

Grinding and Abrasives

Flexibility and productivity are the keywords in today's grinding operations. Machines are becoming more flexible as manufacturers look for ways to produce more parts at a lower cost. What used to take two machines or more now takes just one.

Flexibility is seen in many of the newest model gear grinding machines. Several machine tool manufacturers (Kapp, Liebherr & Samputensili) now offer dedicated gear grinding machines that are capable of either generating grinding or form grinding on the same machine, and the machines can use either dressable wheels or electroplated CBN wheels. On-machine dressing and inspection have become the norm.

Automation is another buzzword in grinding and abrasives this year. Gear manufacturers are reducing their costs per piece by adding automation and robotics to their grinding and deburring operations.

Productivity is being further enhanced by the latest grinding wheels and abrasive technology. Tools are lasting longer and removing more stock due to improvements in engineering and material technology.

All of this adds up to a variety of possible solutions for the modern gear manufacturer. If your manufacturing operation includes grinding, honing, deburring, tool sharpening or any number of other abrasive machining operations, today's technology offers the promise of increased productivity, lower costs and greater quality than ever before.

By William R. Stott



ROTARY TRANSFER GRINDER FROM ITM

International Tool Machines of Florida, Inc. (ITM), located in Palm Coast, FL, has introduced a new multi-station grinder, the RTG Rotary Transfer Grinder, a compact grinding cell made up of as many as five precision grinding heads attached by a high-speed rotary transfer mechanism.

The RTG can produce complete gears, worms, cams, splines, shafts, and

other ground parts. The machine's concept is to produce a complete workpiece by spreading the grinding operations over up to five different grinding stations on the same machine. The cycle time to produce a ground part is equal to the longest single operation plus transfer time.

For example, the RTG can grind OD, ID, face, threads, gear teeth, lobes, etc., in sequence, without having to remove the part from the machine. According to Kenneth H. Larson, Jr., VP of sales and marketing, cycle time reductions of over 80% are possible when compared with conventional setup and movement between machines.

The multi-station design also allows for improved part quality and longer wheel life because finer wheels and lower feed rates can be used for the shorter grinding operations without affecting the overall cycle time to produce a complete part, Larson says.

The machine can be equipped with a variety of loading options, including

cassette, hopper, vibratory, and robotic loading. Options such as in-process gaging, finished part inspection, oversize blank inspection, wheel balancing, wheel dressing, and machine networking are also available. Motor spindles up to 50 hp are available.

To further enhance productivity, Larson says, up to 10 multi-station grinders can be run by a single operator.

ITM manufactures a wide range of grinding machines, including a variety of tool and cutter grinders, as well as their Series 2005 Universal Gear Grinder, which is designed for the high production grinding of gears up to 20" in diameter.

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Today's Flexible Gear Grinders

Form grinding and generating grinding used to be separate processes, requiring separate machines from separate manufacturers. Either you had a form grinding machine or you had a continuous generating grinding machine. Or, if you had applications that required both processes, you needed two or more very expensive, dedicated machines. However, over the past year, Kapp, Liebherr and Samputensili have introduced machines that incorporate both form grinding and generating grinding processes on one machine. In addition, these machines are capable of using either electroplated or dressable grinding wheels.

KAPP KX300P Introduced in 2004, the KX300P features spindle-integrated balancing of the grinding tool, and it comes with on-board gear inspection. The machine can be equipped with a custom-designed automatic loading system.

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LIEBHERR LCS SERIES With the LCS series, CBN profile grinding can be used for grinding internal gears, either spur or helical. The LCS 300 was introduced at EMO 2003 in Milan.

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SAMPUTENSILI S CLASS The S class gear grinding machines from Samputensili can grind external gears, shafts, worms or rotors. Besides profile and continuous generating grinding, the machines can also shave grind. The S 250 G was introduced in October at EMO 2003 in Milan. The S class grinders can be equipped with on-board inspection, an external balancing unit and various automation systems for workpiece exchange and storage.

