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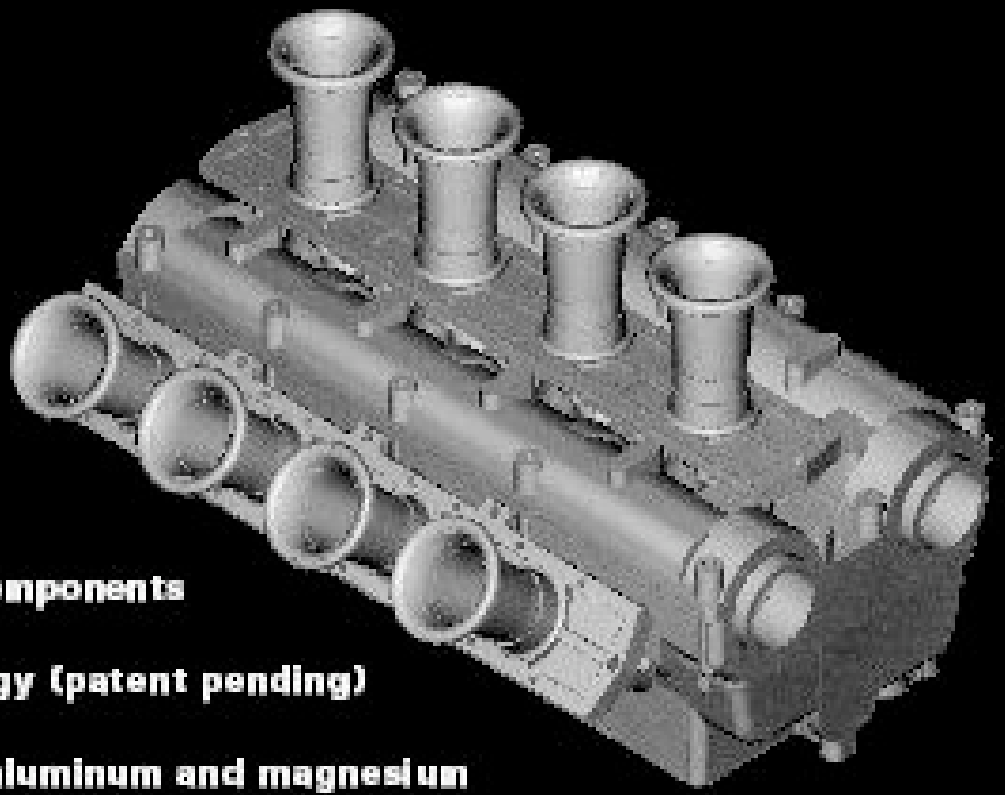
Project Management Specialists



Suppliers of advanced specialty engine components

Developers of dual swirl porting technology (patent pending)

Engineered thin-wall cast components in aluminum and magnesium

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Background

- Internal combustion engines will be the prime mover for at least one generation
- Smaller, lighter, lower friction and inertia
- Decrease parasitic losses by reducing displacement per distance
- Drive by wire/variomatic transmissions

The Goal

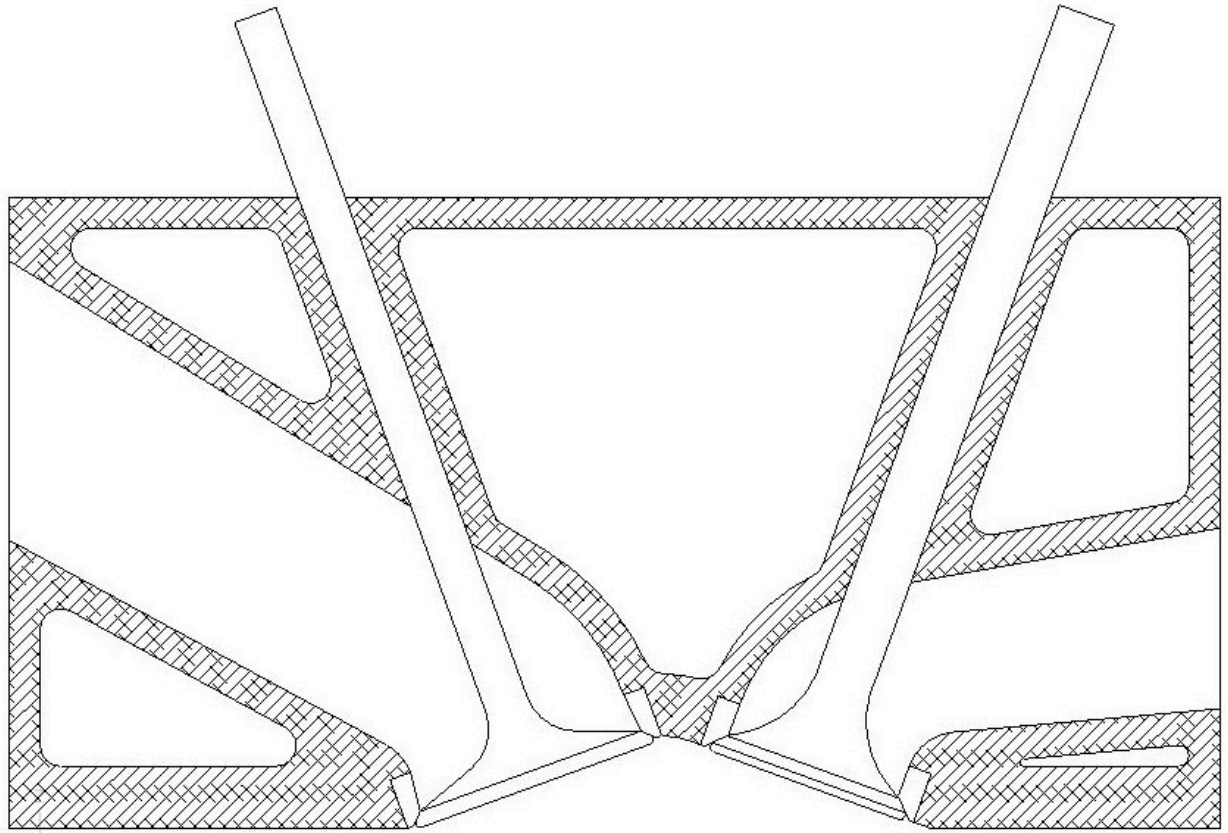
A small displacement power plant that has exceptional characteristics throughout the power band.

