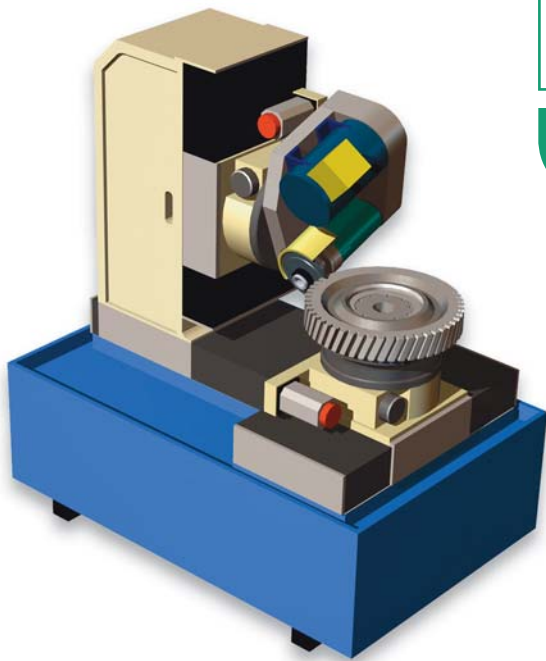
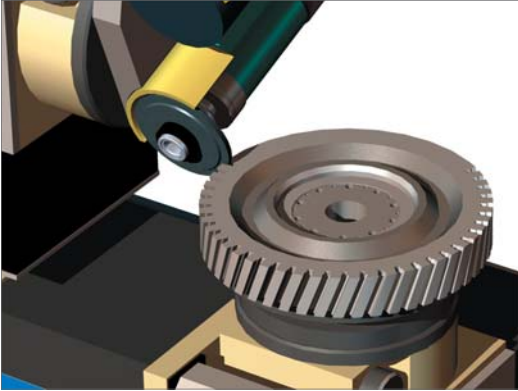


WHAT ABOUT GRINDING?

Grinding has been shown to be a viable alternative to some broaching operations. Access to the “lobes” of the profile is limited, requiring a broach or small diameter tool or grinding wheel. However, the bulk of the material can be removed from the root form by grinding. Rough grinding the forms offers several benefits:

- 1) Eliminates the need for most, if not all, of the roughing broaches, thereby saving the purchase price, maintenance (resharpening) cost, inventory carrying cost and setup time of roughing broaches.
- 2) Enables the broach machine to be set up with only semi-finishing and finishing broach details, thereby opening the possibility of having broach lines for multiple part numbers set up on the machine, thereby further reducing setup and change-over time.
- 3) Increases overall capacity: stroke length and cycle time on the broach machine is reduced, thereby increasing overall throughput.
- 4) Can avoid or at minimum postpone buying more broaching machines. A grinder suitable for rough grinding root forms requires considerably less capital investment than a broaching machine.



WHY THE HUFFMAN APPROACH IS BETTER

- Huffman offers several machine sizes and configurations to accommodate a range of disk sizes—from small regional jet and helicopter engines to large land-based Industrial Gas Turbine Engines.
- Four-axis machines are suitable for disks with non-helical slots.
- Five-axis machines are available for grinding with shear (helix) angle.
- An automatic, on-board wheel truing system is included to maintain the proper wheel profile.
- Machines have a T-top door for over-head crane access for heavy parts and fixtures.
- Proven, reliable, process-capable machines.



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Rough Grinding Root Forms In Turbine & Compressor Disks

Turbine blades and disks require complicated “root form” profiles in order to withstand the centrifugal forces present during operation. (In this document, the terms Blades and Disks are used to encompass both the compressor and turbine section of a turbine engine. Compressor blades and disks typically have a “dovetail” form and turbine blades and disks typically have a “fir tree” or “Christmas tree” form.)

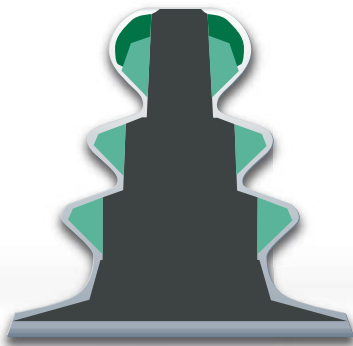
These disk root forms are traditionally manufactured by broaching. The broaching process itself, once in production, is fast and efficient. That is, the actual cutting time—the time when the broach tool is engaged in the workpiece—is relatively quick. However, other aspects of the process make broaching a very expensive and time-consuming process. These factors include:

- The purchase price, maintenance cost, floor space requirements and long lead-time of broaching machines.
- The special concrete base and other infrastructure to support broaching machines.
- The purchase price, maintenance cost (resharpening & inventory) and long lead-time of broach tools.



Broach Roughing Tools

■ Roughing Broach ■ Semi-Finishing Broach ■ Finishing Broach



- The time required to set up and change over broach machines for different part numbers.
- Manufacturers of turbine disks are very open to alternate methods to address the significant disadvantages of broaching.
- As shown in the diagram on the left, a series of broach tools is used to complete the entire profile; starting with roughing broaches, then semi-finishing broaches, then finishing broaches. The broach tools are set end-to-end on the broach machine. In one stroke on the broach machine, the entire disk root profile is machined. The total length of broach tools can sometimes be well over 100” [2500mm].

