Different Directions

Users' needs drive development of different reaming systems.

Iscar Metals

Reaming is a secondary operation performed when holes must meet stringent size, geometry and finish requirements. The tooling applied ranges from traditional hand reamers, like those used for hundreds of years, to sophisticated systems that enable fast, high-volume production of high-precision holes.

In the following, we look at three reaming systems that address different end users' needs. The first is designed for quick changeovers on CNC machines. The second is aimed at applications where cutting speed is the major consideration. And the third combines reaming and boring in one tool.

Fast and Flexible

Manufacturers of automotive parts face cost-control and just-in-time-supply pressures. They must minimize cycle times. One way they accomplish that is by operating equipment that can be quickly changed over from making one part to another. This has led to the replacement of traditional transfer lines with machining cells. In many cases, the CNC machines in these cells must be fitted with new tooling systems.

To take the place of the servo-adjustable reaming tools typically used on transfer lines, Valenite LLC, Madison Heights, Mich., has developed a reaming system aimed at high-volume, high-precision applications performed by CNC machines and transfer lines. The tooling, called MODCO BHR (Brazed Head Reamer), features interchangeable, quick-change cutting heads fitted with multiple brazed-in carbide blades.

The quick-change connection provides sufficient rigidity and repeatability to enable the reamers to finish holes to ISO H7 standards without requiring any adjustment. In addition, the multiple cutting edges evenly distribute cutting forces and permit the tools to be applied at productive machining parameters. In medium- and high-carbon steel, for example, speeds of 50 to 100 m/min. and feed rates of 0.40 to 0.50 mm/rev. are typical, and surface finishes of 0.3μm to 0.8μm R_a are imparted.

Currently, Valenite is quoting the tooling in custom packages for major manufacturing programs at automotive OEMs and their main suppliers. The reaming system is configured to match specific materials, machine tools and production volumes. Five different shank sizes accommodate heads that are engineered to ream blind- or through-holes with diameters from 9.75mm to 32.50mm. Four-blade heads are for holes up to 15.49mm in diameter; larger holes are reamed with six-blade heads.

The blades are available in two grades. One is in an up-sharp, uncoated VP-1R20 micrograin carbide. It is intended for reaming aluminum and other nonferrous materials, as well as titanium alloys. The other is a PVD TiN-coated VP-5R15 micrograin carbide grade for steel and stainless steels, iron and all nickel/cobalt/iron-based superalloys.

Bob Coleman, Valenite's product manager for engineered solutions, pointed out that a reamer is a finishing tool, not the primary tool for removing metal.

"The typical operation would be to drill, bore and then ream," he said. "If you have a good-quality drilled hole, you can directly ream as well. But you're not taking out a whole lot of material; it's a finishing operation."

Valenite

BHR tooling features interchangeable, quick-change cutting heads fitted with multiple brazed-in carbide blades. Tooling systems are configured to match specific materials, machine tools and production volumes.

He said 0.25mm per side is the maximum amount of material that should be left in the hole for removal by a BHR reamer. Because the reamers are self-guiding, Valenite recommends that they be used with adjustable and floating-style holders. According to Coleman, "A reamer typically will follow whatever bore is already in the part. What you want to do is let it move around a little bit, to find the center of the hole."

Coleman also pointed out that machining cells help increase productivity when cutting the new workpiece materials being used by the auto industry. Tough and abrasive materials that wear tools quickly are a problem on transfer lines, because changing out tools requires shutting down and restarting the entire line. The cell approach permits the use of redundant tooling that can be changed quickly, facilitating the productive reaming of materials such as CGI (compacted graphite iron).

Hard Headed

Interchangeable, multitoothed cutting heads of solid carbide, secured by a quick-change bayonet mechanism, are the distinguishing features of a high-production, precision reaming system from Iscar Metals Inc., Arlington, Texas.

Made for high-speed reaming, Bayo T-Ream tools finish holes from 9.5mm to 32mm in diameter to ISO H7 standards. Typical machining parameters on low-alloy and cast steel include cutting speeds in the range of 80 to 120 mm/m and feed rates of 0.7 to 1.1 mm/rev. The system is aimed at mass-production applications where speed is the major consideration. According to Iscar, the tools permit penetration rates more than 30 times greater than those possible with conventional reamers.

Separation of the tool cutting and location functions promote high accuracy and reaming at high speeds. Each reamer flute edge includes a cutting zone and a guiding zone. The flute's cutting zone is in the chamfer, at the beginning of the flute edge, where chip formation occurs.

The guiding zone is a cylindrical land that supports and leads the reamer through the hole; clearances are tight enough that the part surface is burnished. The function of the cylindrical land also mandates that the back taper of the tool be small. The rear diameter of the reamer is 0.01mm to 0.02mm smaller than the front.

