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2.61 Internal Combustion Engines

Spring 2008

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VVT technology

- Variable cam phasing
 - Many companies (Fiat, Nissan, Toyota ...)
- Cam switching
 - Honda VTEC
- Valve-lift geometry control
 - BMW Valvetronic
- Hydraulic/electro-hydraulic lift control
 - Jacobs VVT
 - Lotus/Eaton
- Electromagnetic valve
 - FEV EMV, Visteon EVA

VVT technology

Images removed due to copyright restrictions.

Please see Moriya, Yoshihito, et al. "A Newly Developed Intelligent Variable Valve Timing System."
SP-1171, *Journal of Engines* 105 (February 1996): 960579.

VVT technology

Images removed due to copyright restrictions.

Please see: Hosaka, Takefumi, and Minoru Hamazaki. "Development of the Variable Valve Timing and Lift (VTEC) Engine for the Honda NSX." P-238, *Journal of Engines* 100 (January 1991): 910008.

Yasuda, Makoto, and Hirotsugu Maruyama. "A New 1.6-liter Twin-cam 16-valve Nissan Engine." SP-864, *Journal of Engines* 100 (February 1991): 910677

BMW Valvetronic

Photo removed due to copyright restrictions.

Please see any photo of the BMW Valvetronic engine, such as
http://www.autozine.org/technical_school/engine/valvetronic_cut.jpg

The Jacobs VVT – loss motion system

Images removed due to copyright restrictions. Please see patents related to the Jacobs variable valve actuator and lost motion system, such as: 7484483, 7059282, 7152576.

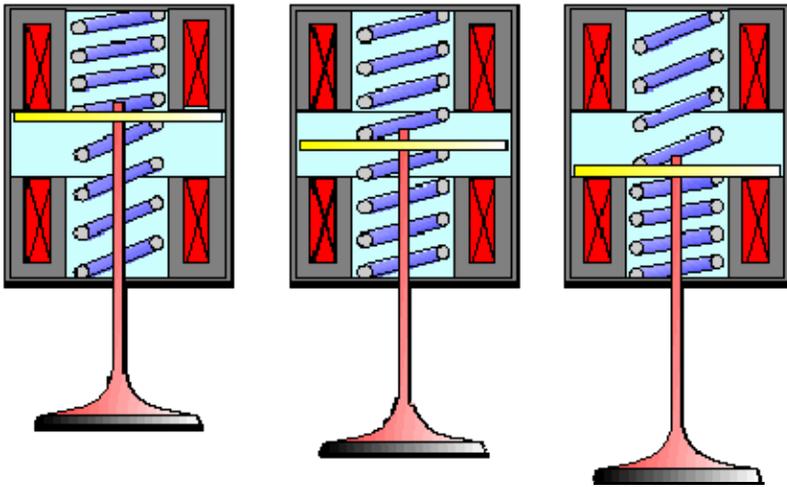
Lotus research AVT

Image removed due to copyright restrictions. Please see slide 8 in Milovanovic, Nebosja, and Jamie Turner. "Requirements for the Valve Train and Technologies for Enabling HCCI Over the Entire Operating Range." Diesel Engine Emissions Reduction Conference, 2005. ([PDF](#))

Lotus/Eaton electro-hydraulic system

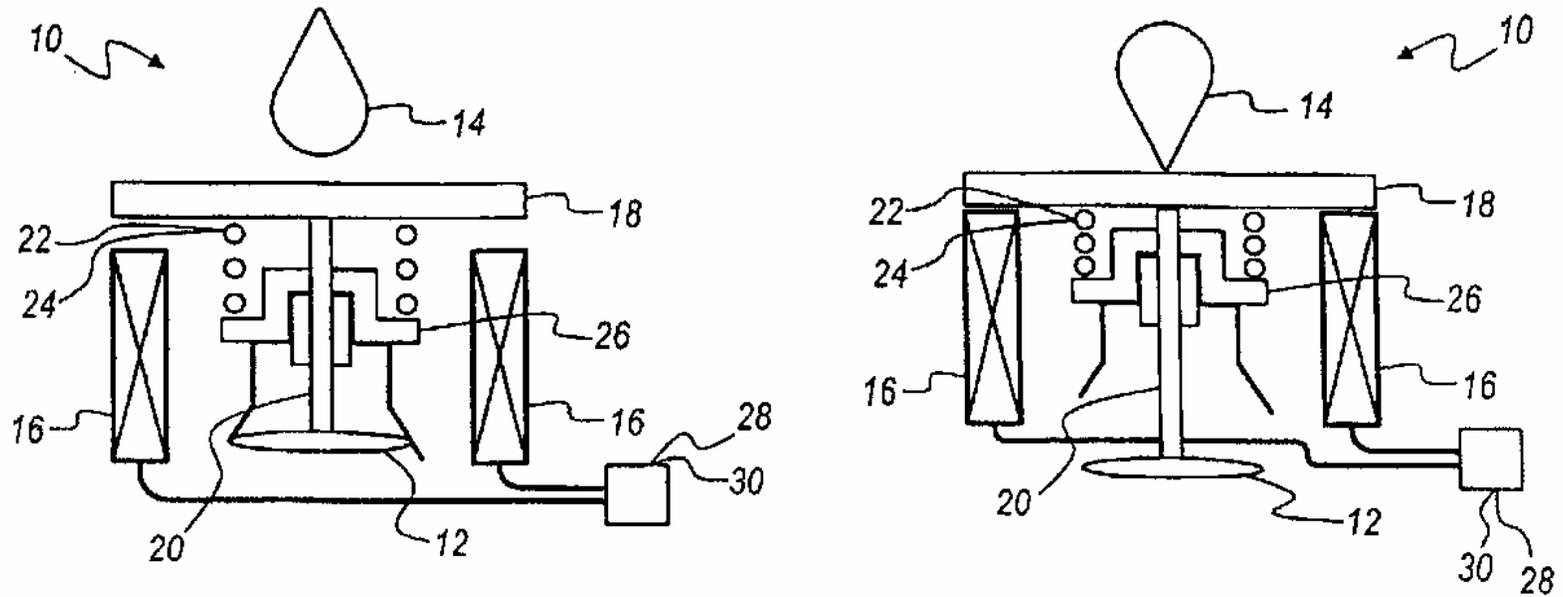
Image removed due to copyright restrictions. Please see slide 6 in Milovanovic, Nebosja, and Jamie Turner. "Requirements for the Valve Train and Technologies for Enabling HCCI Over the Entire Operating Range." Diesel Engine Emissions Reduction Conference, 2005. ([PDF](#))

Electromagnetic Valves



- Advantage
 - flexibility
- Challenges
 - Significant force required
 - $F \propto (\text{RPM})^2$
 - Seating velocity
 - Noise
 - Packaging
 - Cost

Visteon VVT System



US Patent 6,681,731 B2