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Staying Competitive Through Automation

Sam Haines, president of Gear Motions Inc., is building what he believes to be the only fully automated gear grinding job shop in the country at the Nixon Gear division in Syracuse, NY. In January, Nixon installed a new Reishauer RZ-400 gear grinder. After a runoff and shakedown period, the machine will soon be equipped with a robot, parts movers and software.

"When we finish this project," says Haines, "we believe we'll be the first job shop in the country with automated gear grinding of this magnitude."

Haines says this latest investment is part of a natural progression for the company, which built its first manufacturing cell more than 10 years ago and which has been working on ways to improve throughput and manufacturing processes ever since.

"In order to compete worldwide, we have to employ more technology," Haines says.

Last year, Nixon Gear spent nearly \$750,000 to fully automate the pre-heat treat part cell, which produces gears for the BMW Mini Cooper automobile. That cell includes a fully automated bar-fed turning center and robotically loaded CNC gear hobbing machine, enabling the company to take parts from raw material to pre-heat treating with minimal human intervention, Haines says.

That manufacturing cell allows Gear Motions to produce as many as 2,000 gear sets (4,000 parts) per week, Haines adds.

In addition to buying the latest-model equipment, which Haines says is proving to be about twice as productive as the previous technology, Gear Motions has also been investing time and money into developing robotics systems to make existing machines more productive. Nixon Gear recently completed design and development of a small, inside-the-machine robot system, for its Gleason TAG400 gear grinder. The hard finishing operation for the very small Mini Cooper parts is expected to double production simply by reducing changeover time, Haines says.

Developing automated manufacturing has enabled Gear Motions to develop significant process capability, Haines says. "One of the things we've learned as we employ more technology is that it's not only productive from a time standpoint, but it's improving process capability as well."

Over the past three years, Gear Motions companies have invested more than \$3 million in technology. The large gear division, Oliver Gear, in Buffalo, NY, recently installed the new Höfler Helix 700 gear grinder with on-board inspection. On-board inspection helps significantly reduce the time spent moving large, heavy parts to the company's quality lab. Automation on that machine has led to faster setups and greater part yields, according to Oliver's vice president, Mike Barron.

"The investment seems to be paying off for the Gear Motions companies," Haines says. "We were able to emerge from the recent recession with a bottom line *and* move the ball forward for our customers." He says the company has been able to reduce the lead time for its biggest customer down to one week.

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NEW GLEASON-HURTH ZH 200 GEAR HONING MACHINE

Gleason has introduced the ZH 200 gear honing machine, a completely re-designed and re-engineered version of the company's ZH 250 gear honing machine.

The ZH 200 incorporates a direct-drive honing head and headstock to deliver higher accuracies and speeds on workpieces up to 200 mm (7.87"), with



maximum tooth widths of 50 mm (1.97"), and module range of 0.5 to 4.5. The ZH 200 can combine its high cutting speeds with an optional, fast, fully integrated gantry loader system, thus offering the potential for significant improvements in overall cycle times.

The ZH 200 has been designed for ease of use, reliability and maintainability in even the harshest environments.

Like the ZH 250, the ZH 200 uses Gleason's patented Spheric® Honing process. This process ensures that every workpiece/tool contact point is precisely controlled, thus significantly improving tooth geometry, run-out and pitch errors, thereby producing a high-quality flank surface with low-noise tooth contact characteristics.

The Gleason-Hurth Spheric® Honing software is fully integrated with

the Siemens CNC controller, enabling the operator to create the optimum machining cycle simply by entering the tool and workpiece information. The machine software automatically creates the machining cycle.

Gleason-Hurth also provides the tooling: in this case both the internal gear abrasive honing ring for machining and the diamond dressing tools used to dress the abrasive tooling.

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All On-Board! Integrated Inspection and Dressing Increase Productivity

Grinding gear teeth used to be a very time-consuming process involving multiple setups and transfer of parts between a gear grinding machine and a gear inspection machine.

