

# NASA TECH BRIEF

## *Langley Research Center*



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### Electro-Chemical Grinding

Nickel alloys, used extensively in hypersonic engines, are difficult to machine by conventional means. Tool pressures are very high, and tool bounce in interrupted cuts is excessive. Conventional grinding results in loading the wheel, or breakdown, which makes it difficult to hold size, contour, and finish. These conditions make it virtually impossible to machine certain engine parts such as a conical one that has to be held by a flange at the base and machined for several feet down a contour to a sharp end.

This application of electro-chemical grinding is unique in that the control of rotation speed (to maintain constant surface speed), constant feed rates, and contour control are so exacting that the parts are almost 100-percent electro-chemically machined, thus keeping tool pressure at virtual zero. Precise control of the surface and feed speeds essentially eliminates mechanical grinding, thereby maintaining grinding wheel size. It also allows precise control of contour.

In electro-chemical grinding (ECG) there is essentially no danger of galling. ECG permits constant surface finish and allows burr free interrupted cutting. Holes, slots, and eccentricity of the part are not the problems that they are with conventional machining.

In this application of electro-chemical grinding the work piece is mounted on the lathe spindle. The aluminum-oxide copper-bond grinding wheel is mounted on the compound of the lathe. A very close gap distance (0.001 to 0.002 in, or 0.0025 to 0.005 cm) is maintained between the work piece and the grinding wheel. The grinding wheel is capable of carrying high current and is insulated from the lathe bed. It is connected to negative direct current (-dc), and the work piece is

connected to positive direct current (+dc). The wheel bonding material breaks down at a rate that keeps the projection of the abrasive material at about 0.005 cm. This gap is filled with high-velocity salt water. The flow of the salt water carries away the removed metal and dissipates the heat generated by the high current densities. The exact rate of metal removal and the type of electrolyte salts to be used must be matched to the material being machined.

A hydraulic tracer is mounted on a cross-slide and follows a template which controls part contour. A remote speed control also follows a template on the cross-slide and maintains the work piece speed of rotation so that a constant surface speed is presented to the grinding wheel. The lead screw on the lathe is used to obtain a constant feed rate in thousandths per revolution.

The grinding wheel, rotating at 5500 SFM, acts as an electrolyte pump and maintains a smooth flow between it and the work piece. High current densities remove 94 to 98 percent of the metal as the wheel is fed over the work piece. Overall current values are held at reasonable values, as grinding wheel contact area is comparatively small.

#### Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer  
Langley Research Center  
Mail Stop 139-A  
Hampton, Virginia 23365  
Reference: B72-10744

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**Patent status:**

Inquiries concerning rights for the commercial use of  
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