- Acts like a diesel at low rpm
- Good top end power
- Superb scavenging even at low rpm
- Minimal overlap for best charge stratification possible

Current Good Practice

- 4 valve, pent roof cross-flow layout valve
- Inlet ports at close angle to valve
- Valve angle low enough to insure good chamber shape and flame front
- Cosworth BDA is the archetype of current generation of engines

Example – Current Practice



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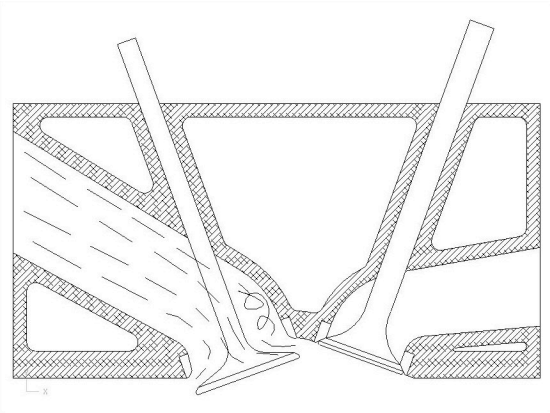
Operating Conditions - Examples

1) Standard head with inlet open
2) Racing head at full lift
3) Down draft head
4) Simple convergent head

Note that all of these designs create turbulence on the far side of the valve stem and/or require some level of flow redirection.

Various Views



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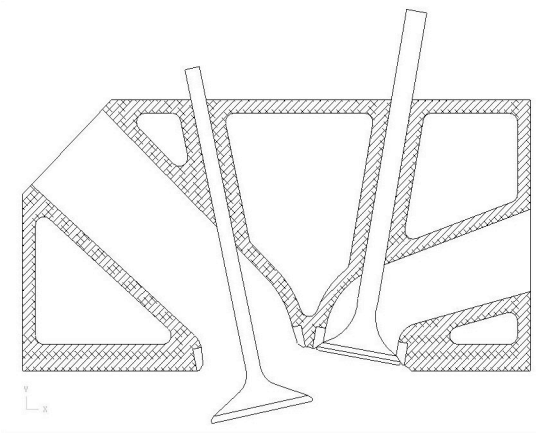

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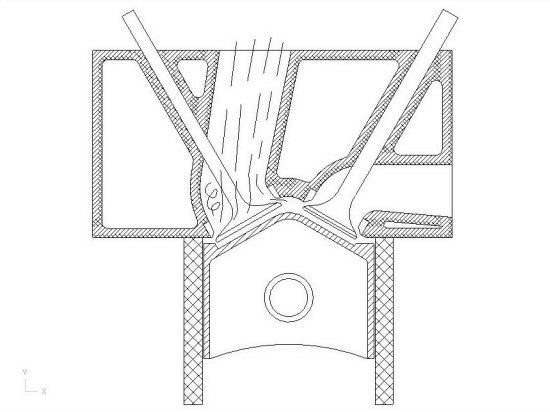

