

Demand for indexable carbide insert cutting tools has grown over recent years, due in large part to the increased production requirements for wind turbine and other large-module gearing. Shown here is an indexable carbide insert hob from Seco Tools Inc.

Big Gears Better and Faster

CARBIDE INSERT CUTTING TOOLS PROVIDE
INCREASED PRODUCTIVITY AND QUALITY

William R. Stott, Managing Editor

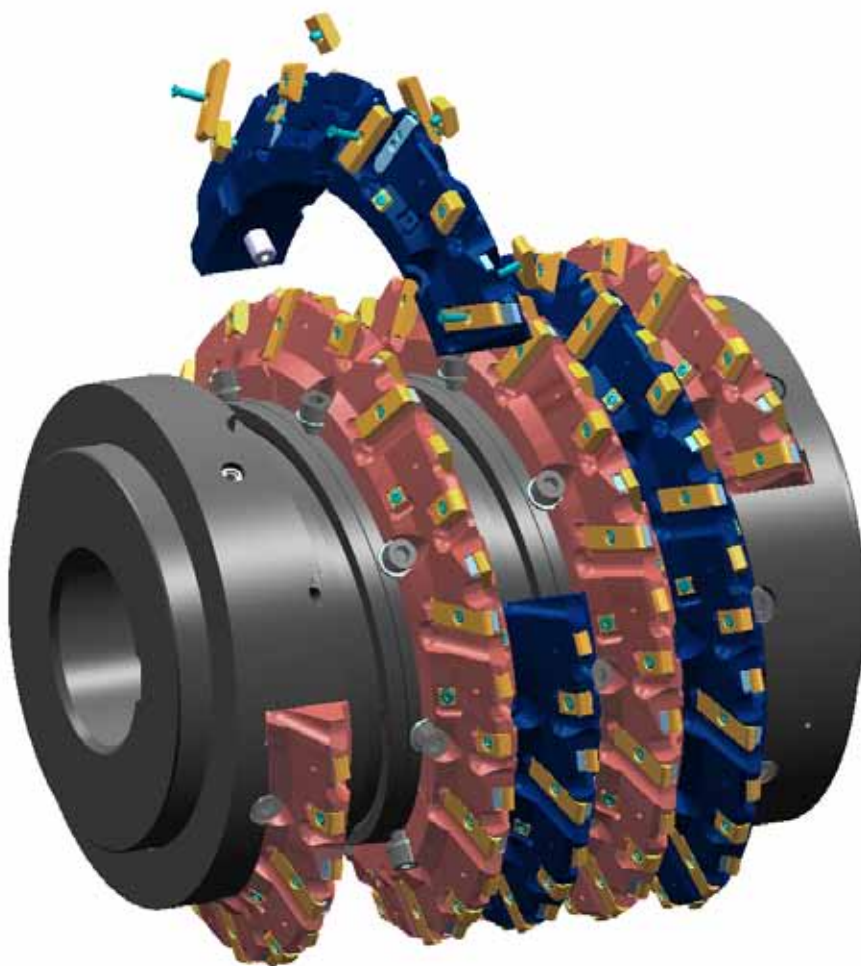
Indexable carbide insert cutting tools for gear manufacturing are nothing new. Ingersoll first introduced indexable carbide insert gashing tools in 1977, and carbide insert hobs in

1979. LMT-Fette began making these tools in the mid-1980s.

But big gears have recently become a very big business, thanks in part to the wind turbine industry, but also

due to increased production requirements in mining and other energy sectors. The result is that there's been a renewed interest in carbide insert cut-

