▶ BY BRAD LEWIS, ASSOCIATE EDITOR

Burn Small, Burn Deep

Fast-hole EDMs create deep holes in tough-to-machine materials.

In the world of electrical discharge machining, "fast" is relative. While sinker EDMs are routinely knocked for their slow cutting rates, other machines, such as fast-hole EDMs, are prized for their fast cutting speed.

In addition, fast-hole EDMs have the advantage of being able to cut almost any material easily. Therefore, such machines offer the best of both worlds for small-diameter applications: A fast-cutting EDM tool that makes deep holes in difficult-to-machine materials.

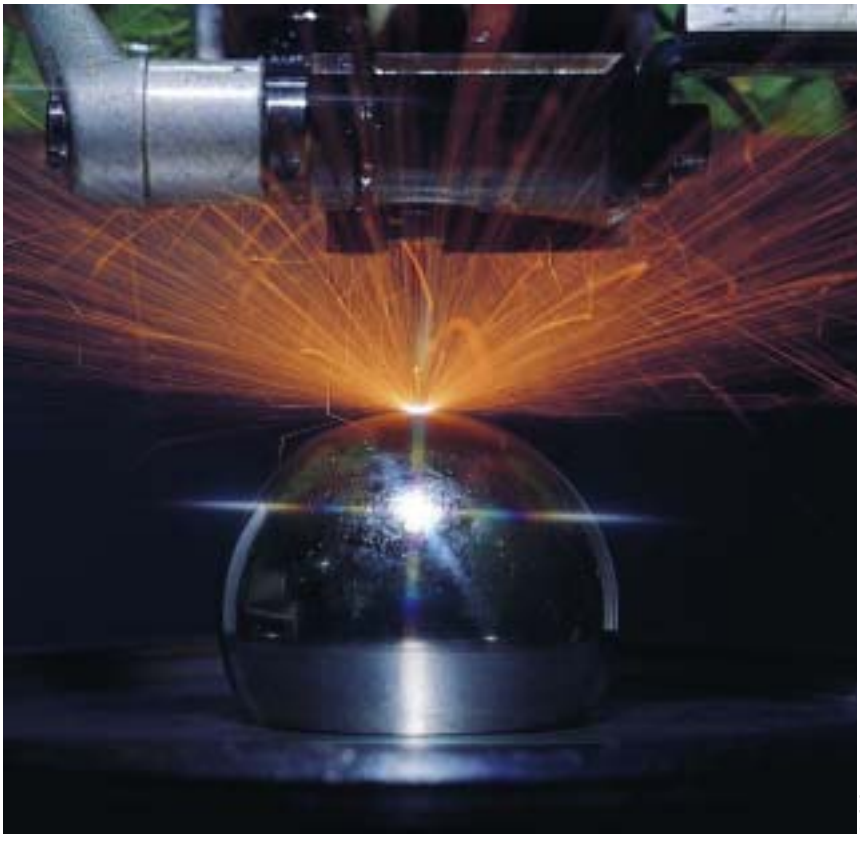
The technology behind a fast-hole EDM holemaker is nearly identical to that of a conventional EDM. A thin, hollow electrode, usually made of brass, is electrically charged and sunk into the workpiece. Unlike conventional sinker and wire EDMs, though, the electrode is not simply fed into the workpiece. Rather, it spins at a relatively low speed—from 60 to 400 rpm, depending on the application—like a slow-motion drill. Dielectric fluid is flushed through the electrode to create the conductivity needed for spark erosion. Spinning the electrode helps maintain an even burn, which improves hole concentricity.

What Work?

Initially, the machines were used to make starter holes for WEDM applications, said Clive Greatorex, sales manager for Belmont Equipment & Technologies Co., Madison Heights, Mich. Soon after, the technology began to be used for production-level holemaking.

P.J. Naughton, marketing manager for Sodick Inc., Mount Prospect, Ill., said there are two basic types of deep-hole EDMs: manual and CNC. The manuals are for making starter holes, whereas the CNCs are for production-level work. "Most of our customers are using them for specialty applications in aerospace, such as turbine blades," he said.

