The Rotating Cylinder Valve 4-stroke Engine
A Practical Alternative

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The Rotating Cylinder Valve
4-Stroke – A Practical Alternative

- 4-stroke emissions
- 2-stroke performance
- 2-stroke price
- Proven in the field
- Innovative, but NOT radical
Principle of Operation

- Cylinder rotates around piston at cam speed
- Single port in the rotating cylinder indexes with fixed radial inlet and exhaust ports to provide the valving function
- The rotating cylinder is effectively combined with the rotary valve in a single component, hence the name **RCV** –

**Rotating Cylinder Valve**
Technical Issues

- Major engine components are conventional.
- Conventional piston/cylinder
- Conventional crank
- Rotating cylinder around piston reduces friction and gives even thermal distribution.
- Oil cooling system.

One major design issue: the 4-Stroke Rotary Valve itself
Various attempts have been made to develop rotary valve 4-strokes

‘Cross’ valve design technically successful, but limited cost/performance benefits

‘Aspen’ valve design not technically successful

‘RCV’ valve design is technically successful, and offers major cost/performance benefits

Currently unique legislative incentive to develop low cost 4 stroke technology.
Rotary Valve Seal Design Principles

- A sprung sealing mechanism must be employed
  - ‘The Sliding Seal’
- The spring behind the sliding seal must form a static seal with the rear of the sliding seal
  - ‘The Seal Spring’
- The seal must be arranged so that the cylinder pressure augments the seal spring pressure
  - ‘The Seal Pressurisation Area’
- The seal pressurisation area should be small
- A secondary sprung sealing device must be employed for the inlet and exhaust ports
- All seal components should be kept as light as possible
Basic Valve Seal Design
Sprung Expanding Ring Seal Design
Seal Frictional Losses Calculation

- Seal torque loss is seal force x coefficient of friction x valve radius.
- Seal force is made up of centrifugal force, seal spring force and seal pressurisation force.
- Centrifugal force dependant on RPM and mass of seal components.
- Seal spring force dependant on design of seal spring.
- Seal pressurisation force is dependant on the seal pressurisation area and combustion pressure.
- Most important factor is seal pressurisation area.

<table>
<thead>
<tr>
<th>Seal pressurisation area cm²</th>
<th>1.0</th>
<th>2.0</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Pressure N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2.1%</td>
<td>3.9%</td>
<td>9.9%</td>
</tr>
<tr>
<td>20</td>
<td>2.6%</td>
<td>4.3%</td>
<td>10.3%</td>
</tr>
<tr>
<td>50</td>
<td>3.8%</td>
<td>5.6%</td>
<td>11.6%</td>
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Valve Seal Durability & Lubrication

- A rotary valve is a sliding valve: same surface used for bearing and sealing.

- Sealing surface must be lubricated without excessive lubricant loss or emissions.

- Nearest equivalent to RCV valve is a direct injection 2-stroke piston: a reciprocating sliding valve which achieves low emissions.

- In general piston/cylinder materials/technologies are applicable to RCV valve design (same surface speeds, temperatures and pressures).

- Sprung seal will cope with significant wear before loss in sealing function.

- Seal currently uses conventional materials.
Current Performance

- Corrected max. power 4.1 bhp @ 9500 rpm (ISO 1585)
- 8.7:1 Compression
- BMEP - 8.0
- Peak torque @ 9500 rpm
- Engine is reliable, handles well and starts easily
- Performance achieved without complex setup.

RCV is already matching best production 49cc poppet valve designs
Predicted Performance

Potential power gains following specific improvements:
- Raising CR to 11:1: 8%
- Breathing developments: 5%
- Valve timing and combustion chamber: 5%
- Inlet / exhaust tuning: 5%

Predicted max power: 4.9bhp @ 9500RPM

Reduced variator losses means same rear wheel power as 5.5bhp conventional engine.
Production Benefits of RCV Design

- Lower manufacturing costs. Up to 40% lower than poppet valve or 2TDI
- Use of conventional components means same plant can be used for manufacture
- Low component count
Technical Benefits of RCV Design

- Even thermal distribution
- Large port area
- Reduced frictional losses
- No complex valve train
- Compact combustion chamber
- High BMEP

Large port area and high BMEP means the RCV design is capable of achieving high power outputs.
Application Benefits of RCV Design

- High fuel economy
- Good durability
- Reduced transmission losses
- Compact
- No complex external plumbing
- Optional low cost balance shaft
Reliability Benefits of RCV Design

- Uses conventional components
- Elimination of reliability weak spots
- Low maintenance
- Low component count
Conclusions

- The RCV offers significant benefits over conventional designs

- The RCV is particularly suitable for applications where emission legislation is forcing out the carbureted 2-stroke

- The RCV is a field proven design

- Most RCV components are conventional.

- Only significant technical issue is the rotary valve. This has been successfully addressed

- The RCV engine is a practical alternative to more conventional designs for small engine applications