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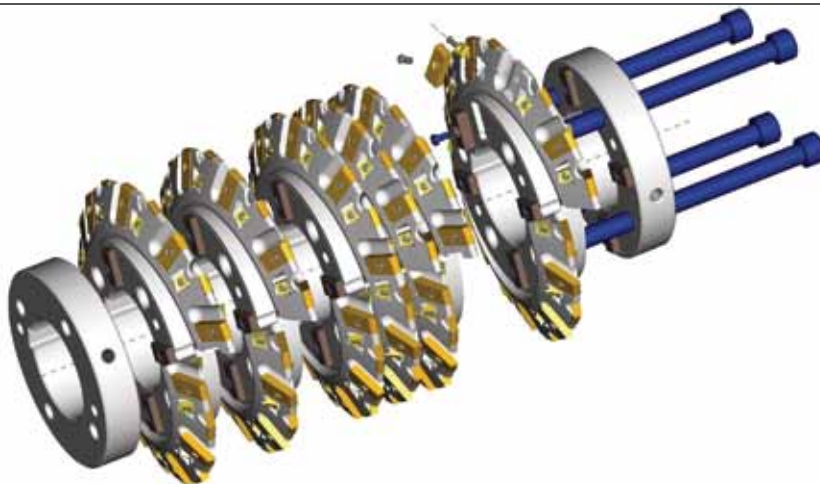


a



b

Multi-start hobs are one of the more recent innovations in indexable carbide insert gear tooling, as shown in these tools from a) LMT-Fette and b) Ingersoll Cutting Tools.



Indexable carbide insert hobs are most commonly assembled from individual segments, as shown in this exploded drawing of an Ingersoll hob.

ting tools, and a host of new suppliers have entered the market—especially the U.S. market—over the past few years.

“The manufacturers of large-module gears used in wind energy are focusing to increase their production efficiency by higher cutting speeds and feed rates,” says Dr.-Ing. Friedrich Momper, manager of gear products at LMT-Fette. Those higher feeds and speeds require carbide tools rather than the traditional high speed steel, Momper says.

Darryl Witte, vice president of sales at Banyan Global Technologies, agrees. Banyan manufactures a line of carbide insert milling cutters, gear gashers and shapers. “Wind growth has for the first time allowed for higher volume manufacturing of coarse-pitch, or large-module, gears. In that higher production mode, indexable carbide solutions are paramount to improve cost metrics in production of these geared components.”

“We have seen a considerable increase in the demand for these tools in finishing and pre-grind applications, for both the indexable gashing tools and indexable hobs and shaper cutters,” says Michael Tennutti, senior product manager at Gleason Cutting Tools, which sells indexable tools under the Opti-Cut brand name. “A major driver has been the global energy market, including applications for mining and heavy construction equipment, but especially for wind turbine gearboxes.”

Why Carbide Inserts?

The main advantage of indexable

continued



Internal gear gashing is one of the primary uses for indexable carbide insert gear cutting tools. Shown here is an Opti-Cut gear gasher from Gleason Cutting Tools.



Different manufacturers offer different approaches to optimizing the technology. For example, milling cutters from Safety (left) use a wedge-style clamping system to enable greater tooling flexibility. Banyan also uses wedge-style clamps on some of its finishing cutters (right).

carbide insert tooling is that it allows manufacturers of big gears to increase their feeds and speeds without having to go to a solid carbide tool. In fact, beyond a certain size range, solid carbide tools aren't practical or even possible to manufacture.

"Costs aside, some coarse-pitch modules simply cannot be produced in solid carbide, necessitating an inserted blade approach" says Gleason's Tennutti. "Larger modules such as 20 module can now be made in diameters ranging from 350 to 400 mm, which is

well beyond the size range possible in solid carbide."

Some manufacturers of these tools offer them in module ranges up to 40, 50 or more.

Because the only alternative to these carbide insert tools is high speed steel (HSS) tools, there is often a dramatic difference in productivity when comparing the options.

"The main advantage over HSS is increased productivity," says Todd Miller, milling tools product manager for Seco Tools. "Carbide can pro-

vide cutting speeds 4–8 times faster than HSS tools. This means you can produce more parts in less amount of time."

"In our experience, especially with large gears, we have found it is not uncommon to see 50–75 percent reduction in cycle times compared to HSS," says Frank Berardi, gear machining product manager for Ingersoll Cutting Tools.

