How to select a secondary spindle.

Secondary Helping

IBAG North America

The selection of a spindle for secondary operations can be tricky for anyone, regardless of experience.

However, just because the available options are limited to the type of machine employed for the job and the specific secondary operations required does not mean that selecting a secondary spindle ought to be a headache.

There are two main types of secondary spindles, based on their power sources: electric and air-powered (or pneumatic). Knowing the relative advantages and disadvantages of each, as well as the machine requirements for each type, is critical.

▶ BY BRAD LEWIS, ASSOCIATE EDITOR

Air-Driven Spindles

As the name implies, air-driven spindles are pneumatically powered, relying on a supply of clean, dry, pressurized air to spin the turbine. As with other secondary spindles, pneumatic spindles are primarily for drilling and milling with small-diameter tools.

Bill Mitchell, vice president of Air Turbine Technology Inc., Boca Raton, Fla., said the primary advantages of air-driven spindles are their light weight, low vibration and quiet operation. In addition, he said that ATT's air turbines are virtually maintenance-free, since the spindles are prepacked with grease and have no vanes or gears within the spindle's housing.

However, certain precautions need to be taken while using these spindles. For example, to keep the motor's air supply free of contamination, special air filters capable of capturing 5µm-sized particles are needed if the shop's air source isn't clean.

The recommended air pressure must be between 90 psi (6.2 bar) and 100 psi (7 bar). According to ATT, insufficient air pressure reduces the spindle's power, while too much pressure exerts and stresses the turbine.

ATT also recommends maintaining an unrestricted air supply. Couplings, reducers or hoses with undersized diameters restrict airflow to the motor and reduce spindle power.

"Most of our customers' problems can be attributed to dirt in the air supply or a restricted air supply, where couplings, reducers or hoses with too small of diameters restrict the air to the motor, 'choking off' the spindle's power," said Mitchell.

Obviously, then, since pneumatic spindles rely on a constant supply of air to maintain their power, air-spindle manufacturers strive to lessen this reliance as much as possible. For example, ATT's spindle speeds are "governed," said Mitchell. That is, the spindle has a governor to regulate the

Air Turbine Technology

Pneumatic spindles require an unrestricted supply of air to achieve their maximum performance capability.

amount of air to the spindle, decreasing the air supply when the spindle is idling and increasing it when cutting. This means the spindle uses less air, which can be expensive, depending upon the source. "A governed spindle can save up to 30 percent on air consumption," Mitchell added.

An often-overlooked benefit of air-driven spindles is how quiet they are. ATT's air spindles, for example, emit no more than 67 dBa.

Electric Avenue

Turning to electrically driven spindles, it is first necessary to recognize that these spindles are a whole order apart from their pneumatic counterparts. Electric spindles have their own independent motor that drives the quill shaft. These motors deliver much more raw power to the spindle and lend a greater degree of control to the operation.

In the mold and die industry, for example, an electric secondary spindle is employed for finishing and semifinishing after the main spindle has completed roughing, according to William Popoli, president of IBAG North America, North Haven, Conn., a manufacturer of high-speed spindles.

While the variety ranges from adapter-types to those permanently mounted on a machining center's column, electric spindles are restricted in terms of what kind of machine they can be used on.

Edward Hendrik, senior engineer for Fischer Precision Spindles Inc., Berlin, Conn., placed great emphasis on the need for the machine to accommodate the spindle's high speed. "The machine has to be up-to-date, or it must be updated to accommodate the faster speed range. Otherwise, it's not really profitable to buy a spindle that goes 40,000 rpm if the machine can feed only 450 ipm," he said.

To meet the demand for high-speed spindles, new machines with increased feed rates allow for faster machining. Hendrik said, "The older machines were built mostly for feeds up to 600 ipm. Today, however, machines can feed up to 2,000 ipm, so they can accommodate the faster spindles."

Indeed, the selection of the right spindle can be the most critical factor when designing machines. Hendrik said spindles were previously designed around the machine, but, today, it's the spindle that drives a machine's design.

Popoli said that newer machines are better candidates for high-speed, electric spindles. "The machine tool has to be capable of feeding at high feed rates with accuracy."

Furthermore, he added that the rapid development of CNC technology and high-capacity, 3-D computer files demand that machines meet higher tolerance levels. "You generally can't take a 10-year-old machine and plug a high-speed spindle into it and expect to cut really nice, accurate molds, because the machine is probably feeding at only 300 to 400 ipm. That's not enough to produce a good part."

Popoli said a 3-axis machining center with a toolchanger is an ideal candidate for the spindles his company sells to the mold and die industry.

Hendrik also noted the need for proper spindle-support systems for the secondary spindle, such as lubrication and cooling systems. Because electric motors run faster, they create more heat, which must be dissipated. For cooling and lubrication, Hendrik recommends an oil-mist system for spindle speeds greater than 12,000 rpm.

