Technology Offer

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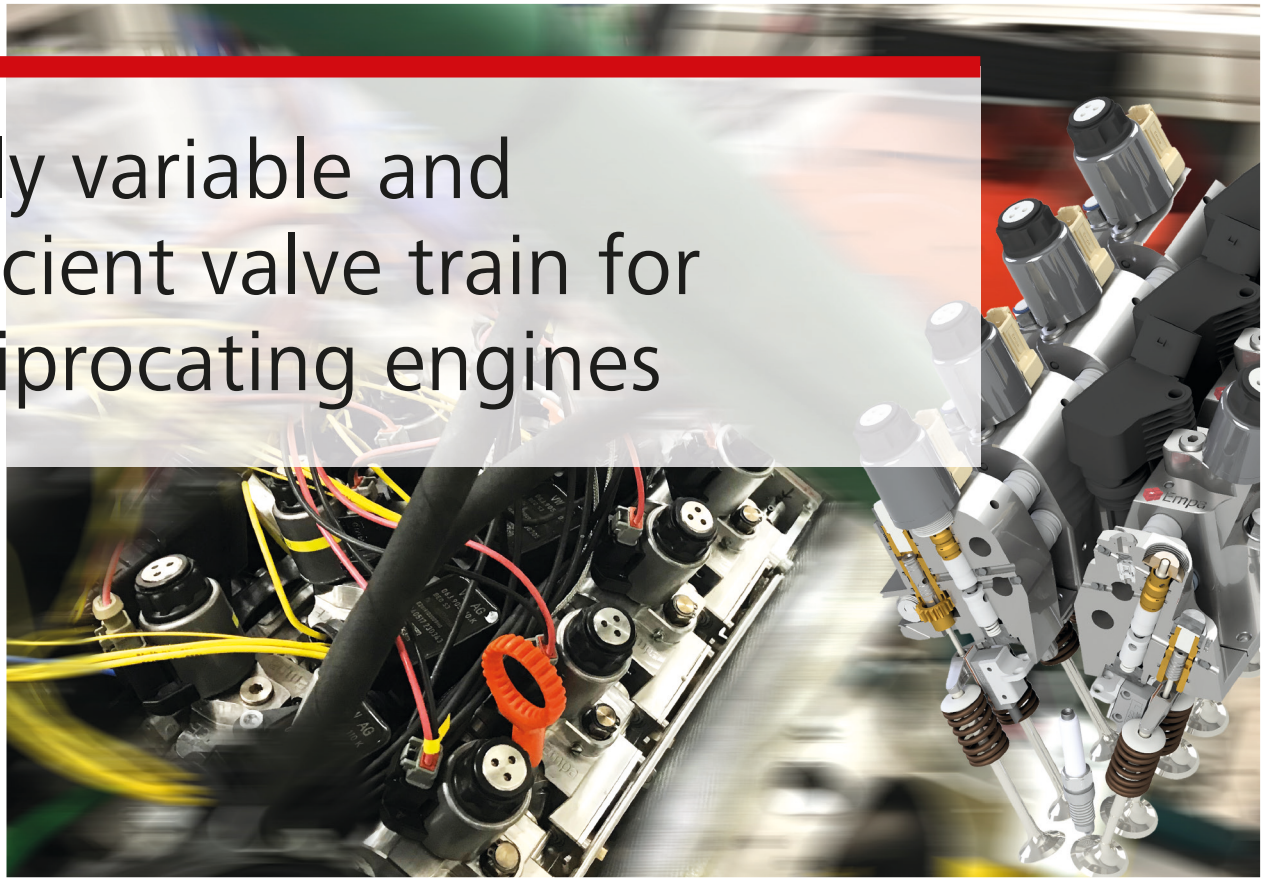
Materials Science and Technology

Fully variable and efficient valve train for reciprocating engines



Invention

The invention consists of an electrohydraulic actuation method for variable lift control and individual timing for gas exchange valves of reciprocating engines. Its main advantages are a low activation energy demand as well as an intelligent hydraulic system layout. This enables the control of the valve movements by simple hydraulic elements without the need for sophisticated feedback control action.

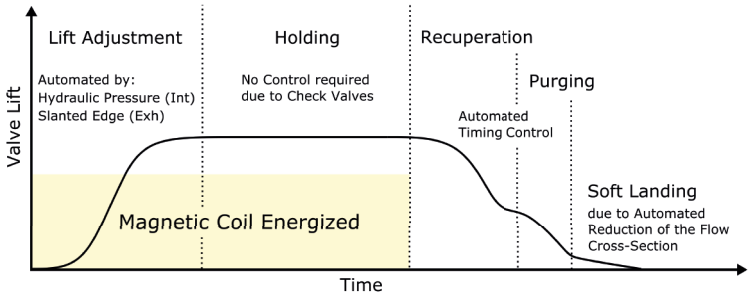
Background

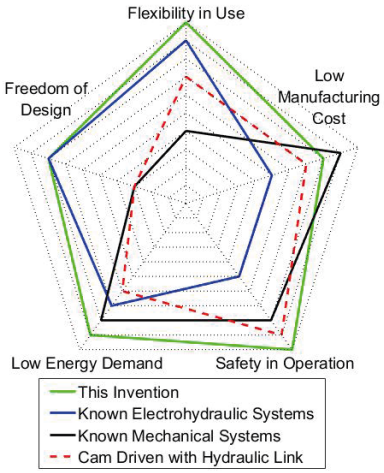
Internal combustion engines profit from variable gas exchange valves in terms of efficiency, performance, optimized boosting concepts, lower exhaust emissions, enhanced cold start strategies, and compatibility with alternative fuels. The efficiency gain by unthrottled operation with full valve flexibility on a classical passenger car spark igniton passenger engine is in the order of 25% for relevant low load operating points, around 15% in relevant driving cycles, and still more than 5% in hybrid powertrains. Additionally, full valve flexibility gives the possibility to implement new combustion concepts such as (partially) premixed compression ignition.

Today's serial production, variable valve actuation (VVA) systems – still based on camshafts – only show limited variability in valve lift profiles despite of their complex mechanical setup. Known camless approaches, however, have not yet found the way into serial production mostly due to their high level of activation energy demand and/or complexity in design and control. The following feature profile shows the assessment of this invention versus known existing approaches:

Advantages

– Very low control effort: simple on/off switching of the solenoids (one per valve actuator) is needed, no requirement for ultra-fast solenoids.
– Optimum activation energy utilization and recuperation: energy demand is lower compared to camshaft operated valve trains.
– Load control from one to the next engine cycle.
– Soft landing.
– The desired valve lift can be either controlled by setting the actuation pressure level or by involving a direct lift limiting mechanism capable of handling high cylinder pressures as well as misfiring.
– State of the art valve springs guarantee for safe operation, even at electrical failures.
– Capable for use of alternative hydraulic fluids, e.g. water/glycol.
– The following Figure depicts the motion sequence:





Applications

This invention can be used on all kinds of internal combustion engines (spark ignition, compression ignition, alternative combustion concepts), as well as on other reciprocating compression or expansion machines with need for full variability in the gas exchange process.

Ownership

Empa, Swiss Federal Laboratories for Materials Testing and Research, Überlandstrasse 129, CH-8600 Dübendorf; Schneider Ingenieurbüro, Dufourstrasse 3, CH-3600 Thun; Patents pending

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Keywords

Electro-hydraulic valve actuation, internal combustion engine, variable valve timing, variable valve actuation

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