Another advantage is that carbide tools can often be run without coolant, which provides additional environmental benefits and cost savings.

But even in module ranges where solid carbide is available, indexable

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Gear milling tools are generally optimized per application, with different inserts for profile and root, as shown in this milling cutter from Seco Tools.



Indexable carbide insert shaper cutters are offered by a number of manufacturers, including Ingersoll (right), Banyan (left) and Gleason.

insert tools can offer some advantages.

"Solid carbide tools are very expensive tools to keep on hand," Miller says. "Typically you need three to four of the same tools per job. One in service, one on the shelf ready to go on the machine and one to two getting re-ground and re-coated. Refurbishing is typically done by an outside vendor, which takes time. Indexable carbide inserts are much less expensive and help reduce costly inventories."

LMT-Fette's Momper agrees. "Using indexable type cutting tools overcomes the issue of reconditioning of solid type hobs," Momper says. "If reconditioning (grinding, stripping

the old coating and depositing the new coating) is not handled properly, this will lead to loss in an effective utilization of a solid type hob. With the inserts, inspected by the supplier, the customer gets a ready-to-start solution with repeatable accuracy and tool life."

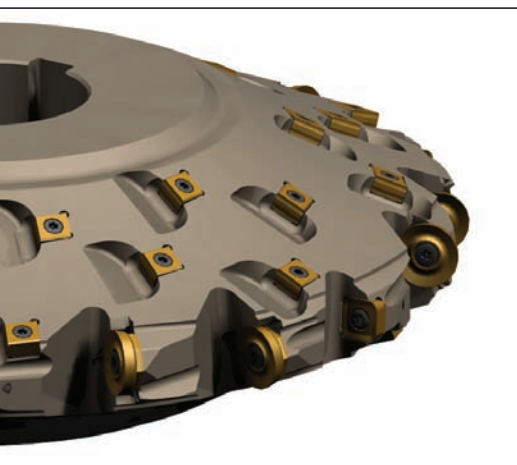
Another benefit of the inserted blade tools is the flexibility allowed by changing out the inserts. This flexibility can allow different parts to be cut with the same cutter body simply by changing the inserts.

"Changes in part material and hardness can be accommodated by simply changing insert grade or edge prep," says Ingersoll's Berardi. "Likewise, slight modifications in tooth involute form can often be accommodated by insert or pocket modifications."

Drawbacks

Taking advantage of carbide tools requires the ability to run at higher speeds and feeds, as well as machinery that is extremely rigid. Because of

continued



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these requirements, you can't just put one of these tools on an old gear gasher and expect it to perform.

"Realistically, the limiting factor in using this technology to its fullest extent has been the available machine tools," says Brian Nowicki, vice president of sales & marketing for Cimtek LLC, which represents Safety Cutting Tools.

Gleason's Tennutti agrees that these tools require modern, rigid machines that have been designed

with carbide in mind: "Today's CNC hobbers and shaping machines offer improved stiffness characteristics and increased power ratings, and can take advantage of today's cutting tool materials and coatings. The user can run at much higher speeds and feeds than with high speed steel tools."

Recent Developments

Despite the fact that indexable carbide insert tools have been around for a long time, there continue to be improvements in their design and

application, as well as new entrants into the marketplace.

One of the newest competitors in this field is Sandvik, whose CoroMill 170 series of milling cutters was introduced at IMTS 2010. Sandvik has developed this tool specifically with the wind turbine industry in mind, concentrating on module ranges from 12–22, according to Kenneth Accavallo, gear industry applications specialist.

Even though they are a relative newcomer, Sandvik is focused on developing its tools for more and more applications, Accavallo says, and they have also been working hard to develop indexable carbide insert hobs, which the company expects to fully introduce to the market in 2011.

But even at the more established companies in the market, R&D continues with an emphasis on increased quality and productivity.