The combination of tight tool tolerances and high cutting speeds requires a more rigid machining system than employed with traditional reamers.

Craig Segerlin, Iscar's national

product manager for holemaking and solid-carbide round tools, said a Bayo T-Ream tool "likes to be stiff, in a SRKIN shrink holder or a ShortIn holder that projects just 1.25", so it doesn't deflect. If you do have a floating holder, you must prep the front of the hole [so it exactly matches] the chamfer angle on the reamer. Most reamers follow the course of least resistance. But once this tool enters at its diameter, where the cylindrical land is, this baby goes straight. As with a boring tool, if you have runout or taper, [the T-Ream] straightens it."

According to Iscar, for optimal reamer performance on cast iron and steel, the diameter of the prereamed hole should be 0.2mm to 0.3mm smaller than the desired diameter. On softer materials such as aluminum, the prereamed diameter should be 0.3mm to 0.4mm smaller. It's recommended that reaming, as well as the drilling that precedes it, be performed during the same chucking of the workpiece. In cases where the reaming takes place during a separate chucking, larger reaming allowances are desirable.

Iscar notes that T-Ream tools are capable of increasing hole diameter by a maximum of 0.8mm and, therefore, are intended solely for fine finishing applications.

The tools' flute configurations are different for reaming blind-holes than for through-holes. Straight-flute tools are for use in blind-holes, because they provide a clear path for the chips to be flushed out of the hole by coolant. For through-hole operations, tools are engineered with helical left-hand flutes that push the chips forward, preventing them from flowing along the flutes and preserving the hole's surface quality. In addition, helical flutes have less of a tendency to vibrate than straight flutes, making them preferable for interrupted and irregular holes.

A reamer typically will follow whatever bore is already in the part. What you want to do is let it move around a little bit, to find the center of the hole.

Another design feature aimed at reducing vibration is the asymmetrical distribution of the cutter flutes. Uneven spacing of the flutes around the periphery of the cutter head dampens the formation of harmonic vibrations that can degrade hole accuracy in terms of roundness and cylindricity. Two of the flutes are oriented 180° opposite one another, however, to permit accurate measurement of the tool's actual cutting diameter.

Iscar points out that maintaining precision in high-speed reaming requires there be minimal runout among the spindle, adapter, shank and cutting head. If control of runout is questionable, larger reaming allowances are recommended; if the machine is not sufficiently rigid, conventional reaming should be considered.

Bayo T-Ream tools operate at cutting speeds and feed rates that are more aggressive than those used with conventional reamers. As an example, Segerlin cited a reaming operation on a steel manifold. He applied a Bayo T-ream tool to a part made from gummy 12L44. It ran at 1,500 rpm, 36 ipm and 0.004" chip load per tooth, to a depth of 0.750". The resulting bore, he said, was 0.6308" in diameter at the top, middle and bottom of the bore (no taper), was round within 0.000020" and had a surface finish of 4µin. R_a.

In some situations, Segerlin said, Bayo-T Ream tooling can produce results equal to a precision boring system, but at a much faster rate.

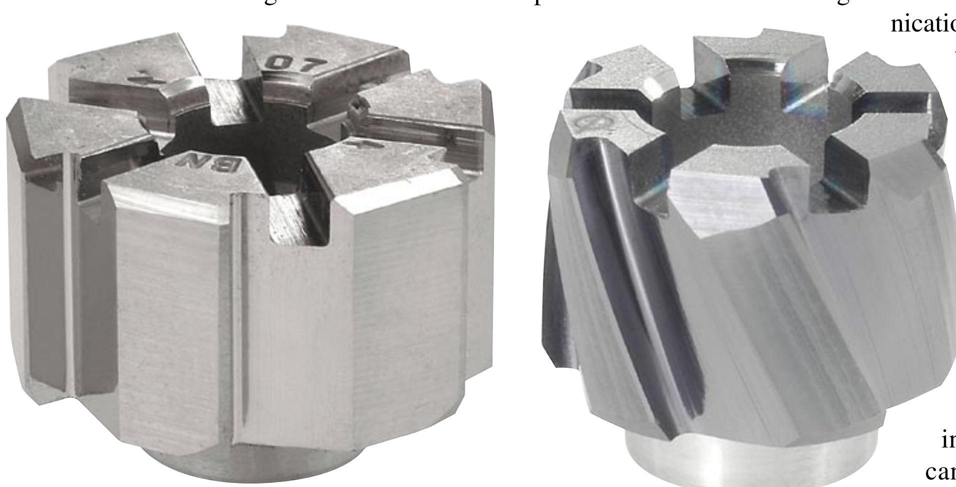
Ream or Bore

Another system on the market provides both precision reaming and boring capabilities. Shefcut precision reamers and boring tools from Cogsdill Tool Products Inc., Camden, S.C., feature a single, adjustable cutting edge supported by multiple guide pads around the tool periphery.

