PG SERIES
THE BENCHMARK FOR
THE DIAMOND INDUSTRY
WWW.COBORN.COM
**UNIQUE AUTOMATION FEATURES**

**Grinding Facets – The ‘Blocking Out’ of a Cutting Tool Radius**

Under program control, the machine will generate numerous facets around the radius of a tool.

For each facet, the control will:

- Rotate the wheel spindle to the required planetary position for soft direction grinding
- Advance the wheel a controlled amount and allow the tool to grind and ‘float’ back to the fixed stop
- Move the tool away from the wheel
- Index the pivot and grind the next facet

**Simultaneous, Synchronous Axis – Grinding Vectors**

The planetary, pivot rotation, wheel traverse, wheel in-feed and rotary module (RM) motions are all programmable and in the basic machine run independently of each other. Optional software is available for the PG4 such that the motion of two or more of these programmable axes can be electronically geared to run with synchronous motion. A repeating sequence of grinding directions or vectors can thus be established enabling complex profiles to be generated, such as elliptical, parabolic, hyperbolic and multiple blended radii.

**Grinding the Radius**

- The program will then swing the pivot over the required arc to smooth the flank in conjunction with the radius
- Hard spots (‘knarts’) can be identified and a sub-arc of pivot rotation selected for focussed attention
- Once the tool is completed the wheel will move away from the tool for inspection / unloading

**Multi-Axis Configuration**

The pivot and grinding wheel axes feature high precision air bearings and in normal production only these two axes would be running for the very final polishing of a low waviness radius tool. The remaining machine axes incorporate high precision linear or rotary bearings. The camera axis alignment is via micrometers.

**SINGLE CRYSTAL DIAMOND GRINDING**

**The Structure of Single Crystal Diamond**

Like wood, diamond crystals have a ‘grain’, but unlike wood the ‘grain’ runs in many possible directions. Diamond can be ground easily as long as the grinding direction is across the ‘grain’ or put another way – parallel to a ‘soft’ direction of the crystal. The PG4 works in a very different way to a conventional grinding machine. It is useful to understand why.

**Planetary Motion Wheel Spindle**

To achieve the correct grinding direction, the PG4 has a wheel spindle which can be positioned in a planetary manner so that the direction of the grinding wheel’s motion at the point where it meets the diamond can be aligned with the soft direction of the facet being ground. This enables rapid material removal rates to be achieved.

For example, with the wheel in the ‘135°’ position, the grinding direction is against the grain and little, if any, material will be removed. At the ‘270°’ position, the diamond is ground rapidly as the grinding direction is now running parallel to a ‘soft’ direction of the crystal.

**Edge Perfection and Vibrations**

Controlled and low waviness SCD tools can only be produced if vibrations at the wheel/diamond interface are eliminated.

A composite granite base to damp vibrations and the air-bearings in the wheel and pivot spindles are all necessary to ensure that the ultimate perfect edges are achieved. Operators can also introduce vibrations as they press switches or tap the touch screen, to avoid this vibration, all aspects of human interface have been assigned to a separate tower which is connected to the main grinding machine via an umbilical harness. Once the program starts there is no further need for the operator to touch the grinding machine itself.
PG4 TECHNICAL SPECIFICATION

**Area**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine dimensions (w x d x h)</td>
<td>790mm x 1310mm x 1900mm</td>
</tr>
<tr>
<td>Control tower dimensions (w x d x h)</td>
<td>610mm x 640mm x 1910mm</td>
</tr>
<tr>
<td>Machine weight</td>
<td>800kg</td>
</tr>
<tr>
<td>Control tower weight</td>
<td>160kg</td>
</tr>
<tr>
<td>CNC control system</td>
<td>CNC control with Intel i7 processor running Coborn.net software on a Windows platform</td>
</tr>
<tr>
<td>Grinding wheel spindle</td>
<td>2.0kW 0 - 12000 rpm programmable liquid cooled high-precision air spindle</td>
</tr>
<tr>
<td>Grinding wheel</td>
<td>Ø 85mm Metal bond wheel or cast iron lap</td>
</tr>
<tr>
<td>Pivot spindle</td>
<td>High-precision air spindle with radial error &lt; 0.0005mm</td>
</tr>
<tr>
<td>Process inspection</td>
<td>Coborn integrated camera inspection system X60 to X600 magnification</td>
</tr>
<tr>
<td>Electrical requirements</td>
<td>380 / 220 3phase 50/60 Hz 16amps</td>
</tr>
<tr>
<td>Mechanical options</td>
<td>Rotary axis (RM) programmable, Coning spindles (CS) manual, Work piece clamping systems</td>
</tr>
</tbody>
</table>