Typically, an operator would set up a part to be ground, then grind one flank or tooth space. The part would then be taken off the grinding machine—leaving that machine idle—and taken to a dedicated gear checker or inspection machine for a thorough inspection. If the part passed this inspection, it would be returned to the gear grinder and set up again. When corrections were necessary, additional test spaces would be ground and rechecked before the rest of the cycle would be allowed to run, meaning even more idle time for the grinding machine.

At Overton Gear & Tool of Addison, IL, removing the gear, transferring it and checking it on a gear checker took anywhere from one to three hours, depending on the size of the gear, every time they had to do it, says executive vice president Kevin Walsh. He adds that it was common at Overton to remove the gear three times before the full cycle was allowed to run.

But recently, Overton invested in a NILES ZE800S profile grinding machine sold by KAPP Technologies of Boulder, CO. That machine came equipped with on-board inspection and on-board dressing, two options that are becoming increasingly common on today's gear grinders.

According to Walsh, an operator can use the machine to grind two opposite tooth spaces, inspect them, immediately make corrections, regrind them and retest them.

"It saves hours," Walsh says. "With this machine, we save a significant amount of time in the setup procedure and don't waste nearly as much material in the beginning because of the on-board inspection."

The first gear that is ground still has to be removed from the machine and sent to the lab for inspection, but the company no longer suffers idle time waiting for the results. Operators have enough confidence in the on-board inspection process to grind the next part without having to wait for the inspection, Walsh says. Instead of being idle one to three hours, "The machine continues to run."

Similarly, on-board dressing of grinding tools is a significant advantage. Instead of a separate device and more setups, dressing takes place on the machine. This helps save idle time and improves quality, Walsh says.



The NILES ZE800S.

Overton Gear specializes in short runs and quick delivery of high-quality cut and ground gears for locomotives, off-highway vehicles, wind power turbines, industrial extruders and other heavy machinery. The company can cut either internal or external spur or helical gears from 12 mm (1/2") up to 2 m (80") in diameter, and it can grind internal gears up to 1.2 m (47") and external gears up to 1.5 m (60"). Overton Gear also has its own in-house heat treating facility.

Because of Overton's niche in short runs and its need for quick deliveries, the ability to incorporate on-board inspection is a significant advantage, Walsh says. "We can grind 10 one-piece orders in a three-day time frame. Before it took us three times as long."

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DRAKE GRINDER COMBINES ROUGH/FINISH OPERATIONS

Drake Manufacturing of Warren, OH, has introduced a new 5-axis CNC grinding machine, the GS:G², which allows the rough and finish grinding of hardened, pre-cut gears in one operation.

The GS:G² employs two grinding wheels, so there's no time lost between rough and finish grinding operations, according to the company's press release.

The machine is equipped with a menu-driven control system that includes Drake's Gear Smart™ programming, which allows part changeovers in 15 minutes or less. The control system can be adapted with additional menu entries for customer-specific applications.

Other features of the machine include CNC contour diamond roll dressing, constant surface speed as the wheel wears, infinitely variable wheel and work speeds selectable for roughing and finishing, and CNC-controlled helix and work rotation.

The GS:G² can grind from 0.5 to 8 module (50 to 3 DP), from 25–250 mm (1.0 to 10") pitch diameter, and it can grind gears to AGMA 12 specifications.

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NEW TOOL GRINDER FROM SCHÜTTE LLC

The new WU305 CNC Universal Tool and Cutter Grinder from Schütte LLC of Jackson, MI, allows for the grinding of gear cutting tools and other cutting tools on the same machine. The WU305 features menu-driven software for the grinding of bevel gear stick blades, gear shaper cutters and hobs, according to David Brigham, vice president.



Automated Deburring

A manufacturer of hydraulic pumps in Italy used to spend a lot of time manually deburring gears. Not only did the manufacturer seek a more efficient way to deburr, but the company wanted to improve the surface finish on the shafts and walls of the gears.

The solution was a completely automated deburring cell, designed and manufactured by Dan di De-Antoni s.r.l., also known as Dan Technology, of Coccaglio, Italy.