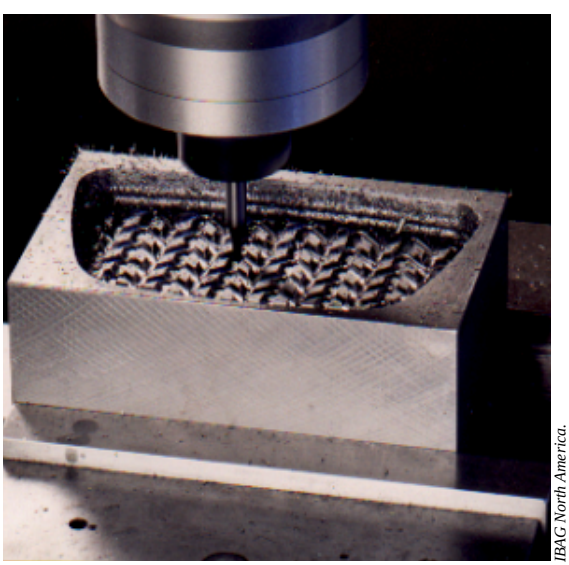
In terms of mounting electric spindles, John Easley, OEM sales manager for The Precise Corp., Racine, Wis., said that, depending on the machine, one way is to mount the spindle on the side of a column, clamped off to one side. "All one would need to do would be to make a correction offset on the axis position of the machine, so it would simply be a matter of switching between the two spindles that you have." However, the variety of electric spindles does not necessarily dictate using a style that mounts on a machining center column.

Another machine consideration is stiffness and rigidity, according to Easley. This criteria is specifically related to how much weight the column can handle, which varies from machine to machine.

Easley added that a critical factor is the overall size of the machine's bed. A spindle added to the column cuts down on the amount of space available for the machine's travel.

Of course, once you get around the machine restrictions, the advantages of electric spindle become clear.

The control offered through an independent power supply allows for vari-



IBAG North America.

Moldmakers are the primary customers for IBAG's high-speed spindles. Here, the company's Model HF 170.4 spindle machines an aluminum mold component.

able speeds throughout the range of the electric motor, said Easley.

However, the upfront costs for all electric spindles, whether they serve in a primary or secondary role, are comparatively higher than other types, such as pneumatic or belt-driven.

Electric Options

Popoli outlined the three basic options available when choosing an electric secondary spindle. On the small end of the price and horsepower spectrum is the 3-hp, adapter-type spindle. Designed for jobs such as machining a cube of steel 1' or smaller, it costs about $15,000. A 10-hp, cartridge-style spindle, which would be permanently mounted on the machine, costs around $35,000. The top end includes spindles for large, automotive-factory machines with 50-hp motors; they cost $60,000.

However, he also emphasized how much electric spindles can save a shop owner. "The primary moneymaker is the amount of time that you save. In the mold and die business—and, in general, any machining of hard material—the main savings is not necessarily in reduced cycle time, per se, as much as it is in eliminating or minimizing hand operations such as polishing," Popoli said.

The purpose of the spindles, according to Popoli, is to "impart the specified surface finish." With secondary spindles, "we end up with a process that's more accurate, and repeatable, and we've eliminated the hand-finishing benchwork that takes up as much as 40 percent of production time on a mold."

In addition, the advantages of the independent power supply cuts both ways. Not only does the secondary spindle's electric motor offer variable speed, apart from the main spindle, but the main spindle's motor is also not used at all during finishing operations. "Running the main spindle's motor at high speed not only wears out the main spindle, but it also creates additional vibration and heat, which affects machine tool accuracy," Popoli added.

The latest improvement in secondary spindles, said Popoli, is the increased use of ceramic bearings. Ceramic bearings have increased spindle speeds up to 30 percent over steel ball bearings. Furthermore, he said these speed improvements come without any loss in spindle life.

Following is contact information for the companies that contributed to this article:

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The only "loss" associated with secondary spindles seems to lie in the amount of money a shop could lose by *not* having one. And while each type has relative advantages and disadvantages, in the end, the best will always be the one that cuts the most costs—and metal—over the long term.

Old machines, new speeds

If you find your current spindle is over 10 years old and not reaching the speeds you need, a spindle-speed increaser, or a speeder, may be the right investment for your shop.

The speeder is perhaps the simplest and most affordable path to performing high-speed operations ordinarily done by secondary spindles. Yet speeders aren't separate spindles. Rather, their operation is based on a planetary gear system of hardened and ground steel gears. The housing, or gearbox, fits onto an existing spindle and boosts the machine's speed.

According to Ken Sheppard, vice president of Stanley Sheppard Co. Inc., Berlin, Conn., machining centers that are run continuously at high rpms shorten spindle life, due to the excessive load on the motor and bearings. Speeders reduce this load and extend spindle life by amplifying the work performed by the machine's spindle. Therefore, higher speeds can be achieved without having to run the machine spindle at full speed continuously.

Stanley Sheppard

The spindle-speed increaser is, perhaps, the simplest and most affordable path to high-speed operations usually performed by a secondary spindle.

Another advantage is that speeders can be adapted to improve the performance of older machines, which further extends the cost savings for shop owners. "The spindle speeds on those old boring machines, which might range anywhere from 500 rpm to 800 rpm, just aren't adequate. Speeders can get them up to three times as fast, when holding up to a 1¼" tool, which is a great way to improve productivity," he said.

Sheppard sells speeders that can hold tool shanks from ⅜" to 1¼" in diameter for heavy-duty milling. Speed-increaser ratios range from 3:1, for large-diameter tools, to 5.67:1, for smaller tools. Depending on the model and the original spindle, the maximum speeds range from 8,000 to 20,000 rpm.

—B. Lewis

For additional information on Stanley Sheppard Co. Inc., call (860) 828-8900, visit the company's Web site at www.stanleysheppard.com or circle Information Services #285.