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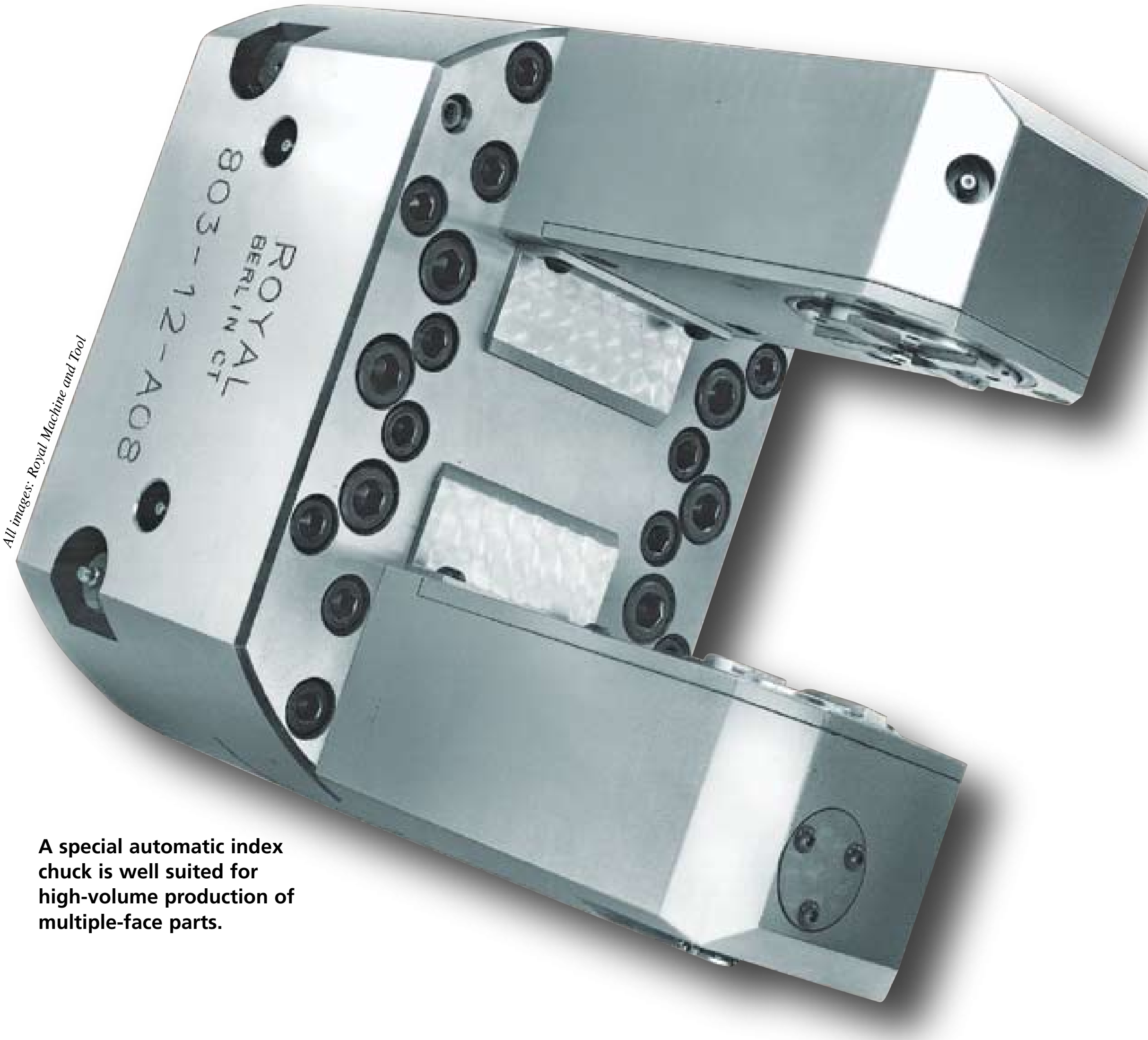

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A special automatic index chuck is well suited for high-volume production of multiple-face parts.

Chuck Choice

Guidelines for selecting the right workholding chuck for the job.