The system deburrs the gears, provides a slight chamfer (edge break) along the tooth edges and superfinishes the walls of the gears (Ra = 0.2 mm) and the shafts (Ra = 0.15 mm).

What used to be done manually is now completely automated for Dan Technology's customer, says Carlos Trujillo, director of sales, marketing and application engineering for the Americas. The system was designed to operate 24 hours a day, seven days a week.

In fact, the deburring cell has a magazine capacity of 8–10 hours, meaning it can run unattended for a full shift. "You may work without labor costs—even on Saturday or Sunday," Trujillo says.

The center of the deburring cell is a deburring machine tool that incorporates a patented system for maintaining constant pressure and speed of rotation of the abrasive wheel on the workpiece, Trujillo says. "Our systems have a lot of accuracy not because of the robots, but because of the technology in the patented Dan units."

The cell includes a robot that manages the magazine of baskets, receiving them, creating stacks and moving stacks with automatic conveyor belts. After the deburring/chamfering operation, the parts move automatically to a parts washing station.

The system can be programmed for different types of gears and different sizes. Systems can also be set up to use brushes for deburring instead of abrasive wheels.

A system similar to the one set up for this pump manufacturer costs in the range of \$190,000–\$300,000.



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Switching the gear-related tooling to standard cutting tools involves changing the 50-taper tool holding and calling up the software, Brigham says.

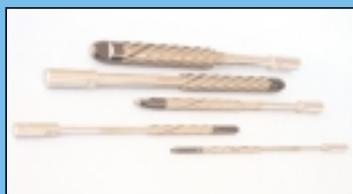
Since the WU305 is a standard machine from Schütte, no special machine components or modifications are required to grind gear tools. As an example, the menu-driven software for the regrind or manufacture of stick blades allows the machine operator the flexibility to modify any ratio on the blades being produced.

"This makes the machine an affordable alternative to having to send your gear-related cutting tools back to the manufacturer," Brigham says.

Full factory support for the North American market is located at the Schütte facility in Jackson, MI.

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SUNNEN ANNOUNCES SINGLE-STROKE HONING TOOLS

Sunnen Products Co. of St. Louis, MO, has introduced a new generation of helix plated diamond tools designed for fast stock removal and consistent bore geometry at competitive prices. The Single Stroke Honing® tools can be designed to optimize customer applications.

With Single Stroke Honing, the tools go through the bore only once, removing a predetermined amount of stock, progressively enlarging the bore. According to the company's press release, thousands of bores can be sized with the same tool.

The Single Stroke Honing tools can be used on Sunnen's VSS Single Stroke Honing system or machines manufactured by others. They can be used with either water- or oil-based coolants.

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LONGER LASTING DEBURRING WHEELS FROM CRATEX

Cratex MX abrasive wheels are commonly used in gear deburring operations, says John Rossi, VP sales & marketing for Cratex Manufacturing Co. Inc. of Encinitas, CA. But recently, the company has developed a new generation of the abrasive wheels that provide a number of benefits.

The company's focus has been on developing a completely non-loading, cool working abrasive wheel without sacrificing wheel life, Rossi says. Cratex's research and development effort has produced a new, stronger cotton fiber backing material without the side effects of increased rigidity.

In some cases, the new wheels allow the deburring machine operator to turn off his automatic wheel dresser or his manual timer, Rossi says. "The enhancements achieved are free cutting, non-loading, long lasting abrasive wheels."

Rossi adds that further experiments with single-wheel grain percentages have been successful in developing a process for polishing and deburring in one step.

Cratex MX abrasive wheels are suitable for use on most gear deburring equipment, including Redin, Chamfermatic and others, Rossi says.

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DR. KAISER, RAPPOLD WINTERTHUR ANNOUNCE COOPERATION

Dr. Kaiser dressing tools are now being sold in Austria and Slovenia by agents of Rappold Winterthur Technologie GmbH of Villach, Austria, according to a Rappold Winterthur press release.

Technicians of Rappold Winterthur are being specially trained by Dr. Kaiser as application engineers for Dr. Kaiser's product range.

