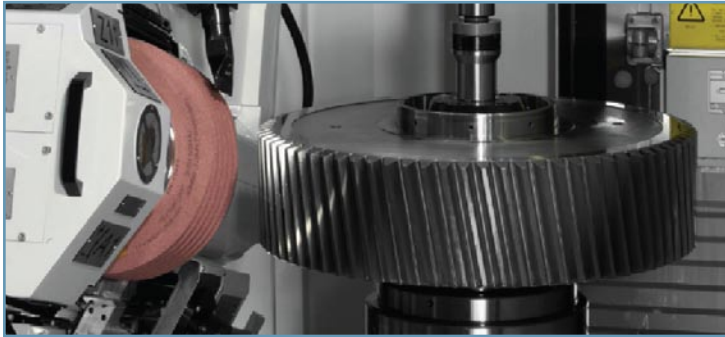


FIGURE 1

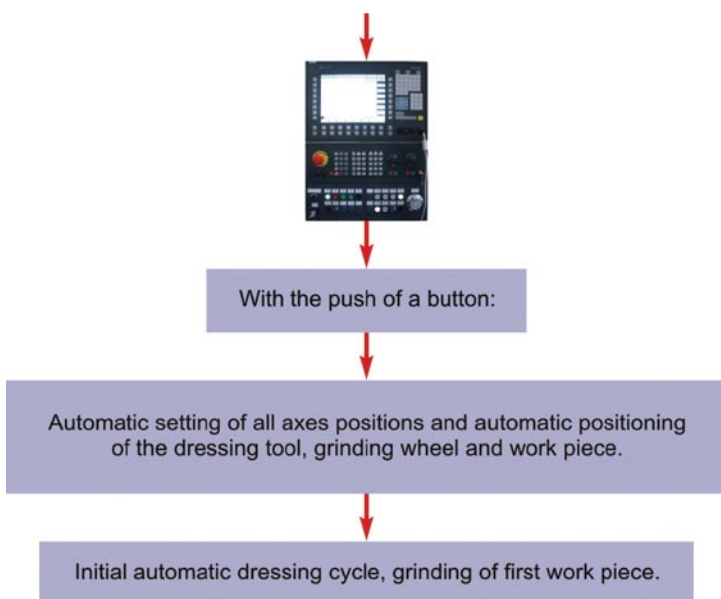


FIGURE 2

tion with a flexible operating system are the prerequisites for a perfectly controlled process from the standpoint of grinding as well as inspection. Due in part to its configurable design concept, the Siemens 840D CNC provides the perfect platform for the integration of the Reishauer electronic gearbox and the MMI (see Fig. 2). The main features are:

- Windows operator interface with real-time data inputs during the running process for quick online optimizing
- Open architecture for the user to program virtually any geometry and technology function for grinding, dressing, and inspection to increase quality and efficiency
- Display of supported diagnostics system for all critical machine functions, including the potential connection to an external network
- Display of supported diagnostics system for basic process analysis with graphic assistance of error detection
- Assistance to the operator during data input via Reishauer technology software for the automatic calculation of machine data settings
- Comprehensive safety functions for axis monitoring (with SSI) to protect operator and machine
- Moving all relevant setup and drive axes with the help of automatic or manually activated electronic hand wheel for safe and fast setup of the machine
- Computer-assisted setup technology

The base or foundation for any constitution—whether it be a house, commercial building, or a machine tool—has to provide the static rigidity to support the function of the structure. When the new machines were first envisioned, we knew that the base had to possess the utmost in structural integrity, be resistant to thermal growth, and provide the platform to build upon. A fabricated base with cast iron subassemblies seemed to satisfy all of the design parameters and objectives perfectly. Any machine we designed had to be easily accessed for loading and unloading, setup, and changed over quickly, while occupying a minimum of plant real estate. You might call it a hybrid of a machine, as the bed is constructed out of steel and the tailstock, workspindle assembly, and tool holding axes are made of cast iron. No other gear-manufacturing machine has such a unique configuration (see Fig. 3).

