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Metal cutting tools and tool holders

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It is known that no machining is possible without cutting tools. Coming in contact with the workpiece material a cutting tool performs the actual removal of the material by means of shear deformation. Cutting tools must be made of a material harder than the material to be cut, must withstand the heat generated in the metal-cutting process and must have a specific geometry. All the cutting tools are adapted to perform certain work in the most efficient manner, therefore there is a great variety of metal cutting tools:

- linear-travel tools travelling in straight-line motions, and rotary tools that feed into a workpiece while either the tool or workpiece is rotating;

- solid cutting tools and indexable cutting tools. Solid tools are made from a single piece of homogeneous material. They can be reshaped after use, but this is a precision process requiring accurate grinding machinery. One of the more recent developments in cutting tool design is the indexable insert. Indexable inserts are standard-sized wafers of hard tool material which are clamped into tool holders or cutter bodies. Inserts generally have more than one cutting edge; when a cutting edge is worn out, a new edge can be brought into use by rotating or «indexing» the insert. Inserts made of almost all tool materials are available. Indexable tooling offers advantages in both high and low production applications.

Cutting tools must be held in tool holders, that are the physical interface between tooling and the machine tool. They

come in a multiple of different machine mount styles from the older R8 style to newer HSK or VDI mounting.

The tool holder is the essential connection between the machining center and the cutting tool. The tool holder fits into and is secured by the machining center's spindle, and in turn secures the cutting tool such as a drill or end mill by clamping onto its shank. The taper of the tool holder matches the tool holder interface of the particular spindle. Tool holder tapers are often conical, including CAT and BT taper specifications. A different kind of taper, HSK, is not tapered at all, but instead includes a variety of flanges for securely locking the tool holder in place. Tool holders use different mechanisms for clamping the tool. A set screw can clamp onto a corresponding flat in the tool's shank. Or, a collet can be compressed around the tool by tightening a nut that also surrounds the tool. More unusual clamping mechanisms include hydraulic tool holders which compress a bladder of hydraulic fluid, as well as shrink fit tool holders which clamp and release the tool by heating and cooling the tool holder's metal to take advantage of thermal expansion and contraction. Other tool holder types use still other methods of clamping. Various clamping mechanisms aim to provide not just secure holding of the tool, but also tool concentricity to the centerline of the spindle that is accurate to a level of runout error appropriate to the tool and the machining process.

Tool holders have three main parts: the taper, the flange, and the collet pocket. Driven or "live" tooling is powered. Static tooling is not.

- The taper is the conically-shaped area of the tool holder that enters the spindle during tool changing.
- The flange is the part of the tool holder to which the automatic tool changer is attached when the tool holder is moved from the tool changer to the spindle.

- The collet pocket is the area into which the collet is inserted before being secured by various types of collet nuts.

Some tool holders shrink-fit around the machining tool or cutting tool and remain firmly in place. Others are optimized to the smallest size possible to allow for maximum clearances during machining.

Tool holder types.

Different tool holder types can be used in metal cutting:

- Machine arbors are motor-driven shafts that turn machining tools.
- Blank adapters can be customized for specific applications or machining tasks.
- Boring heads can hold a variety of cutting tools, but are used mainly with boring bars.
- Collet chucks use collets of various sizes to hold machining tools.
- End mill holders are designed to hold end mills during milling operations.
- Milling or drilling chucks are used to hold various cutting tools during milling or drilling applications.
- Outer diameter (OD) and inner diameter (ID) tool holders can hold a variety of cutting tools.
- Shell or face mill adaptors are designed to hold shell or face mills, tools used to cut surfaces.
- Side cutter holders are designed to hold side cutter tools.
- Saw blade holders are designed to hold saw blades.
- Tapping chucks are designed to hold tapping tools for threading operations.

Tool holders can be coolant-fed or have a coolant-through flange. Some are optimized to the smallest size possible to allow for maximum clearances during machining. tailored to optimize both machine performance and operational efficiency.