"Recent emphasis has been in development of carbide milling grade substrates, coatings and post coat processing to increase tool life," says Ingersoll's Berardi. "In addition to grade development, advanced pressing technology has allowed us to develop freer cutting positive geometry inserts in precision tolerances."

Berardi points to Ingersoll's S-Max double positive insert as an example of the latest in insert technology. "Originally developed for our Max-line milling cutters, it has proven to be an effective and economical performer for rough gear gashing. Improved manufacturing techniques in production of cutter bodies, especially insert pocketing, allows us to now produce finish gear cutters to very tight tolerances without the use of shims or adjustment mechanisms. For the customer, this greatly simplifies cutter set-up and tool change. We are applying this same technology for pre-grind and final finish applications, and we can now provide precision pressed and ground concave and convex inserts to cover the entire involute form."

According to Berardi, one of the advantages of Ingersoll's "freer cutting geometries" is that they reduce power consumption on the machine, especially for rough cutting. "This allows us to perform the same cut at higher operat-

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ing parameters with little or no increase in horsepower consumption, compared with HSS and solid carbide,” Berardi says. “In addition, the double-positive S-Max provides smoother cutting on the tooth flank, which greatly reduces axial forces. This has opened up opportunities for customers who have older equipment, or lower HP machines, to still take advantage of the benefits of indexable tooling.”

Improvements in the tools have resulted in improvements in the part quality.

“As we continue to improve finishing capabilities, we are seeing more applications for machining teeth to pre-grind and final finish dimensions,” Berardi says. “For many applications, we can achieve the profile and finish tolerance by finish milling or finish hobbing, thus eliminating the need for grinding.”

Eliminating the grinding process is also on the minds of engineers at LMT-Fette and Seco.

“With the new gashing cutters and ICI hobs, you can achieve high gear qualities,” says LMT-Fette’s Momper. “In some cases, grinding processes could be minimized or even become redundant.”

“We are now able to achieve gear tolerances of DIN 10 or better, depending on module size, with an indexable carbide tool,” says Seco’s Todd Miller. “Whenever you can get to a point of eliminating grinding, there are tremendous cost savings available. Grinding machines are very expensive, and the grinding operation is typically much more expensive than milling with carbide tools.”

Another recent development in indexable carbide insert hobs is the two-start hob. Ingersoll, Kennametal and LMT-Fette all offer this option.

“This year we introduced a new two-start ICI hob, which can nearly double productivity for machining gears with large numbers of teeth,” says Ingersoll’s Berardi. “This is a segmented design with the same design features as our single-start hob. Although it’s primarily designed for roughing and semi-finishing, for many applications we can achieve finish quality.”

At Safety, the gashing tool has also

undergone significant development, says Cimtek’s Nowicki. Instead of the traditional tangential screw mount used by many manufacturers of gashing tools, Safety employs what Nowicki describes as a “wedge-style clamp.”

The wedge provides increased flexibility for the tool, because it allows quick and easy changing of the inserts to accommodate a wide range of pitch/diameter combinations and surface finishes. A change in inserts is likewise all that’s needed to switch from inter-

nal to external gears, Nowicki says.

Banyan, Gleason and Ingersoll offer indexable insert shaper cutters, but these are also areas where the manufacturers are working to improve the tools.

“For internal gears, we have a new finish gasher with interchangeable hardware that is adaptable for negative or positive inserts with four cutting edges,” says Ingersoll’s Berardi. “The insert pocket is designed to allow the same tool body to cover a range of

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gear diameters of the same module, by changing inserts.”

“Another area of great interest is our development of indexable insert roughing shapers,” Berardi says. “We’ve had great success with this product, and we are working on expanding the offering to cover a wider range of sizes. Shapers are still widely used for double-helical gears and shoulder applications where there is no clearance for gashing or hobbing cutters. It is typically a very time-consuming process. With the indexable roughers we can remove the majority of stock, leaving 0.2 mm or less for the finish shaper. This typically results in 50–70 percent reduction in machining time.”