As an example, he pointed out that one customer wanted to put an aligned hole through every thin-walled blade of a turbine fan. To do this, he put the fan on a rotary table. After the EDM made



Sodick

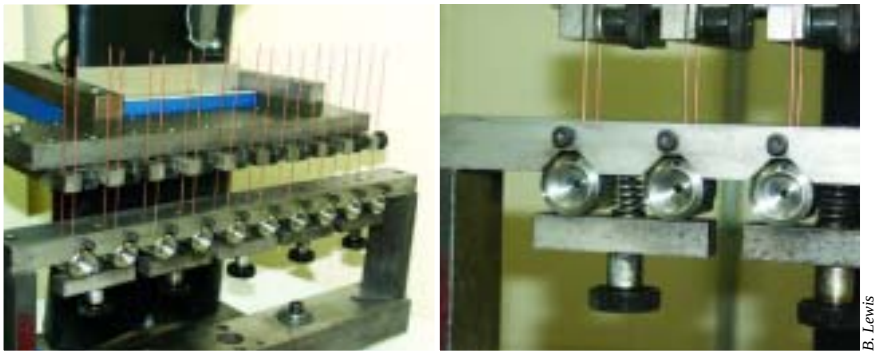
a hole in a blade, the table rotated the workpiece and presented a new blade to the electrode. "The job was basically to burn the hole, index the workpiece, burn and so on."

Greatorex added that fast-hole machines are particularly attractive to medical-part manufacturers for two reasons. They offer virtually burr-free holemaking, and, because the dielectric fluid used contains no oil, there are fewer contaminants left on the finished product.

More and more companies are taking advantage of this technology to produce deep, small holes for the medical and aerospace markets.

Rich Molnar, engineering manager at Norman Noble Inc., Highland Heights, Ohio, EDMed wire-locking holes in fastener nuts used for aerospace components. Such parts require a series of holes around the OD of a hex-shaped nut.

Dimensions for these particular holes vary. Molnar said typical measurements are from 0.020" to 0.100" in diameter and ¼" to 2" deep. The most salient benefit of the machine is its ability to enter at an angle to each face of the nut. In this case, a 60° angle. "If you were to drill that [with a conventional tool], it'd be quite difficult," he said.



B. Lewis

Abet Industries designs and builds its own EDM holemaking machines and power supplies. Here, 20 holes are being EDMed simultaneously.

At Quality EDM Inc., Anaheim Hills, Calif., owner Mike Gervais had to put an 18"-long, ⅛"-dia. hole in titanium for a fluid passage in an aerospace manifold. He said the job took 1½ hours and the tolerance was ±0.005". This kind of performance, he said, would be very difficult to achieve with conventional drilling.

In another application, he put flushing holes down the lengths of stainless steel dental drills. "When dentists drill the jaw bone, they have a flushing hole through the middle of the drill," said Gervais. "We put those holes in about 150,000 parts per year."

The holes are 0.028" in diameter and 1.5" long. Cycle time is 2 minutes per part. Again, with so many parts to do per year, Gervais said speed is critical.

Small Diameters, with Depth

The optimal dimensional parameters for holes produced on fast-hole EDMs are fairly narrow in terms of diameter, usually from 0.012" to 0.125", said Tom Connolly of Abet Industries Corp., a LaGrange, Ill.-based manufacturer.

Of course, smaller holes can be created. For example, a 0.0058"-dia. hole can be made using a 0.004"-dia. electrode, and the right mix of technology and expertise. However, the depth-to-diameter ratio can be an astonishing 500:1, according to Connolly. At the other extreme, Quality EDM's Gervais has EDMed holes as large as ¼" in diameter.

Fast-hole EDMs are not as precise as their wire brethren. They hold tolerances to ±0.0005" and impart a 125-rms finish. That tolerance, said Gervais, "isn't that accurate for EDMing, but [the jobs they do] could never be done with a [conventional] drill," at the dimensions commonly called for.