Rappold Winterthur Technologie GmbH is part of the Rappold Winterthur Group, based in Winterthur, Switzerland.

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SERVICE NETWORK INC. APPOINTS NEW REP.

Service Network Inc. has appointed Kansas-Oklahoma Machine Tools (KOMT) as its exclusive representative for the states of Kansas, Oklahoma, and Missouri. KOMT has offices located in Wichita, KS; Kansas City, KS; Oklahoma City, OK; Tulsa, OK; and St. Louis, MO.

SNI recently introduced two new lines of production grinders, including the SN400-I Internal and the SN200-E External. SNI also offers service, upgrade and remanufacturing of Heald grinders.

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ANCA DEVELOPS DEDICATED STICK BLADE GRINDER

ANCA, located in Melbourne, Australia, has developed a complete system for manufacturing and reconditioning of bevel gear stick blades. The system includes the ANCA SBG (stick blade grinder) CNC machine, loader, fixtures and dedicated software.



According to the company's press release, the system also includes post-process measurement and compensation, which increases efficiency in setup and grinding of batches with different cross sections and geometries.

The SBG was designed to achieve high accuracy and fast cycle times in order to serve the needs of the manufacturers of hypoid gears for automotive differentials.

The machine is equipped with linear scales, and it comes with a rigid pick-and-place-style loader that is capable of tool change in seven seconds. The system can be equipped with a robotic loader as an alternative automation solution.

The machine uses a 250 mm (10") diameter grinding wheel. Precision is achieved through the use of a Renishaw tool probe, both before and after the grinding session. ANCA guarantees ground parts to within 5 micron (+/- 0.002") profile accuracy.

According to the company's press release, the SBG has been successfully installed at the manufacturing operations of a number of leading automotive suppliers.

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**SUNNEN INTRODUCES ML-2000
HONING MACHINE**

Sunnen Products Co. of St. Louis, MO, announced the introduction of the ML-2000, a new model of the company's power-stroked honing machines. The new

**Holroyd Introduces New
Turnkey Superabrasive Facility**

Holroyd Machine Tools of Milnrow, England, has set up a project team to provide turnkey manufacturing systems to customers for Edgetek superabrasive grinding machines.

"Providing turnkey solutions is what we are good at," says Paul Hannah, director for Edgetek machine sales at Holroyd. "It is something we have routinely undertaken for customers for our range of thread grinding machines."

Edgetek machines use high efficiency deep grinding (HEDG), a process that aims to remove a lot of stock quickly, thus increasing productivity. According to Holroyd, the specific removal rates range from 50–2,000 mm³/mm/second, much higher than the 0.1–10 mm³/mm/second associated with creep feed grinding. Also, the process is intended to be used on hardened parts and has been successfully implemented on difficult-to-machine materials, such as nickel-based steels common in aerospace applications and powdered metals used for timing gears and sprockets in car engines.

"We've seen at least a 40–50 percent increase in throughput on every job we've done, and in many cases, it is much, much more," Hannah says. "In one recent U.K. application, a single 5-axis Edgetek superabrasive machine replaced seven conventional milling and grinding machines, providing a reduction in the throughput time for a complex finished part from 8 hours to just 12 minutes."

HEDG uses CBN abrasives, which offer high thermal conductivity to remove heat from the grinding process, and the machine tools are designed for rigidity and high spindle speeds. The machines are built on a granite polymer base and column. The base typically weighs 3 tons and has no resonant frequency, according to Holroyd.

"With our new service, we undertake to engineer our customer's complete process on an Edgetek machine, typically integrating automatic loading facilities, measuring machines for SPC, washing machines for parts cleaning, coolers and filters, design fixtures, work benches—in fact, anything that the customer requires," Hannah says.

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machine is designed specifically to meet the needs of job shops and mid-volume production applications.

According to the company's press release, the ML-2000 has twice the power and more speed than older Sunnen MBC-style honing machines. All setup is accomplished through computer control. There are no belts or pulleys to change.