The Future

A number of manufacturers are working to increase the size range of gears for which indexable tools are an appropriate option. In particular, smaller gears seem to be one of the next targets.

“We are constantly working on ways to cover a wider range of gear tooth sizes, especially in smaller mod-

ule gears,” says Ingersoll’s Berardi. “I believe we will see some breakthrough in this area in the near future.”

Kennametal produces inserted blade hobs as small as 4.5 module, according to Klaus Wichmann, manager of gear milling for Kennametal GmbH in Germany. But Wichmann believes modules as small as 3 are possible.

Banyan is also aiming for smaller gears. “We continue to push to smaller pitch sizes, not only for gear, spline and rack milling, but also for finer pitch hobbing, so as to reduce the costs associated with what is commonly viewed as one of—if not the—most expensive tools used in gear manufacturing,” says Witte.

Another area that will continue to improve is the customization of the inserts and insert configuration to achieve specific goals.

And, of course, the manufacturers will also continue to work on better insert materials and coatings. “Continued advances in substrate, geometry and PVD coating technology will continue to improve cutting speeds, metal removal rates and ultimately cycle

times,” says Cimtek’s Nowicki.

Conclusion

Even though these tools have been around for a long time, in one form or another, there has clearly been a resurgence in the marketplace, both in the demand for the tools and the number of suppliers who make them. Also, there has been significant research and development on the tools, meaning that they provide greater productivity, higher quality, and more manufacturing options than ever before.

So manufacturers of large-module gears who haven’t yet investigated these tools might want to reconsider. The range of suitable applications for indexable carbide insert gear cutting tools has grown considerably, and it appears that it will continue to grow for the foreseeable future. ⚙

See pages 46-49 for complete contact information on the companies mentioned in this article.



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Carbide Insert Cutting Tools—The Suppliers

Below are profiles of the major companies who are suppliers of carbide insert cutting tools for gears. The cutting tool ranges are described, and any specialties or unique capabilities are noted.

Banyan Global Technologies



"Our tools are sold as a custom solution for every application," says Darryl Witte, vice president of sales. "We evaluate the machine tool, fixturing and part condition to tailor-fit a tool to the process. Customers have the freedom to purchase the cheapest tool possible, the most cost effective, or the one that will return the highest quality part; every one of which will return a different design with a different cost."

"We at Banyan use our years of metalworking experience to design optimal indexable carbide solutions for both coarse and fine pitch gear cutting."

Solutions offered: Rough and finish gashing cutters for internal or external application from 1–50 module, 1" to 36" diameters. Spline milling tools any size. Indexable shaper cutters for roughing, 2–25 module, indexable hobs from 2–45 module.

For more information:
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Cimtek LLC



"Safety's biggest advantages lie in multiple areas," says Brian Nowicki, vice president of sales & marketing for Cimtek. "First is Safety's experience. Safety was one of the innovators of gear gashing and has been selling gear gashing tools in Europe for more than 30 years.

"Second, Safety uses a "wedge-style" clamp versus the traditional tangential screw mount. This unique design allows Safety gashers to cut a wide range of pitch/diameter combinations with a single cutter, simply by changing inserts and/or wedges," Nowicki says.

In addition, the unique wedge design allows the gashers to machine both internal and external gears with the same cutter body, or to rough machine and finish machine with the same cutter body, simply by changing inserts, Nowicki says.

Solutions offered: Milling and gashing cutters from module 5–45.

For more information:

Cimtek LLC
Brian Nowicki, vice president of sales & marketing
Phone: (847) 628-9942
brian@cimtekllc.com
www.cimtekllc.com

Gleason Corporation

"Gleason has considerable knowledge and experience in gear manufacturing, and we have invested significant R&D in the analytical development of the tool tooth profile," says Michael Tennutti, senior product manager for Gleason Cutting Tools. "This allows us to optimize the finishing stock for pre-finish tools, and to improve the final gear accuracy for finishing tools."



