

Precision and Automation

# REIGN

at Reishauer

By Dennis Richmond



## Concept and design collide in the **RZ150**, resulting in a high-performance gear grinder unlike any other currently available on the market.

**T**he last two decades have brought about an evolution in automotive gear manufacturing. It was apparent 10 years ago that automatic transmission manufacturers were headed in a direction that would require post heat treated gears be hard finished, not only as a broad requirement to improve accuracy and reli-

ability, but to also attain noise reductions, allow gears to carry more load, and have extended life in an effort to meet the demands of a discriminating buyer. By making higher quality gears that go into automatic transmissions the manufacturer is able to transmit additional horsepower and torque to the drive wheels through the same sized or smaller gearbox allowing greater fuel efficiency. As cars

became more aerodynamic, greater attention was paid to transmission noise, and that in turn precipitated the need for higher quality gears. The need for far greater productivity and quiet gears led to the development of the RZ150.

**Concept and design:** The RZ150 is the only two-spindle gear manufacturing machine of its type on the market today. The three-position turret assembly provides for the shortest possible time between loading (approximately four seconds) as well as the facilitation of the wheel dressing operation.

Not only is loading and unloading done off-line, the workpieces are pre-synchronized to the thread in

the wheel to minimize idle time during the grinding portion of the cycle. In keeping with the “need for speed” the RZ150 utilizes the continuous generation method of grinding (similar to hobbing) and employs a threaded multi-start grinding wheel.

The machine is comprised of 12 numerically controlled axes with high precision measuring systems for accurate and continuous path control. Of those 12 axes, five are in synchronous motion during the grinding process. Four axes are in synchronous motion in order to effect the precise shaping on the wheel during the dressing operation. Most NC-axes are equipped with absolute encoders, which result 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 RZ150 bed is a robustly fabricated steel construction that was designed for very high stiffness to withstand the high stresses encountered during the grinding and dressing process. Both the control panel/pendant and hydraulic/lubrication components are integrated into the basic machine structure (Figure 2) taking up a mere 54 square feet of floor space. The machine requires only a small amount of valuable shop real-estate, the smallest foot print of a machine of this type despite its spectacular performance, which some have described as “shock and awe.”

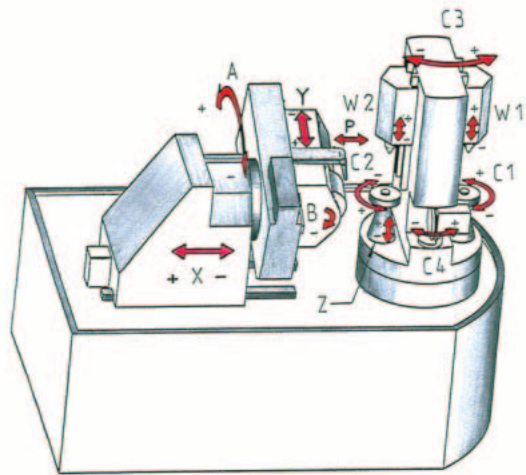
The complete grinding system layout is comprised of a material handling system, coolant/filtration equipment, and the machine itself. The typical space needed for the complete system is approximately 15x20 feet. The control panel is even hinged on the back of the machine so that it can be swung out away from the machine for service—a feature that maintenance technicians dream about!

The RZ150 is equally adept at grinding shafts as it is bore-type parts. Shafts are usually supported with the optional tailstock(s), and there is normally no need to support

bore-type parts with a tailstock due to the inherent stiffness of the workspindle design. Some of the machine’s specifications include:

- OD of 20 to 150 mm.
- Maximum face width of the gear 50 mm
- Maximum length for shaft-type gears is approx. 350 mm
- Pitch rating of module 1 to 3 mm
- Helix angle plus or minus 40 degrees
- Diameter of grinding wheel is 275-206 mm
- Maximum wheel width is 125 mm

The grinding principle—as is the case with all Reishauer machines—employs the continuous generation method and can be best described as “worm in worm gear design.” That is to say, a vitrified grinding worm with a rack profile, in essence, moving tangentially to



