



Corkscrew Milling Saves \$35,000 In Machine Time

Corkscrew milling – different than orbital milling – provides sweat-fit hole dimensions and finish for precision dieset guide-pin holes, plus saves \$35,000 annually in machine time.

Sinking large-diameter blind holes into tough hot-work steels isn't easy, but die- and moldmakers often have no choice. They need to create guide-pin holes in mating halves of a toolset for forging, stamping or molding. Unless the holes are perfectly round and smooth-sided, the sweat-fit with the guide-pin won't hold. And if the mating holes don't align exactly, the dieset can seize or be damaged when put to use, endangering the machine and anyone nearby.

The problem is perhaps most extreme in big forging dies, where guide-pin holes run big enough to hide a bagel — 2" – 4" diameter by more than 4" deep. Standard indexable mills have not worked well on guide-pin holes because they cut out-of-round or score the bore with zigzag tool marks, leading to loose sweat-fits with the guide-pins.

For a lot of tool and die shops, prevailing practice is to do it the old fashioned way. Open the hole with a spade drill, then finish-bore for final size, roundness, straightness, and finish on one half of the dieset. Then repeat for the other holes until all four are done. The problem is, it's very slow. It can take a full day to complete just one toolset this way, even when all goes well.

The Good News

That's the bad news. The good news is that several forging shops have switched to a new method that cuts machining time for guide-pin holes by 4:1, and eliminates a lot of error sources besides.

They corkscrew-mill the holes with a new Ingersoll Hi-Pos+ indexable end mill. It completes a whole dieset in an hour and a half and produces a hole that looks like it's been bored. Dimensions are accurate within 0.0005", and the bottom is a true flat, 90° square from the wall. And, there is no need to move to a second machine just for the holemaking..



Corkscrew milling with new Ingersoll Hi-Pos+ indexable endmill cuts holemaking time by more than 4:1 in forging diesets.

A typical die measures 20" x 24" x 12". Die makers mill the holes with a 1-1/2" Ingersoll Hi-Pos+ indexable endmill at 3000 sfpm and 40 ipm feed.



"The horsepower required to spade-drill such large holes can easily stall most modern CNC machines used in fine cavity work," says Konrad Forman, Ingersoll product manager, who has helped spearhead the new practice. "For that reason we've seen many moldmakers moving the toolset to a jig borer or heavy-duty drill press just for the guide-pin holes. Moving to a second machine slows things down and also introduces another source of error.

"With corkscrew milling, there's no stalling problem – and no shuttling between machines."

Beyond Orbital Milling

Corkscrew milling involves simultaneously feeding on all three axes: advance on the Z-axis while interpolating on the X- and Y-axes to enlarge the hole. It is a step beyond orbital milling, where the Z-feed is done separately from the X-Y interpolation. The cutter's centerline follows a helix. It is a programming step up from orbital milling, where you plunge to depth on the Z-axis and then interpolate.

Since there is only a small contact area between tool and workpiece at any instant, cutting forces are much lower than in spade drilling. And the friction between drill flutes, chips, and sidewall of the hole is all gone.

True Square Corner

The new Ingersoll indexable mill works here because the edge of the inserts is manufactured to trace a true

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helix with respect to the cutter's centerline, leading to absolutely straight sidewalls and a 90° bottom. Insert geometry also promotes very free cutting with uniformly low cutting forces. The result is the kind of finish generated with a solid carbide endmill, according to the manufacturer. By contrast, kinematically, conventional square inserts following a helical path simply cannot

create a square corner at the bottom of a blind hole, and can not avoid leaving lap lines in the sidewalls.

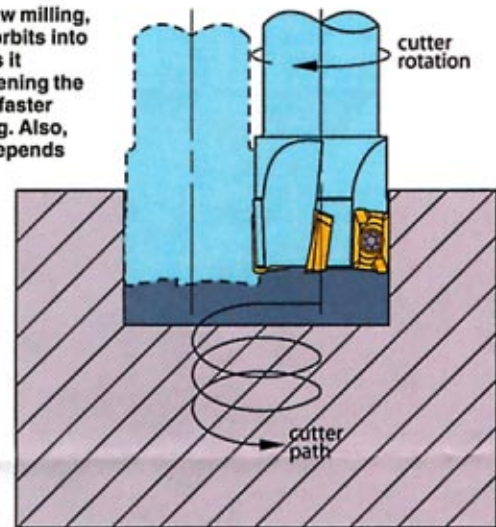
Customary practice with the new method is to corkscrew-mill both holes to identical diameter and location, then enlarge holes in the top die by 0.005" for clearance. Next, the guide pin is turned to 0.003"–0.005" larger than the bottom die hole, to create a tight sweat-fit. Finally the bottom die is heated to expand the hole enough to accept the guide-pin. When everything cools and contracts, the pin is locked firmly in place.

Case In Point

One forging-tool shop using the new method standardizes on 3" guide-pins and high-nickel 4130-type steel, Rc 38, for big dies. A typical die measures 20" x 24" x 12". Diemakers mill the holes with a 1-1/2" Ingersoll Hi-Pos+ indexable endmill at 3000 sfpm and 40 ipm feed. In about 1-1/2 hour per dieset, they complete all four holes and produce and "sweat in" two guide-pins.

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In corkscrew milling, the cutter orbits into the work as it rotates, opening the hole much faster than drilling. Also, hole size depends on the program, not cutter size. This reduces drill inventory requirements since you don't need a drill for every hole size.



Based on current volume of two diesets per week on average, the new method saves about \$35,000 a year in machining time.

Handling Expansion

Forman, the product manager, has helped a couple of forging tool makers take it a step further, correcting for differential thermal expansion that develops over time between the mating halves of a forging die in use. "By noontime in many forge shops," he explains, "the bottom die runs 200° hotter than the top die because it has spent more time in contact with hot billets. So its guide-pin holes are 0.005" – 0.010" farther apart than those in the top die. This can cause seizing and tool damage."

Accordingly, Forman advises milling the hole in the top die as a very short slot rather than a true round. The few thousandths of slot length are enough to accommodate the spread of the guide-pins as the hot die expands. "While you can't readily create a slot with a spade drill or boring tool, it's easy with an indexable mill," Forman says. *Ingersoll Cutting Tools*

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