"We have also been able to optimize the combination of rake face configuration, edge preparation definition and coating type and thickness for maximum performance of our Opti-Cut inserted carbide tools. These characteristics are all specifically developed for each individual application."

Solutions offered: Carbide insert tools for ID or OD gashing (both roughing and finishing tools), gear shaping and gear hobbing. Carbide insert hobs are available for diameters greater than 125 mm.

For more information:
Gleason Cutting Tools Corp.
1351 Windsor Parkway
Loves Park, IL 61111 USA
Phone: (815) 877-8900
sales@gleason.com
www.gleason.com

Ingersoll Cutting Tools



"All of our gashing and hobbing cutters feature the angled insert screw hole, which Ingersoll introduced to provide more secure clamping and easier access for indexing inserts—especially in hob assemblies," says Frank Berardi, product manager for gear machining at Ingersoll Cutting Tools. "It has the added benefit of error-proofing insert orientation."

"The unique segmented design of Ingersoll hobs provides an expandable assembly, and simplifies repair. The spiral segments are manufactured in one setup, ensuring the highest precision possible. Because of this, segments can be ordered separately for replacement or expansion of the assembly. This can be done by the customer, as there are no fitting operations involved."

"Perhaps the greatest advantage we offer is the 30-plus years of experience in designing indexable gear cutting tools. These are highly engineered products, and most often each application requires a unique solution."

Solutions offered: ID and OD roughing gashers for modules 6 and up, ID and OD finishing gashers for modules 6 and up, roughing and fin-

ishing gashers with through-tool coolant channels, carbide insert hobs for modules 6 and up, including multi-start hobs and shapers in modules 6–12.

For more information:
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Rockford, IL 661108-2749
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www.ingersoll-imc.com

Kennametal

"Kennametal is a pioneer in using positive geometries on the inserts and innovative positioning of the inserts in the body," says Klaus Wichmann, manager of gear milling for Kennametal Technologies GmbH in Germany. "This leads to a very effective and smooth cut. Further, this innovative design helps to reduce the power the machine needs to run the cutter. This saves the machine from wear as well as the cutter itself."



"Kennametal has invested a huge amount of money to increase the manufacturing quality, especially of the tool bodies. We are using a unique and state-of-the-art closed-loop system between the production machine and our measuring and quality station. This brings us 1-2 better quality classes compared to the standard methods."

Solutions offered: Carbide insert gashers (for both internal and external gears) from module 6–40, finishing gashers (for both internal and external