**Figure 1**

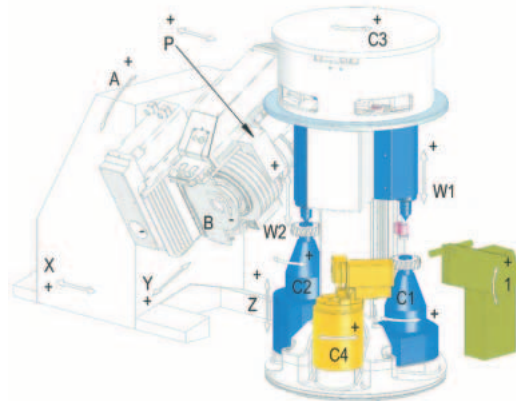




Figure 2

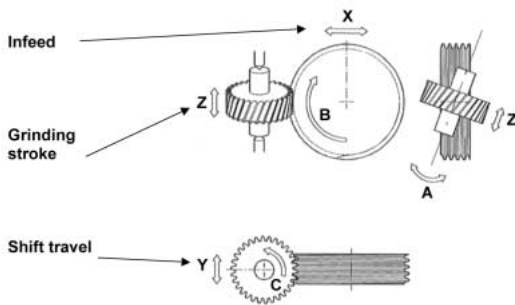
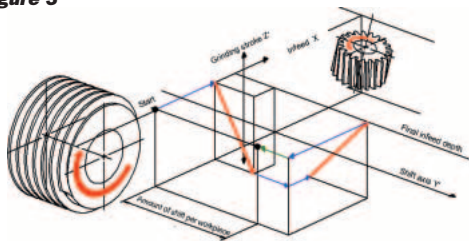


Figure 3



the workpiece while generation of the involute profile occurs. The wheel is shifted tangentially as the workpiece is fed past it to expose a sharp section of the wheel in the cutting zone and to evenly distribute wear over the face width or usable portion of the wheel as well. Because a sharp portion of the wheel is present at

all times, most gears are able to be ground in as few as two passes; one roughing and one finishing pass (Figure 3). When the usable width of the grinding wheel is exhausted, the diamond roll is rotated into position to refurbish the wheel by removing approximately .2 mm from OD and flanks of the wheel. Size of the gear and resulting center distance between tool and gear is automatically compensated for through the control of the machine, so no manual intervention is necessary.

Due to the high grinding spindle RPM, a balancing system is critically necessary to guarantee a smooth and quiet grinding process. On the RZ150, an integrated type automatic balancer is used which contains two balancing weights that are moved by electric motors via two 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 the dressing process.

The wheel dressing unit for profiling the grinding worm is a very important device. It must dress a very precise grinding wheel form responsible for generating the gear profile. Alignment of the dressing tools to the thread on the grinding wheel is facilitated by the use of acoustic sensing devices and is completely automatic, no operator involvement is required. This automatic alignment assures fast and accurate positioning, eliminates the possibility of damage to the tool and extends the diamond tool's usable life. Profiled diamond-discs or composite rolls mounted on a super-precision, high-speed spindle are used to dress the grinding worm profile. Different types of dressing tools can be selected that best fit the desired profile according to the customer's specific requirements. This method is very fast but not universal in its application. However, it is well suited for high volume production.

The automatic stock-dividing sensor is located outside the working area and takes place on the workpiece spindle in the loading position. The measuring process determines the tooth width and the tooth gap of all teeth of the gear to be ground and calculates the corresponding angular position for best fit of workpiece in relationship to the grinding worm thread so that a precise mesh is guaranteed for the subsequent grinding operation (Figure 4). The same stock dividing system is also

used for crash prevention. The system measures not only the tooth width and gap, but also counts the number of teeth and determines whether the tooth width is within a preset range. As a result, the machine knows that the correct workpiece has been loaded and that pre-machining is within acceptable limits. If a deviation is detected, the machine rejects the part.

The RZ150 is equipped with the modern Siemens 840 D CNC control. It is a multi-processor control with outstanding performance and reliability, and probably one of the most powerful control systems you can buy today. A special control feature is the electronic gear box, or EGB, developed by Reishauer, which synchronizes the two independent work-spindle axes to the corresponding master axis. In fact there are two EGBs, which are combined in one module. This EGB-module runs on its own computer system with special software and two super fast servo-controllers. The EGB-module is embedded into the Siemens control system. The NC includes the well-known S7 PLC for all logic controls. It is programmed in

the state of the art PLC-programming language from Siemens, called "Step 7." The 840 D also includes the Safety Integrated System, or "SI" for short. This is a true two-channel safety system which continuously monitors all NC-axes to prevent any "potentially dangerous" movement in case of hardware or software failure. Another standard feature the Siemens 840 D offers is a highly sophisticated diagnostic system for checking of all components of the NC-axes as well as checking of inputs and outputs of the PLC and all the other control components.