The company's corporate communications manager, Fred Ogburn, said the blade is set with a slight back taper, enabling it to function "almost as a single-point-type tool. Even though you have a blade cutting, you're really cutting on the front tip of that blade." The tools are engineered to produce accurately sized, straight and round holes to ISO H6 finish standards.

Bore tolerances, including straightness and roundness, can usually be held within 5µm (0.0002") on typical shop equipment. Surface finishes as fine as 4µin. R_a or better are attainable in some materials.

The cutting blade is independent of the tool body, is micro-adjustable over a limited range and can be preset to cut a specific diameter. Ogburn said, "A Shefcut tool is not an adjustable reamer, per se. It does have a micro-adjustment feature, but it is a fine-tuning-type of adjustment." The adjustment range of a few 10-thousandths of an inch is intended to fine-tune the hole size and compensate for blade wear.



Iscar Metals

The flute configurations of Bayo T-Ream tools are different for reaming blind-holes than for through-holes. Straight-flute tools (left), designed for blind-hole use, provide a path for coolant to flush chips out of the hole. Tools with helical, left-hand flutes push the chips forward. This prevents chips from flowing along the flutes and preserves hole surface quality.

Cogsdill

A Shefcut precision reaming and boring tool mounted in a Cogsdill floating holder. Typically applied in precision reaming applications, floating holders are designed to compensate with radial and angular float for misalignment between workpiece, tool and spindle.

The guide pads, independent of the cutting blade, are not adjustable and are ground just a few tenths under the blade size specified to cut a certain diameter. The pads can be tailored to suit specific applications, such as multiple diameters, short or extended work lengths, interrupted cuts and piloted operations.

The operation chosen, reaming or boring, determines the method of holding the tool and the cutting parameters selected. When precision reaming, the tool is allowed to locate in the prepared bore. It is usually run at lower surface speeds and is held in the spindle with a floating toolholder or a precision holder. The tool body is "necked down" immediately behind the cutting head for increased flexibility.

"As a result," Ogburn said, "the tool will seek the bore until the guide pads are fully engaged, at which point it will produce an accurate and straight bore. But you've got a little play in the tool."

He cited an application on a slant-bed lathe where a Shefcut reamer, held in a Cogsdill floating holder, eliminated a honing operation in the production of an aluminum air cylinder. Overcoming the questionable alignment inherent in the lathe, the tool reamed the cylinder bore and achieved a (hole size) tolerance of 0.0002" and a surface finish of 6µin. R_a at a speed of 150 sfm and a 0.007-ipr feed.

When held rigidly, the tools can accurately locate a bore in applications such as truing a hole in a casting. For boring, the tool is run at higher spindle speeds. A rigid machining setup includes an accurate spindle connection, such as an HSK or adjustable toolholder.

"You wouldn't float the tool in a case like that, because you are actually locating the bore to a particular requirement," Ogburn said. He reported the example of a precision boring application that involved locating a 0.6245"-dia. bore in a gray cast iron spool valve, where the tool ran at 1,500 rpm, 0.005 ipr and produced a surface finish of 32µin. R_a.

The relationship of the guide pads to the blades is key to tool performance. The crucial measurement is the difference in size between the guide-pad diameter and minimum-cut diameter. That difference is known as the "security zone," because it must be maintained in order to avoid tool damage.

A micrometer can be used to measure and adjust the tool's cutting diameter. However, Cogsdill recommends the use of a setting fixture, especially for production applications. With a fixture, the tool is placed between adjustable centers and gaged by two probes. Using the guide-pad diameter as the reference point, one probe measures the tool cut diameter and the other measures blade back taper.

The front adjustment screw sets the blade cut diameter by moving the blade until it is higher than the guide pads by the amount of the security zone, or approximately 0.008mm to 0.013mm above the pad diameter. Then, the rear adjustment screw sets the back taper by moving the rear of the blade flush with, or as much as 0.013mm to 0.020mm below, the pad diameter.

The bulk of the tools Cogsdill produces are custom-engineered for specific applications. The company does offer a line of tools for reaming popular hole sizes, although every tool is manufactured for a specific cut diameter. The "standard" tools are stocked in a semifinished condition. Prior to delivery, the guide pads are ground to order and blades are mounted to match specific hole diameters. △

The following companies contributed to this report:

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