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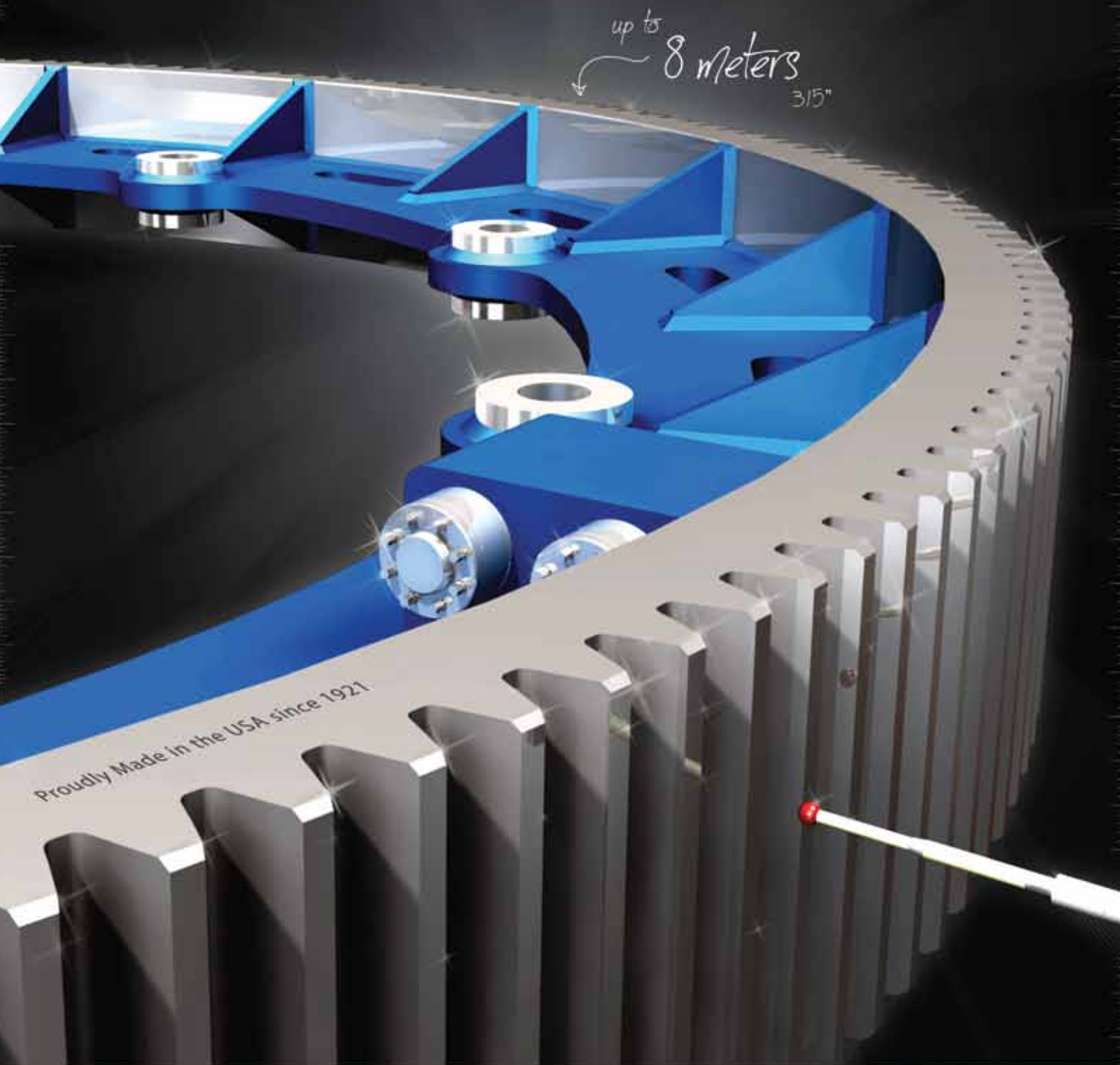
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gears) from module 3–30, hobs, including multiple-start hobs, from modules 6–40, as well as other specialized tools.

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Latrobe, PA 15650
Phone: (724) 539-5000
www.kennametal.com

For more information:
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1702 Nevins Road
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Sandvik Coromant

A relative newcomer to the carbide insert gear cutting industry, Sandvik Coromant has targeted module ranges that are most commonly used in the wind turbine industry, says Kenneth Accavallo, gear industry applications specialist.

Sandvik's first entry into the gear tool market is its Coromill 170 series of milling cutters, designed for roughing gears in modules 12–22. Although Sandvik's range is more limited than other manufacturers, they are also developing additional products for gear manufacturing, including indexable carbide insert hobs, expected to be formally launched in 2011.

Solutions offered: Carbide insert milling cutters in modules 12–22, with carbide insert hobs to be launched in 2011.



LMT-Fette

According to Dr.-Ing. Friedrich Momper, manager of gear products, LMT-Fette offers:

- A wide range of gear gashers and indexable carbide insert hobs
- Customized tools to the specification of customer profiles
- State-of-the-art carbide grades and coatings, as well as insert geometries tailored for gear cutting processes
- Engineering and application know-how for both solid-type hobs as well as indexable type gear cutters

Solutions offered: Single-start carbide insert gear hobs from modules 5–40, double-start gear hobs, gear roughing cutters with or without internal cooling from modules 6–36, gear finishing cutters with or without internal cooling from modules 8–24.