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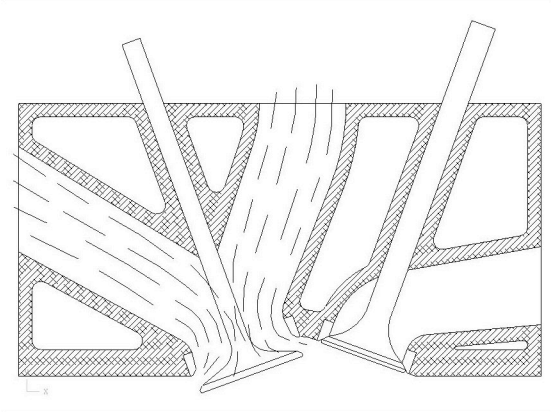

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A New Approach

"Dual Swirl Porting System"

(Patent Pending)

- Create swirl in transition to cylinder
- Air flow effectively bypasses valve stem, systematically reducing turbulence
- Entire annulus of port utilized
- "Right Turns" at valve eliminated. Inlet flow energy undiminished

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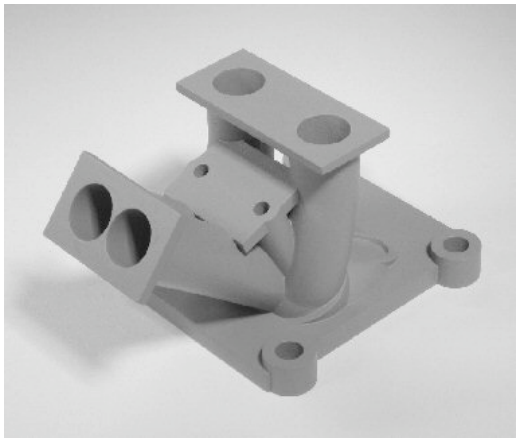
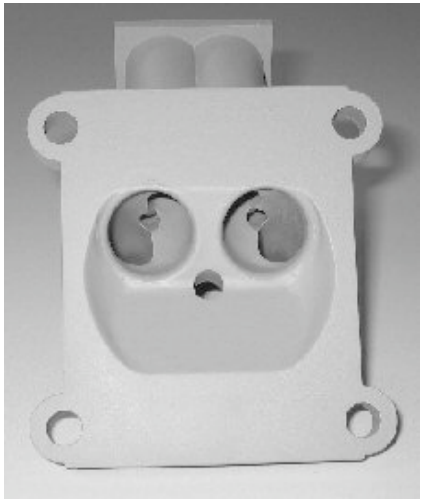
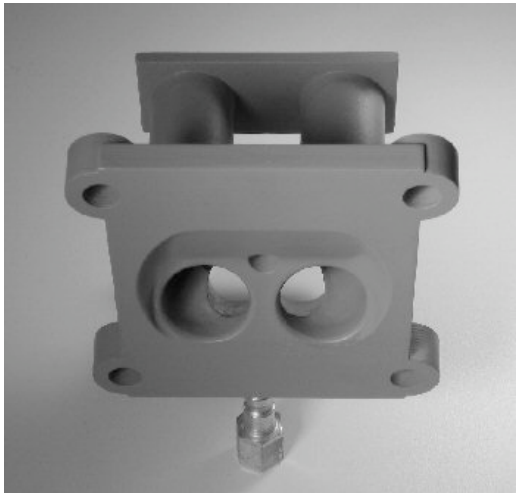
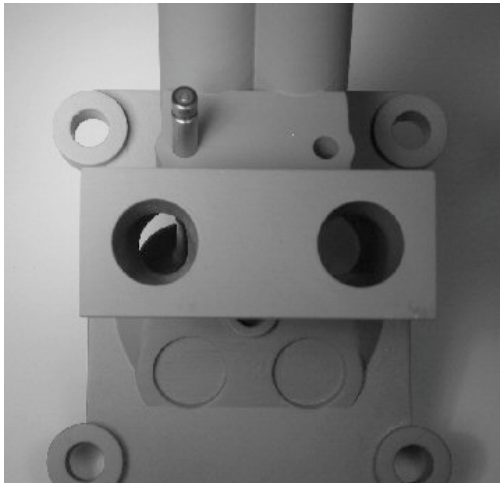
Flow Test Model - Four Views









Project Engine Development

1) Create flow models for evaluation
2) Select a representative engine for use as a ‘baseline’
3) Refine the baseline to produce power and flexibility of current high performance units
4) Design, tool, cast and machine replacement head, manifolds, cam tray, etc.

Development (continued)

1) Install new head on old bottom end and test
2) Compare data between engines

All other mechanical components are the same, including cam profiles, exhaust, complete bottom end re-used.