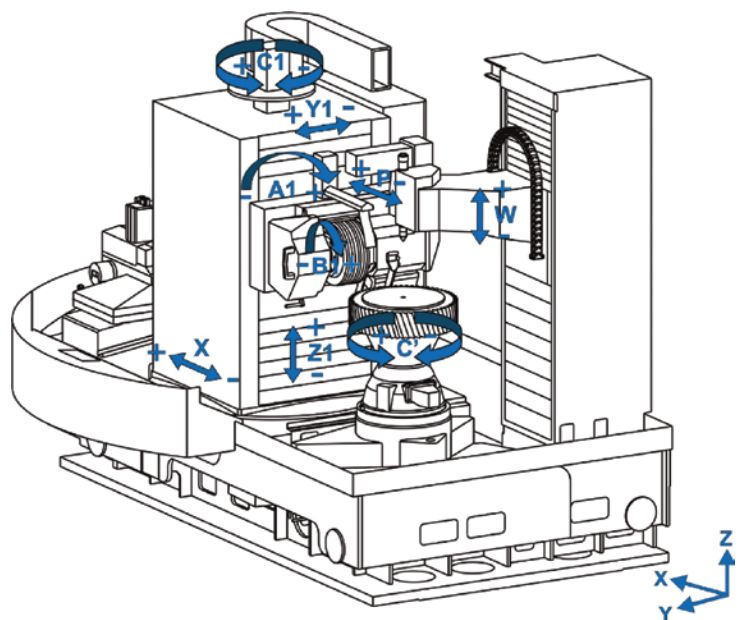
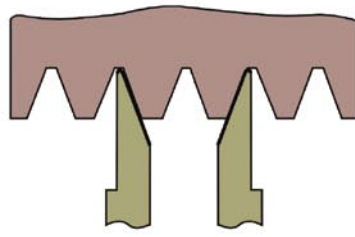
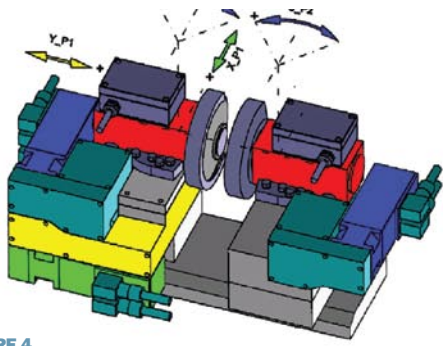
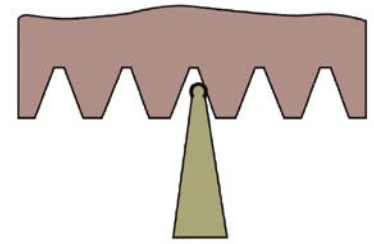


FIGURE 3



SINGLE TAPER DIAMOND DISC SET



OR DOUBLE RADIUS FORM ROLL FOR PROTOTYPE WORK

FIGURE 4

The entire C1 axis, which houses the grinding spindle and all of its related axes, rotates 180° to facilitate wheel change and dressing of the grinding wheel, as well as its home position when in the grinding mode. In its three o'clock position (as seen from the operator perspective) the main column is in the grinding location, which allows for easy access whether manually or automatically loading the workspindle. When the column is in the six o'clock position the grinding spindle affords an ergonomic position for the operator to change the grinding wheel, and to that end it can be programmed to suit the height of the operator. As an alternative, an optional wheel-changing device is available. Rotate the column to the nine o'clock position and witness the speed at which the wheel is dressed, with the infeed at both ends of the stroke making the dressing process a breeze, even for wheels having up to seven starts. The 12-axes machine (six rotary and six linear) is configured for just about anything that one can throw at it.

To be in accord with the "flexibility" concept of the machine, the wheel dressing operation had to incorporate an efficient means to dress wheels for higher volume jobs as well as the single piece lot size or prototype work. Enter the RP 160-2 dressing unit.

Designed to offer the best of both worlds, the RP 160-2 dressing unit (two rotary axes and one linear) serves as a well-conceived platform that can house a single rotary diamond tool to "line dress" nearly any tooth modification without the need for a dedicated tool for prototype or low-volume work. Conversely, this unit can be equipped for use with a traditional set of single tapered diamond disks for series production (see Fig. 4).

Onboard inspection for gears that can be ground on the RZ 1000 was a natural progression, given the fact that typical gears could tip the scales at well over half a ton. The weight—coupled with the time consumed to lift the gear off its fixture, transport it to the gear lab, measure the results, and then return it to the grinder, remount the part, and make the necessary corrections—was enough justification to



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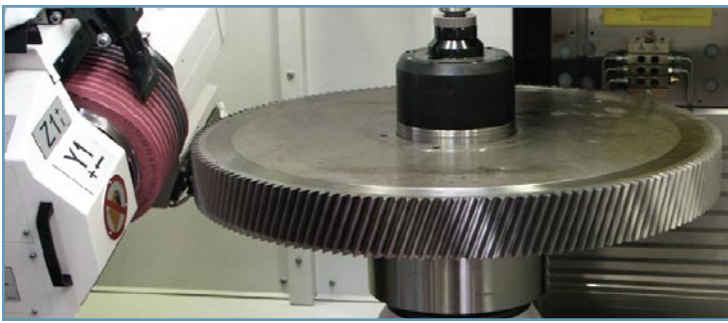


FIGURE 8

to assure print and color separation. In Fig. 8 you'll see a press gear being ground on a RZ 1000. Gear parameters were:

- Module 4.5 mm
- Number of teeth 163
- Face width 80 mm

WHEEL PARAMETERS:

- Outside diameter 300 mm
- Width 145 mm
- Number of starts 3

PROCESS DATA:

- Grinding time 17 minutes
- Floor to Floor time 18 minutes


The RZ 1000 is the largest continuous generating gear grinder in the Reishauer product line, providing outstanding productivity and flexibility for an entire variety of parts and meeting all demands for quick setup and short changeover times, highest accuracy, and advanced software for improved process and onboard inspection capabilities. 



FIGURE 9

ABOUT THE AUTHOR:

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