As with sinker EDMs and WEDMs, the workpiece cut on a fast-hole EDM

EDM tapping burns mistakes

Though it's not widely employed, EDM tapping has saved countless expensive parts from the scrap heap. At least, that's the sentiment of Quality EDM's Mike Gervais.

He said his company does the job about 20 to 30 times per year, but it's not done on a fast-hole EDM. For this job, Gervais turns to a sinker EDM and equips it with a special tap sinker. The tap, he said, is an undersized electrode that goes down and orbits out the cavity, after the hole has been drilled. The orbiting action generates the thread.

Norman Noble's Rich Molnar concurred: "It's a lifesaver. I've seen jobs where an engineer or toolmaker forgot to put in some tapped holes and the part was already hardened. Instead of taking a chance and ruining some geometry on the workpiece, they'll EDM-tap the hole."

Orbiting, Molnar said, is the popular method for EDM tapping. "The electrode looks like a screw and it's dropped into the hole. It goes in at the pitch already laid onto it."

He added that there's usually no class of thread for this operation. "It's a tool we purchase off the shelf, because it's inexpensive." But, if a class-fit thread is required, he said the work is likely to be more involved.

Because of the relative complexity of the operation, Molnar recommends a CNC EDM. He said the EDM's servos carefully position the sinker, which helps regulate the voltage.

He didn't completely discount the possibility of EDM tapping on a manual machine, but he cautioned "you would need the right kind of operator."

While the operation mostly corrects production mistakes, such as forgetting to tap a hole after the workpiece has been hardened, Molnar said it is practically the only way to tap hard materials. "With PCD or carbide, there's no other approach to it. You're bound to EDM at that point. It's generally slow and painful, but it can be done."

—*B. Lewis*

B. Lewis

For Abet, the ability to produce multiple holes at steep angles are the main advantage of EDM drilling.

must be electrically conductive. Similarly, material hardness is not a limiting factor. Common workpiece materials, said Molnar, are stainless steels, tool steels and carbides. Occasionally, his company has had to put small holes in tough-to-EDM materials, such as PCD.

Molnar's company mostly EDM-drills 300 stainless steel. He said it "tends to be gummy and if you drill it [conventionally], you'll end up with a nasty burr." By using a fast-hole EDM, a much smaller burr is produced. "It's about 0.001" to 0.002" long, which is easily finished off."

Needless to say, because the electrode doesn't contact the workpiece, "walking" is rarely a problem. "If you had to drill a ball surface, how would you drill it?" asked Molnar. He said it would be impossible to put the hole in by conventional means. "You'd have to EDM. Something that's a noncontact tool."

Rodney Sumner, technical representative for Current EDM Inc., Mountain View, Calif., concurred. He added that since the operator can control the gap between the electrode and the material, and the electrode never touches the workpiece, deflection is minimal.

This also means that the electrode can enter at unheard-of angles in most any material. Sumner said his company offers EDM holemakers with angles of entry ranging from -15° to 120°.

Although he conceded that a fast-hole EDM can be slightly affected by deflection, Molnar said that 90 percent of the time it can enter in on an angle.

Sodick's Naughton also said small-hole EDMs, like all EDMs, are also far less labor-intensive than conventional machines. "Once the operator sets up the part program and fixtures, he can walk away," he said.

In addition, because the electrodes wear out quickly during the process, the machines have an automatic electrode changer. He said that a 12"-long electrode would last 12 to 15 holes when EDMing through a 1"-thick stainless steel workpiece.

Problems with Solutions

The downside to EDM fast-hole drilling is obvious. For starters, the diameters are inherently limited by the technology. For any diameter over ¼", it simply makes more sense to conventionally drill the hole or employ a sinker EDM.

Second, "speed is the No. 1 determiner of precision and tolerances," said Connolly. "When the EDM drill is doing what it does best, precision can be sacrificed." It's when mitigating factors, such as tight tolerances, are added in that a job can quickly move beyond the capability of a dedicated fast-hole EDM. "If you try to hold tolerances and precision, you're giving up speed, which is the machine's primary advantage," he said.

