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Systems for boring large holes.

BIG Bores

▶ BY NORMAN SCOTT, INNOVATIVE TOOLING SOLUTIONS

Parts manufacturers define "large"-hole boring differently. Whether a bore is considered big—or small—usually depends on the diameter of the hole that the individual manufacturer's machine can bore and the part being produced. So, what might be a large bore to a company machining household appliances may be small to one that produces power-generation equipment.

Boring large holes effectively on a production basis is limited by the machine's ability to handle tools automatically through its toolchanger. In the case of medium-size machining centers, the limitation generally is the size of the tools. These machines usually can handle tools that weigh no more than 55 to 65 lbs. and are designed to bore holes between 8" and 10" in diameter. The standard length of these boring tools is 16".

There are horizontal boring machines (HBM) equipped with automatic toolchangers that can handle larger boring bars, but they too are limited by the weight and diameter of the tool.

For symmetrical parts, large bores can be efficiently machined on horizontal and vertical lathes. However, when the bore is an integral feature of a large casing, housing, valve or other part, rotating the component is not practical. In these cases, it is more efficient and cost-effective to produce the bore by rotating the tool rather than the part.

Heads Up

Mounting contouring heads and controlled boring tools on CNC HBMs offer an additional axis of control, allowing the user to machine large-diameter bores and complex geometries.

Contouring heads and controlled boring systems from Innovative Tooling Solutions (ITS) permit changes to be made to the cutting diameter during the machining process.

These heads and boring tools are mounted to the spindle sleeve and use the rigidity of the spindle-sleeve bearings to enable boring of large diameters and deep bores. The mounting surface typically is three to four times greater than the 2.75"-dia. gage line of the ANSI B5.50 taper, adding considerable

All images: Innovative Tooling Solutions

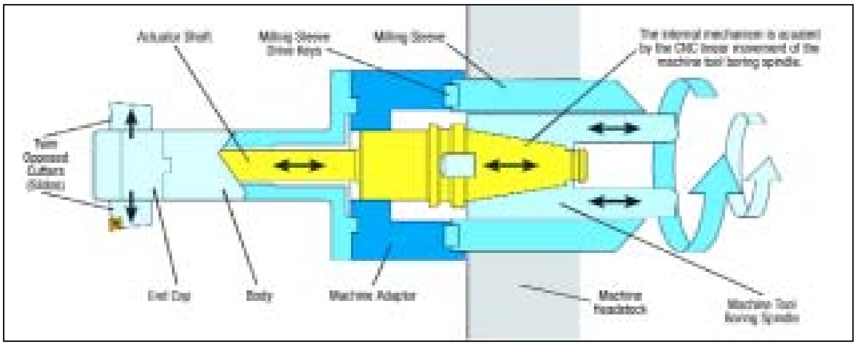
A horizontal boring machine with a 125mm-dia. spindle is set to apply a twin-insert, controlled boring bar to parallel bore, internal face and taper bore a 20", single-cavity valve body.

stability to the cutting tool. The rigidity of the tooling and the precision of the internal mechanism enable the tool to accurately reflect the capabilities of the machine tool on which it is mounted.

The spindle taper is locked onto the internal mechanism of the contouring head or the controlled boring tool. The linear motion of the spindle W-axis, which is controlled by the machine tool's CNC, is translated 90°, creating the radial motion of the twin, opposed cutter slides. Controlling the cutting tool by programming the spindle axis enables the tool to bore multiple diameters. Combining this motion with the Z-axis motion provides the ability to generate tapers, radii, undercuts, threads and other features typically associated with turning machines.

Controlling the tool's radial motion with the linear motion of the spindle W-axis also enables tolerances of less than 0.001" to be achieved electronically rather than mechanically, as is typical with standard boring systems. Holding close tolerances with standard boring tools usually requires a trial cut and manual adjustment of the tool to achieve the correct size.

With this type of contouring head or controlled boring tool, the semifinished diameter can be measured with a bore gage or probe, and the spindle axis offset can be adjusted, via the CNC, to establish the finished size. The same tool, applied during the complete machining sequence, also can produce multiple diameters within the cutting range of the tool.



The ITS controlled boring product incorporates a precision internal mechanism, which is actuated by the machine tool's CNC, to control the radial motion of the twin, opposed cutters during machining.