Of course, this CNC-system makes it possible to create a user friendly MMI (man machine interface). The actual input screens allow entering of all necessary data as indicated on the blueprint of the gear. All parameters are purposely arranged to accomplish a clear overview (Figure 5). A wide range of modification possibilities is covered by an easily understood data input screen. Separate screens are available for the tooth-modifications and tooth-corrections. Small deviations to the gear flank form, usually caused by the applied grinding parameters during production, can be corrected via program input without changing the original gear modification data. When the data has been entered, a graphic representation appears on the screen which allows the operator to visually check whether the input data is correct. This feature allows us to estimate the whole topology of the gear flank which is to be ground with the entered modification data.

Automation and material handling equipment for the RZ150 can be configured in a wide array of in-plant handling equipment. One such system uses wire baskets to store the workpieces. The wire baskets with ground gears are stacked up and interchanged automatically with baskets of gear blanks, a robot arm is equipped with a double gripper and brings the workpieces from the wire basket to the workpiece spindle in two stages. Yet another system was equipped with a double gripper loader and a conveyor for the workpieces. This is a universal system which allows short set-up and change over-time.

For a new workpiece, only the gripper-fingers and the workpiece pallet-inserts have to be changed. The gears are loaded and unloaded manually from the conveyor pallets or by a robot system. As options we offer auxiliary devices such as centrifuges to remove adherent oil, measuring stations that inspect specific blank dimensions to avoid clamping problems, or a station to reject parts for statistical quality control.



Figure 4

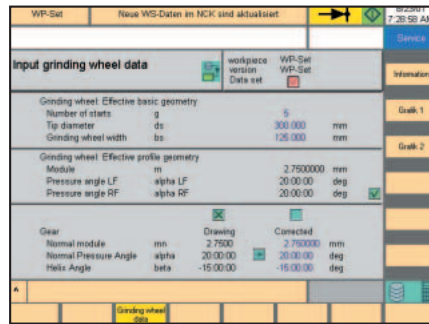
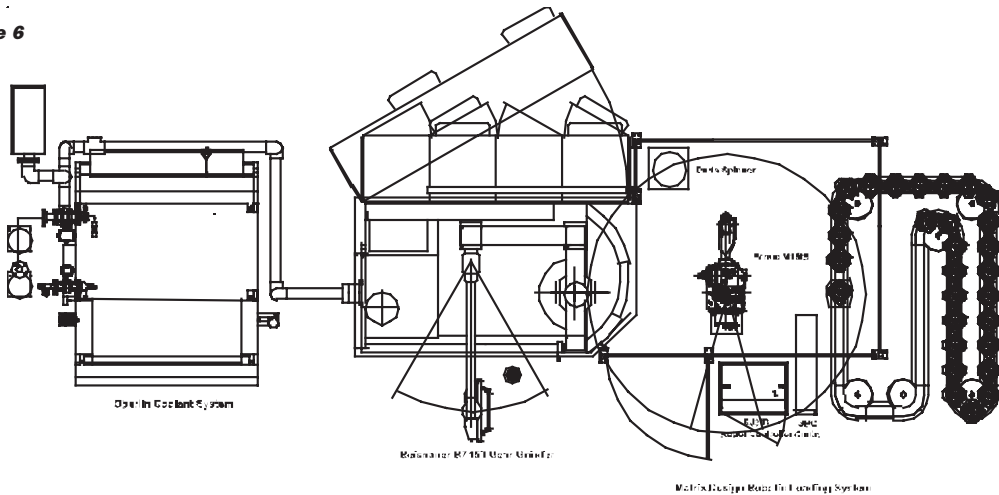


Figure 5

Figure 6



Reishauer is one of a small handful of machine tool builders serving the manufacturers of high precision, hardened gears in the global marketplace. We urge all of those pursuing this type of technology to carefully evaluate the process, the machine, and the company behind it before making a purchasing decision. 📄

**ABOUT THE AUTHOR:**

Dennis Richmond is vice president of the Reishauer Corporation. He can be reached at (847) 888-3828, or via e-mail at [dennis.richmond@reishauer-us.com](mailto:dennis.richmond@reishauer-us.com). The company's Web site is [[www.reishauer.com](http://www.reishauer.com)].

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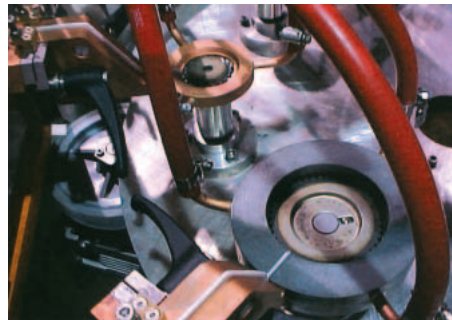
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