**Axis**

<table>
<thead>
<tr>
<th>Axis</th>
<th>Description</th>
<th>Feedback Resolution</th>
<th>Program Resolution</th>
<th>Travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Wheel head traverse</td>
<td>0.0001mm</td>
<td>0.01mm</td>
<td>100mm</td>
</tr>
<tr>
<td>Y</td>
<td>Wheel head infeed</td>
<td>0.00005mm</td>
<td>0.0001mm</td>
<td>45mm</td>
</tr>
<tr>
<td>T</td>
<td>Planetary head tilt</td>
<td>Manual</td>
<td>Manual</td>
<td>0 to 20°</td>
</tr>
<tr>
<td>B</td>
<td>Planetary head orientation</td>
<td>0.01°</td>
<td>0.1°</td>
<td>360°/continuous</td>
</tr>
<tr>
<td>C</td>
<td>Pivot spindle</td>
<td>0.0001°</td>
<td>0.001°</td>
<td>+/- 100°</td>
</tr>
<tr>
<td>V</td>
<td>Infeed table</td>
<td>0.000005mm</td>
<td>0.00001mm</td>
<td>30mm</td>
</tr>
<tr>
<td>A</td>
<td>Rotary module (Optional)</td>
<td>0.0002°</td>
<td>0.001°</td>
<td>360°/continuous</td>
</tr>
<tr>
<td>TPX</td>
<td>Fixture X</td>
<td>Manual</td>
<td>Manual</td>
<td>12mm</td>
</tr>
<tr>
<td>TPY</td>
<td>Fixture Y</td>
<td>0.0005</td>
<td>Manual</td>
<td>12mm</td>
</tr>
<tr>
<td>TPZ</td>
<td>Fixture Z</td>
<td>Manual</td>
<td>Manual</td>
<td>75mm</td>
</tr>
<tr>
<td>TPA</td>
<td>Fixture tilt</td>
<td>Manual</td>
<td>Manual</td>
<td>-20 to + 20°</td>
</tr>
<tr>
<td>Xc</td>
<td>Camera X</td>
<td>0.001mm</td>
<td>Manual</td>
<td>12mm</td>
</tr>
<tr>
<td>Yc</td>
<td>Camera Y</td>
<td>0.001mm</td>
<td>Manual</td>
<td>12mm</td>
</tr>
<tr>
<td>Zc</td>
<td>Camera Z</td>
<td>Manual</td>
<td>Manual</td>
<td>80mm</td>
</tr>
</tbody>
</table>

DIMENSIONS AND FOOTPRINT
MULTI-FUNCTIONAL CAPABILITIES

The PG4 is an automatic, ultra-high precision grinding machine that is designed specifically for processing natural or synthetic single crystal diamond (SCD) tools. A world-first engineering solution for the precision manufacture of controlled waviness and complex geometry tools.

Drawing on over 75 years of experience in designing machines for grinding and polishing diamond and related ultra-hard materials, the PG4 now enables many of the laborious and time consuming processes, such as blocking out, to be fully automated and the subsequent final radius polishing to be completed without human intervention.

The PG4 uses high quality air bearings for both wheel spindle and the pivot which are essential pre-requisites for controlled and low waviness SCD tools. Programming is extremely simple and minimal training is required.

The PG4 is an ideal machine for SCD tool manufacturers who are looking to minimise production costs and use their skilled operators in more demanding areas.

TOOL FORMATS

Low and controlled waviness tools
Complex profile tools
Elliptical, parabolic, hyperbolic and blended radii profiles
Facetted, coned and radiussed indenters

Coborn Engineering Ltd
Chesham Close, Cedar Road,
Romford, Essex, RM7 7PJ, UK

coborn.com
Tel: +44 (0)1708 744666
Fax: +44 (0)1708 725187
Email: sales@coborn.com
Tool Inspection & Graphical User Interface (GUI)
- High resolution touch-screen
- Tool profiles generated from tool program
- Digital zoom and image dragging facility
- Simple programming via menus
- Machine operation training in one day
- Rotary axis training in one additional day

Tool Cooling Unit
- Cools tool shank using sub-zero compressed air
- Removes thermal expansion effects
- Programmable 'on/off'

Control System
- Fast Windows-based PC and associated drives
- Connects to grinding machine by umbilical harness to avoid vibration transmission
- All units pluggable
- Remote diagnostics via internet
- 3 phase, multi voltage/multi-frequency supply

Variable Weight Loading For Table
- Programmable table force

Floating Table
- High precision linear bearings
- Constant load, dead weight systems, 0.5-3.0kg
- 0.5nm in-feed scale

Composite Granite Base
- For optimum vibration damping and thermal stability
Camera
- GigE camera for fast image capture
- X, Y micrometer adjustment for camera alignment

Zoom Lens
- Extra long focal length for in-process inspection
- x60 - x600 magnification
- x1000 magnification - optional extra (inspection only)

Planetary Motion
- Coborn, high precision planetary with rolling element design
- 0.1° planetary position resolution
- AC servo motor drive via non-influencing motor and belt
- Speed, direction and angular position programmable
- 0 - 20° tilt for conical clearance

Wheel Traverse
- Non-influencing linear drive
- Can be synchronised
- Fully programmable speed, and stroke
- Sinusoidal acceleration / deceleration

Air-Bearing Wheel Spindle
- Ultra-high precision air-bearing
- Water cooled to provide thermal stability
- Speed up to 12,000 rpm programmable
- Rotation direction programmable
- Brushless, vibration free integral drive

Tool Post
- XY tool position adjustment via micrometers
- Tool height adjustable
- +/-20° tilt cylindrical clearance
- Nest accepts round and square shank tools

Air-Bearing Pivot
- Ultra high precision air-bearing pivot
- Brushes, vibration free integral drive
- ±50nm rotational error
- Maximum arc of rotation 182°
- Position resolution 0.001°
- Position & speed programmable
OPTIONAL FIXTURES & EXTRAS

Many optional fixtures are available and the most common are shown below. Coborn can also design and supply custom fixtures and tool holding solutions according to customer requirements.

RM76 – Rotary Axis
- For coning, cylindrical grinding and index positioning
- Programmable rotation to 0.001°
- Collet chuck to suit tools up to Ø16mm
- Other adaptors available

SAM – Metal Bond Wheels
- High quality, porosity free
- Extremely long life, designed for dry grinding
- Dynamically balanced to gyroscopic tolerances

PS2B – Planetary Scaife Bench
- For top lapping of SCD tools after radius grinding
- Re-sharpening worn tools and general facet work
- Adjustable planetary motion allows ‘set and leave’ operation

Optional Software Module
- Helical Block
- Curve Block
- Contour Block
- DXF Import Module

TRC – Tool Radius Check
- Microscope with image analysis software to measure tool radius and radius waviness
- Generates custom designed QC graphical data sheets which can then be supplied with the associated tool