Delaware Diamond Knives

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DDK's technical and scientific applications for diamonds and tungsten carbide are manufactured in its laboratory facility in Wilmington, Delaware. The site is well equipped with the latest technology for creating precision edges on diamond, tungsten carbide, sapphire knives, tools and parts.

DDK's diverse product line includes applications in bone research, microsurgery, heat sinks, transmission electron microscopy, neuroscience, wafer breaks / scribes, and high precision tooling. Most of the company's clients are in the United States, Germany, Japan and Switzerland.
Problem Statement

• Design and build a fixture to hold a thin slice of diamond against a grinding wheel.
• The fixture must hold the diamond against the grinding wheel at the correct angle and force.
• The device must prevent wearing of the grinding wheel.
• We expect to have a working prototype that can be used on site.
Overall Product and Process

- **Product:**
  - A diamond blade for use in fiber optic cleaver

- **Process:**
  - Diamond is grown or purchased
  - A shaft of diamond is cut into thin slabs
  - The slabs are grinded down to appropriate thickness by grinding one side and then the other to induce parallelism
  - Diamond slab is polished
  - Diamond slab is cut in half across the diameter
  - Diamond is ready to be inserted into a cleaver
Current Fixture and Set-Up

- <INSERT VIDEO OF CURRENT FIXTURE>
Areas of Improvement

- Requires constant operator attention
- Lacks repeatability and accuracy
- Requires vast operator experience
- Has low efficiency
- Lacks ability to consistently hold diamond level
Proof of Concept

• <INSERT VIDEO OF POC WITH POINTING AT COMPONENTS>
Control Diagram

User inputs desired reduction distance and force on diamond.

Machine Lowers

Computer sets distance at 0

Yes Is any force in load cell

No

Machine Lowers

Machine lifts to top and stops

Yes Is distance reached

No

Is Force reached

No

Yes

Don't move

<INSERT VIDEO SHOWING HOW THE SYSTEM WORKS>
Automated to Manual

• Due to set-backs with the encoder drive controller, we were unable to implement the control scheme that we developed.
• All testing was done manually to validate the Proof of Concept.
Testing

• <INSERT VIDEO OF TESTING, SHOWING TESTING>
Validation

• Proof of Concept was able to grind a diamond
• Fixture prevented lap wear by oscillating across grinding surface
• Force sensor detects initial contact and current force
• Tilt and rotation stages allowed accurate corrections to diamond orientation
Shortcomings

• Initially, the force sensor did not detect the force from the lap wheel
• The lap wheels are not uniform or level, thereby the Proof of Concept does not account for the shape of the lap wheel
• Occasionally during grinding adjustments to the diamond fixture were required to compensate for the lap wheel shape
• Motor ran hot
Suggested Improvements

• Early on, a pad was inserted under the force sensor so that it would be pinched by the plates
• Improve the process for grinding the lap wheels, thereby making them more uniform and level
• Reduce any slop in the fixture
Parts to Replace

- Vertical Linear Stage—exceeded necessary travel distance
- Motor—overpowered, ran hot
- Force Sensor—low accuracy, provides data as voltage reading
- Encoder Drive & Controller Card—difficulty with supplier, faulty parts, out-of-date components
Sponsor Implementation

• An encoder drive would power the vertical linear stage
• Software would have to be designed to take input from the force sensor and the encoder drive to control the encoder drive
• Develop a more streamline procedure to mass-produce the fixture
• Purchase the equipment required to machine/weld the fixture or manufacture it out of house
Benefits to Company

• Improved production rate by additional 50%
  – Able to handle larger orders
  – More efficient use of lap table space
• Less required operator attention time
  – Operator needs to set up
  – Operator needs to remove finished product
• Simple, easy to understand operation
  – Tilt and rotation stages are the only manually set components
  – Computer program takes inputs of initial thickness and desired thickness and grinds diamond to desired thickness