Seco Tools



“Seco has worked hard developing innovative coatings and carbide grades with superior performance,” says Todd Miller, milling tools product manager. “Today, Seco is a leader in coating technologies with the development of our DurAtomic coating. We also have an extensive engineering background with the design and development of milling cutters and tool holders. We have brought all the same technology into the development of our gear milling cutting tools and are continuously improving.”

Solutions offered: Carbide insert roughing and finishing tools with modules from 1–50, carbide insert hobs with modules from 6–26.

For more information:
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2805 Bellingham Drive
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Faster Gashing in Finland

For nearly 50 years, Takoma Gears (Parkano, Finland) has specialized in providing large-scale gears and gear components to customers, mainly in its domestic market. Concentrated heavily in the marine industry, the company prides itself on minimizing lead times and costs while meeting extremely strict quality requirements.

Dedication to maintaining these standards leads the company to constantly evaluate its operations and track developments in technology that can lead to process improvement.

Traditionally, Takoma has used HSS hobs for the cutting of gear teeth. In 2009, the company purchased several new machines for the production of large gear components for use on ships. Slewing rings with an outer diameter of approximately 2 meters (6.56 feet) are produced from 42CrMo4 steel and require high dimensional tolerances. Takoma initially began machining the slewing rings' teeth with a specialized gear cutter that provided acceptable quality levels, but was expensive and required lead times of up to 12 weeks to receive. Feeling that a better option must exist, the company contacted a provider of tooling used in many of the secondary operations of its parts.

"We have worked with representatives from Sandvik Coromant for over 30 years in regards to drilling, milling and turning tools," says Jyrki Koitto, production manager at Takoma Gears. "We knew that they were increasing their focus on tooling for cutting gear teeth, so we asked if they had or would be interested in developing a tool that would perform this application for us."



After consulting closely with Koitto and other employees at Takoma, Sandvik Coromant engineers spent several months designing and testing a custom tool optimized for the process. The gear cutting tool that resulted from these efforts was brought to Takoma for multiple tests and runoffs and then implemented with Sandvik Coromant's assistance. It achieved very similar results to the original tool, but with a slightly reduced cost. More importantly, turnaround times for delivery were less than a week, compared to 12 weeks for the old tool. This allowed Takoma to maintain much more flexibility in responding to customer needs. Additionally, while working on this project with Sandvik Coromant, Takoma was exposed to the CoroMill 170, a new cutter for gear milling that the company felt held potential for some of its other applications.

The CoroMill 170 was developed to optimize milling applications in large gears, module 12–22, an area traditionally covered by indexable inserts and HSS tools. The tool provides robust performance through design focus on its shape and providing secure insert seats. Takoma chose to apply a 300 mm (11.81 inch) version of the tool to a marine ring gear measuring

approximately 2.5 meters (8.2 feet) in diameter. The part was machined from 34CrMo4 steel.

Takoma had previously used a 230 mm (9.06 inch) HSS hob to cut teeth on the ring gear. Running at a speed of 25 meters/min (82 feet/min) and feed rate of 0.12 mm/rev (0.0047 inch/rev), the operation took 1,260

minutes per component. Upon applying the CoroMill 170, Takoma was able to increase cutting speed and feed rate to 126 meters/min (413 feet/min) and 0.20 mm/rev (0.0079 inch/rev), respectively. This reduced cycle time by nearly 60 percent, to just 510 minutes per component.

"We are now using the CoroMill 170 all of the time and saving a significant amount of time," says Koitto. "By shortening our machining time, it also allows us to reduce turnaround to our customers. Instead of taking five weeks to process an order and provide finished parts, we can now provide customers with the same service in four weeks."

In addition to allowing faster service to their customer, productivity gains from implementation of the CoroMill 170 have resulted in annual cost savings of 20,000 euros.

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**For Sandvik, please see p.49.*