The machine can be equipped with an optional automatic size control feature, which allows better control of bore size, finish and geometry. With this feature, the honing cycle automatically stops when the bore is to size.

The ML-2000 provides an alternative to I.D. grinding and other finishing processes. Because of its stock removal rates, preliminary reaming, boring or grinding can be eliminated on many operations, according to the release.

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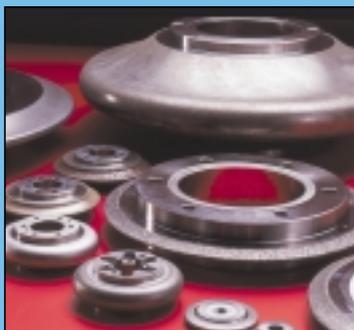
KAPP EXPANDS SALES CHANNELS

KAPP Technologies of Boulder, CO, is now offering CBN-plated wheels to be used with or without a KAPP form grinding machine.

"We are excited to be able to supply CBN-plated grinding wheels to the entire gear and form grinding industry," says Tom Lang, vice president and general manager of KAPP Technologies. "This opens up new markets to us and gives us the opportunity to work with customers who before now couldn't use our wheels because they didn't use KAPP machines.

KAPP manufactures high-precision, galvanically plated CBN and diamond tools. In the past, KAPP sold its tools with its machines to provide a complete customer-focused, turnkey machining process. KAPP's products include CBN-plated form grinding wheels for discontinuous profile grinding of involute gears, rotors and other special profiles. KAPP form grinding wheels can produce both internal and external profiles.

KAPP also manufactures CBN-plated cylindrical worms and diamond-plated Coroning™ tools. The worms are used for



continuous generating grinding of involute gears. The Coroning rings are used for continuous honing of involute gears.

"Now all gear manufacturers, regardless of machine type, can take advantage of our quality and delivery," said Lang. "Others advertise delivery of CBN wheels within weeks; our standard is 10 days."

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NEW CNC GRINDERS FROM CHINA

Shaanxi Qinchuan Machinery Development Co. Ltd. of Shaanxi, China, has announced two new models of CNC gear grinding machines.

The 8-axis (5-axis simultaneous) YK7250 CNC uses worm wheels for continuous-generating grinding of gear teeth. According to the company's press release, the machine is suitable for either single workpiece or batch production.

The YK7250 comes with CNC-controlled worm wheel dressing, electrostatic oil mist collection, temperature control system and dynamic balancing of the grinding wheel. It is designed for grinding gears from 100–500 mm diameter, from 2–8 module and face width up to 200 mm.

The company has also developed a new model of gear grinding machine specifically designed for internal gears. The 4-axis YK7550 CNC gear grinding machine is designed to meet the needs of manufacturers of planetary gear reducers, internal combustion engines, gas turbines and other equipment that requires internal gears.

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PRECISION DEEP GRINDING OF GEARS

Companies in the Czech Republic and Russia have developed a new method for grinding gears, according to the Eureka project, a Belgium-based research

& development network that strives to foster international cooperation in a variety of technology-based fields.

The new technology uses precision deep grinding using form-grinding wheels made by fusing abrasive grains of alumina corundum and silicon carbide to the surface of the tool with strong ceramic bonds.

"We developed various formulae for new high-porosity tools and conducted industrial tests in 14 Russian factories," says professor Viktor Starkov, director of the Research Centre at the Moscow State Technological University "Stankin."

The new tools and process produce higher quality gears and increase productivity, says Josef Frumar, production manager at Carborundum Electrite, a partner in the project and manufacturer of grinding wheels from the Czech Republic. Carborundum Electrite carried out most of the trial testing of the new technology.

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NEW WORM GEAR GRINDING MACHINE FROM DOIMAK

The RER-W Series grinding machine from Doimak is designed for machining worm gears of any type of profile (ZK, ZN, ZE, ZA) and multiple starts. In addition, it can machine worm gears of variable lead and constant diameter as well as those of variable diameter and constant lead. Features include CNC-controlled wheel-head tilting up to +/- 30° and automatic calculation of the wheel profile and dressing path.

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