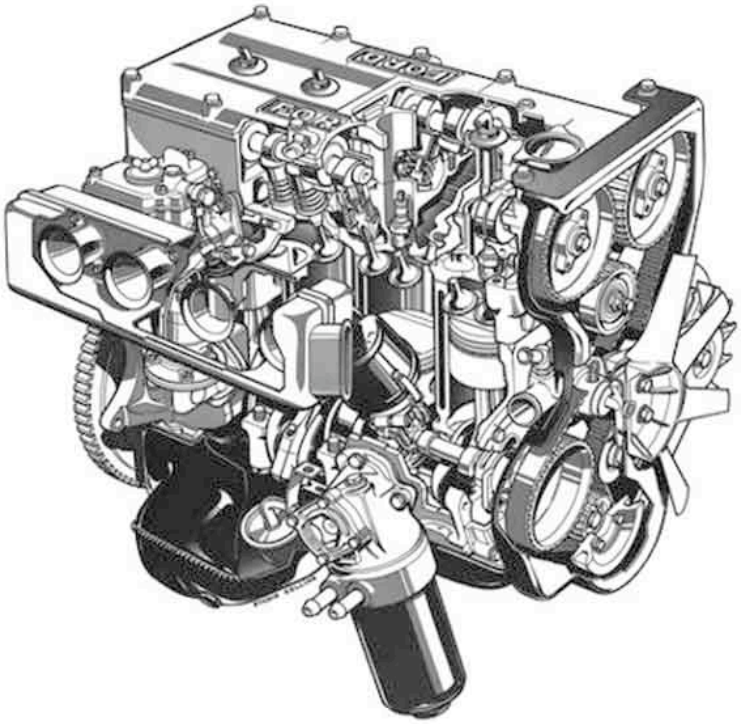
Subject Engine – Cosworth BDA

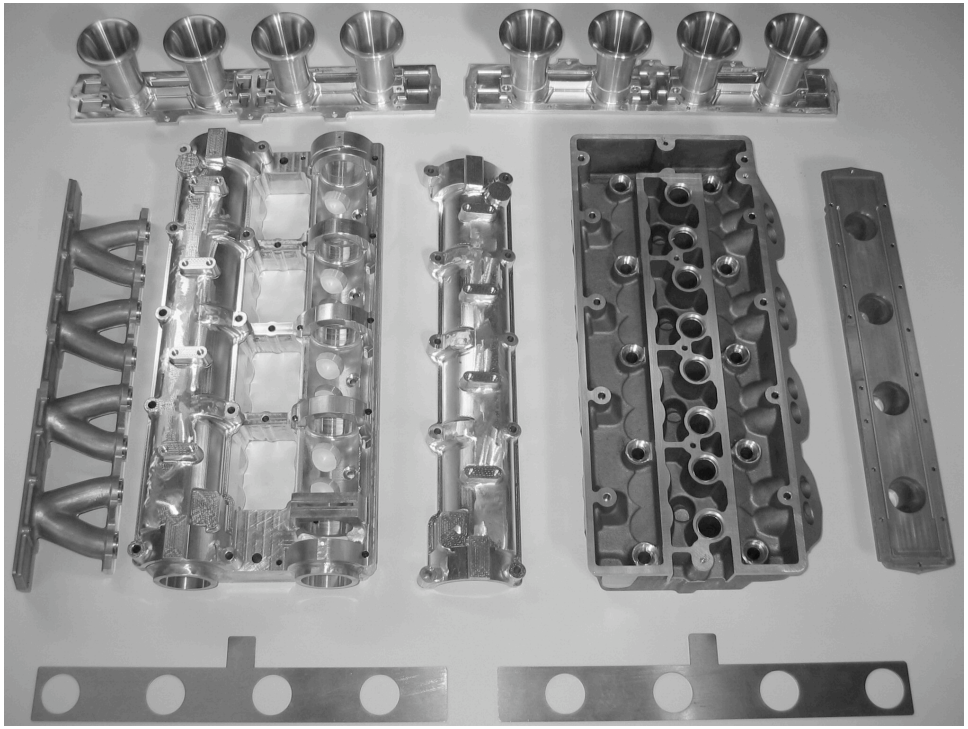
- BD Series engines were first four-valve “production” engines available
- Were the model most others followed
- 40° included valve angle
- 150 hp @ 9500 rpm on L2 cams with good flexibility
- 160 hp @ 11,000 rpm on F1 cams with severely diminished lower end performance
- Static compression ratio 11:1
- High inertial and friction losses

Refined Version

- 151 hp @ 8,000 rpm, 203 hp @ 11,000 rpm
- Smooth idle at under 1,000 rpm
- Valve timing reduced by approx. 30°
- Cams, pistons, inlets, rods, exhaust and block changed
- Same high parasitic losses as original

Old and New Engines





Summary

- Allows replacement of current large powerplants with smaller units
- Reduces displacement per mile and associated parasitic losses
- Substantial potential for further development
- Initial test results:

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