In Action

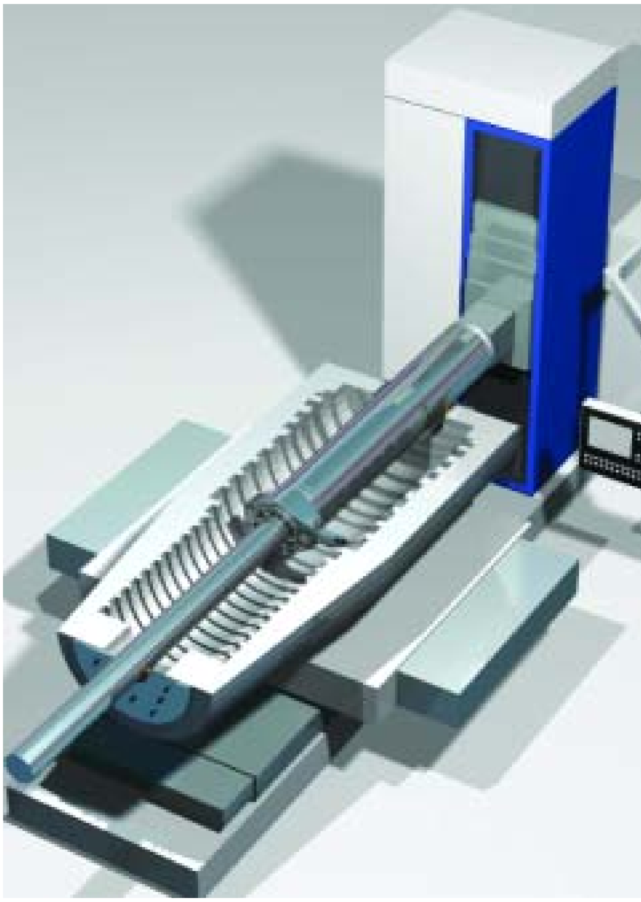
Machining the internal diameters of a power-generation steam chest are demanding operations and are typical of the jobs performed by the ITS CH16 contouring head. For one such part, a single ITS 3"-dia. bar measuring 20" long was used to bore a number of diameters ranging from 16.0" to 22.5". Additional boring operations and the back-face machining were performed from the opposite side after the steam chest was rotated 180° on the HBM.

For a 20", single-cavity valve body (see opening photo, page 40), an ITS bar was used for parallel boring, internal facing and taper boring. The double-cutter system provided a balanced cutting action and the necessary stability to accomplish the interrupted-cut, extended-length boring operation. This enabled the 32-rms finish to be held in the seat pockets while maintaining a bore tolerance of 0.001".

The ITS CBS-SX bar has an overall assembled length exceeding 32', with an effective forward boring length of 185". It is capable of a 35"-dia. change. This large change capacity, combined with interchangeable toolholder clamping units, gives the bar a machining envelope of between 38" and 80" (diameter).

The CBS-SX bar illustrated at right is shown mounted in a typical turbine casing. The scope of the work performed includes rough, semifinish and finish boring, facing and profiling. All the internal machining operations are performed automatically by programming the spindle axis to control the radial motion of the cutting tool simultaneously with the axial motion supplied by the machine's table axis. Changing from forward boring and facing to back boring and facing is achieved quickly and accurately via Sandvik's Capto modular tooling system.

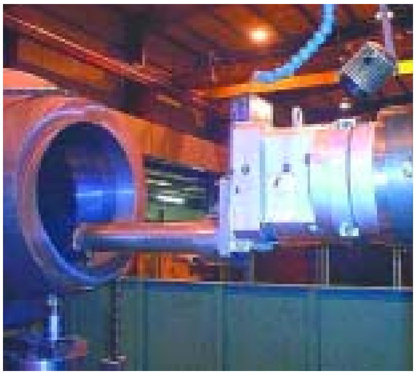
Each CBS-SX bar is custom-built, according to the specific part and machine tool. The boring bar is composed of three main elements: the bearing housing, boring head with diameter control and an optional support pilot.



An illustration of a CBS-SX boring bar mounted in a typical turbine casing, with the top half of the casing removed to show the operations being performed. The boring bar is composed of three main elements: the bearing housing, boring head with diameter control and an optional support pilot.

The bar as shown is supported at each end of the turbine casing via purpose-built bushings assembled directly to the casing journal bores, guaranteeing the required alignment of all internal machining to these end features. The nonrotating bearing housing accommodating a tapered roller bearing and wiper-seal configuration is attached directly to the machine tool. The inner sleeve of the bearing housing interfaces with the actual boring and facing head.

Rotational torque is delivered to the boring and facing head via the inner shaft, which is attached to the milling sleeve of the machine tool. The outside diameter of the nonrotating bearing housing and the outside diameter of the rotating pilot are finish-ground to provide a suitable sliding condition for the bars axial movement through the bushings.



Controlled boring of various diameters is performed in a cast-steel steam chest for the power-generation industry.

About the Author

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