THERE ARE MANY considerations in selecting the optimal chuck for a particular job. A good place to start is by considering how the chuck holds a part. Presented here are some rules of thumb for selecting a chuck based on how it grips a workpiece.

Initially, look at the workpiece to be held. Round bar stock is the simplest geometry to hold, but not all parts come from bar stock. Some workpieces arrive as castings or forgings with nonuniform shapes. When that's the case, the selection process requires additional thought because of the variety of available chucks and options.

The most common chucks are standard 2- or 3-jaw chucks and collet chucks, which hold relatively simple-shaped parts. More intricately shaped parts may require an anvil-type 1-jaw chuck or a 4- or 6-jaw chuck.

The following are basic chuck designs and the types of parts they are best suited for holding.

- A 1-jaw chuck is for parts having a qualified side surface as a datum.
- A 2-jaw chuck primarily holds square parts.
- A 3-jaw chuck is mostly for round or hexagonal parts.
- A 4-jaw chuck stabilizes the grip on square parts.
- A 6-jaw chuck is for holding thin-walled parts that require wraparound clamping to avoid distortion.
- A collet chuck is for parts that require wraparound clamping to maintain close concentricity requirements without marking the parts.
- An index chuck holds parts with various centerlines as a reference.
- A diaphragm chuck holds parts that require an optimal grip during machining plus critical part tolerance without allowing distortion and markings.

Having all of these chucks in a toolroom would be ideal, but that is almost never the case. Therefore, when selecting the most appropriate chuck, determine the best method of chucking based on the workpiece or family of parts to be held, the machine tool being used, production volume, the machining process, part tolerance and finish requirement.

Various types of chucks, including 2- and 3-jaw chucks, are both lever-operated and wedge-operated.

Workpiece Configuration

Workpiece configuration often determines the most effective way to hold a part, based on part tolerances and machining operations required to produce the part. For example, a collet chuck would provide the accuracy needed to hold a part with a finished bore and face and achieve tolerance requirement when the OD, grooves and threads must be square and concentric to the surfaces within 0.0005".

It would be ideal to machine a part complete in a single clamping because handling the part as little as possible avoids tolerance buildup. This is possible in many instances because the proper chuck permits gripping the part in a secure way while allowing access to all machined areas.

Not all parts are symmetrical. Some have a flange or outrigger, which may require counterbalancing the part or reducing the speed of the process. To counter the effects of an irregularly shaped part, a counterweight is mounted opposite the part's runout area. This provides balance to the workpiece rotation, which enables imparting consistent surface finishes and achieving part tolerances.

Some parts have thin walls and distort when clamped with a standard 3-jaw chuck. A solution may be to use a collet or diaphragm chuck, which completely wraps the grip diameter and is more accurate than a standard 3-jaw chuck. Or, the solution may require a reduced clamping pressure to secure the part without distorting it. In most cases, distortion occurs because of extreme clamping pressure. The first concern is that gripping pressure be substantial enough to safely and securely hold the part. The appropriate pressure is generally found on a trial-and-error basis. Before repositioning the part or machining it, test the part by indicating a diameter in the free state and check for lobing or use a mating part as a gage.

Machine Tool

Like having a toolroom with all the available chuck styles, the ideal—but impractical—situation when properly chucking a part would be to have access to all available styles of machines. A more realistic approach is to have a workpiece, if possible, that can fit into a machine with the right capabilities. That can be determined by ensuring the chuck mounting is compatible with the machine by answering the following questions.

- What is the machine's speed and horsepower?
- Is there sufficient spindle speed to achieve the required cutting speed?
- Does the machine cylinder have the necessary pressure for the chuck, and is there adequate cylinder stroke to actuate the chuck?
- Is there enough swing clearance for the chuck, part and tooling to process the part?

The machine work envelope determines the clearance a chuck can safely rotate. In some cases, the part may be larger than the chuck, and it must be confirmed that it can rotate within the machine envelope.