Another concern with fast-hole EDMs is that tapering at the bottom of holes can occur. "There's an issue of electrode straightness when you go very deep," said Connolly. "You may not be able to predict it accurately."

Once the electrode bends, he said, "it's more like boring than drilling." This leads to increased electrode wear. "In order to achieve the required speeds and depths, the electrodes are eaten up at a much higher rate."

One possible solution is to use a machine with a high-quality power supply. Greg Langenhorst, sales manager for MC Machinery Systems Inc., a division of Mitsubishi EDM, Wood Dale, Ill., said the Mitsubishi ED-2000M's power supply prevents bottom tapering by carefully regulating electrode wear in the hole.

Sometimes, though, an improved electrode can reduce wear and tapering. For example, Sodick's manual K1C machine employs carbide-tungsten pipe electrodes. Sodick says these offer minimal wear when eroding hard materials or holes from 0.010" to 0.012" in diameter. Such electrodes, however, can run about $25 each, whereas standard electrodes cost only $4.

Molnar said tapering is particularly acute in blind holes. In such cases, he cautions operators to keep an extra-sharp eye on electrode wear. If the wear rate is too high, then entering the hole multiple times becomes necessary, which generates a bell-mouth at the top of the hole.

To counter this electrode drift, Quality EDM's Gervais recommends using guides and bushings. Operators have to make sure their guides are straight and the tubing is aligned, he said. "If you don't do that, the electrode will drift." His company relies on guides for mak-

The following companies contributed to this article:

Abet Industries Corp.
(708) 482-8282
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Belmont Equipment Co.
(800) 493-4932
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Current EDM Inc.
(650) 966-9676
www.currentedm.com

MC Machinery Systems Inc./ Mitsubishi EDM
(630) 616-5920
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Norman Noble Inc.
(800) 474-4322
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Quality EDM Inc.
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Ramco Machine LLC
(978) 948-3778
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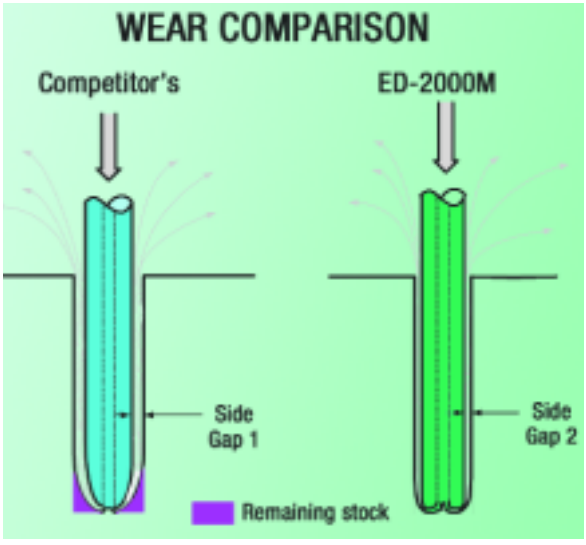

Mitsubishi EDM

Mitsubishi says its EDM ED-2000M has a power supply designed to prevent bullet-shaped or tapered holes.

ing long holes, and it often makes its own guide bushings out of stainless steel.

For Randy Jezowski, owner of Ramco Machine LLC, Rowley, Mass., preventing tapering is often a matter of breaking down the job into its components. "Many times, we can put in really small holes, but they're not terribly accurate," he said. "As the electrode leaves the guide, water pressure causes the electrode to whip a little bit." This, he said, results in a barrel-shaped hole, whereby the hole is wide in the middle and narrow at the ends. Of course, when that happens, the hole is not true.

His solution is to first "shoot" the hole smaller than necessary, then put it in the WEDM and bore it.

Not for Every Job

As with any piece of equipment, fast-hole EDMs offer advantages and disadvantages. While hole diameters are limited, depth-to-diameter ratios cannot be matched by conventional drilling.

Could EDM holemaking replace conventional drilling? Of course not. But for certain jobs, it is the only option.