Machine modifications may be required if an application calls for special fixturing, such as an index chuck or a chuck with retractable locators, which allows the operator to initially clamp the part on a locating datum. Then, retracting the locator allows clearance to machine areas that would otherwise be inaccessible to the cutting tool. In most cases, index chucks require a separate hydraulic unit with a programmable logic controller to monitor chuck operations, double-acting cylinders to allow independent part clamping/unclamping and indexing, and a cylinder adapter and tubing in lieu of a standard cylinder and drawbar/drawtube. For high-production applications, these types of changes are usually permanent. Therefore, production volume must be considered when making machine modifications.

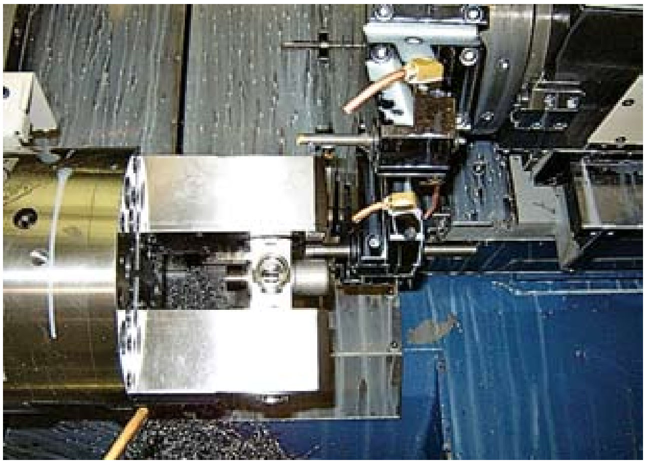
Production Volume

When making a single piece, it is best to use a manually operated chuck and universal jaws to clamp the part. This is the least expensive means and does not require cylinders and drawbars. Also, the universal jaws are readily available. Cycle time is not an issue because the part is only a one-off. Therefore, the workpiece can be pecked at without concern for any load from clamping or tool pressure.

High-volume production of precision parts, though, may require unmanned machining, with clamp/unclamp detection, pressure monitoring and sensing for proper part location. Lights-out machining may also require automatic part loading and unloading and automatic tool offsetting and breakage detection. In this scenario, the chuck is supplied with through-coolant for chip flushing on the part locating surface. Also, feeding air through the chuck may help determine if the part is locating, or seating, properly.

Machining Process

Once the process is determined, the clamping method can be checked to ensure the part is located properly and there's sufficient clearance for the tooling, coolant delivery and chip evacua-



Check clamping methods, such as the one for this automatic index chuck on a single-spindle lathe, to ensure there's sufficient clearance during machining.

Keywords

chuck:
Device that affixes to a mill, lathe or drill-press spindle. It holds a tool or workpiece by one end, allowing it to be rotated. May also be fitted to the machine table to hold a workpiece. One or more adjustable jaws actually hold the tool or part. May be actuated manually, pneumatically, hydraulically or electrically.

collet:
Flexible-sided device that secures a tool or workpiece. Similar in function to a chuck, but can accommodate only a narrow size range. Typically provides greater gripping force and precision than a chuck.

—CTE Metalworking Glossary

tion. Gages are normally provided to confirm chuck pressure, and shim stock is used to confirm a part is seated and gripped securely. A dry run of the toolpath will confirm proper clearance.

The process indicates the datums for the dimensions being machined. In turn, this determines how a part is located and gripped. The part includes a datum that acts as a base from which all required dimensions are relative. This datum becomes the chuck's locating surface and grip surface.

Next, examine the tools and their toolpaths for adequate clearances. A clearance is adequate if the part's clamping integrity is not breached. This rule also applies when allowing room for chip evacuation. On some machines with gang-type tooling, trailing tools may interfere with the chuck body or jaws. Also, adjacent tools on a turret may interfere with or require modification of the chuck jaws.

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In many cases, a part cannot be completely machined in a single clamping. For example, a part may be held in a 3-jaw chuck for roughing with a heavy DOC and transferred to a collet chuck for finishing because the part may have to be oriented more precisely or in a different fashion. In addition, a collet chuck may be the best option where maintaining finished part roundness, or concentricity, is vital.

Reviewing each of these four categories—workpiece configuration, machine tool, production volume and machining process—should assist in determining the appropriate chuck and top tooling to produce a quality part in a safe and timely fashion. △

About the Author

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