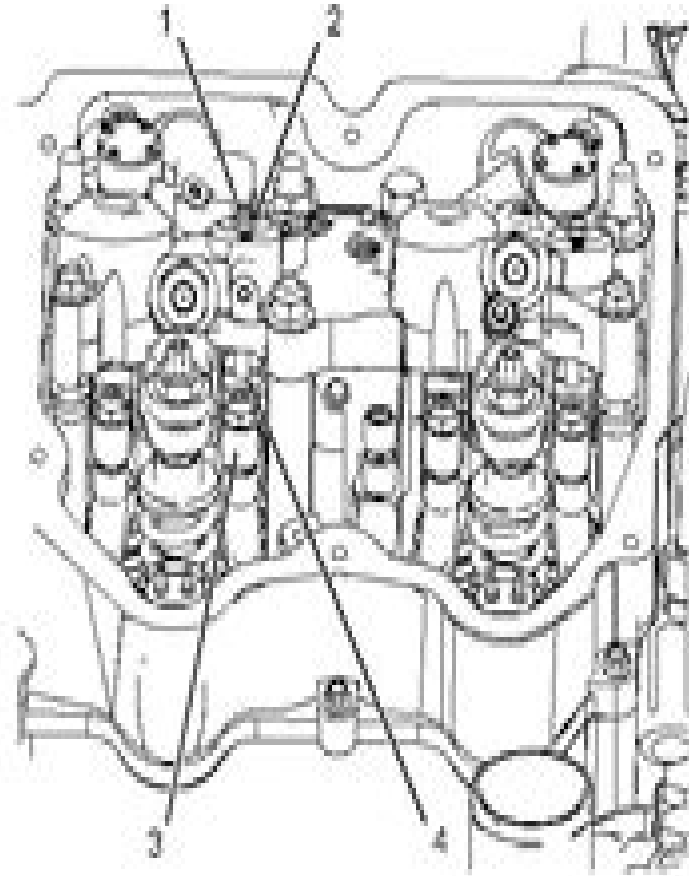


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Variable Valve Actuation Systems for the Optimization of Engine Torque Wolfgang Demmelbauer-Ebner, Alois Dachs, Hans Peter Lenz, Society of Automotive Engineers, 1991 *Regenerative Hydraulic Variable Valve Actuator for Internal Combustion Engines* Ahmad M. Sabri, 1999 *Non-linear Digital Control of Electromagnetic Variable Valve Actuators* Ling Hang, 1994 **Model-based Control of Electro-pneumatic Intake and Exhaust Valve Actuators for IC Engines** Jia Ma, 2008 **Valve and Actuator Technology** Wayne Ulanski, 1991 **Performance Enhancement of Limitorque Valve Actuators** Tarique Haider, 1991 **Development of a New Fully Flexible Hydraulic Variable Valve Actuation System** Mohammad Pournazeri, 2012

The automotive industry has been in a marathon of advancement over the past decades. This is partly due to global environmental concerns about increasing amount of air pollutants such as NOx oxides of nitrogen CO carbon monoxide and particulate matters PM and decreasing fossil fuel resources. Recently due to stringent emission regulations such as US EPA Environmental Protection Agency and CARB California Air Resource Board improvement in fuel economy and reduction in the exhaust gas emissions have become the two major challenges for engine manufacturers. To fulfill the requirements of these regulations the IC engines including gasoline and diesel engines have experienced significant modifications during the past decades. Incorporating the fully flexible valvetrains in production IC engines is one of the several ways to improve the performance of these engines. The ultimate goal of this PhD thesis is to conduct feasibility study on development of a reliable fully flexible hydraulic valvetrain for automotive engines. Camless valvetrains such as electro hydraulic electro mechanical and electro pneumatic valve actuators have been developed and extensively studied by several engine component manufacturers and researchers. Unlike conventional camshaft driven systems and cam based variable valve timing VVT techniques these systems offer valve timings and lift control that are fully independent of crankshaft position and engine speed. These systems are key technical enablers for HCCI 2 4 stroke switching gasoline and air hybrid technologies each of which is a high fuel efficiency technology. Although the flexibility of the camless valvetrains is limitless they are generally more complex and expensive than cam based systems and require more study on areas of reliability fail safety durability repeatability and robustness. On the contrary the cam based variable valve timing systems are more reliable durable repeatable and robust but much less flexible and much more complex in design. In this research work a new hydraulic variable valve actuation system VVA is proposed designed prototyped and tested. The proposed system consists of a two rotary spool valves each of which actuated either by a combination of engine crankshaft and a phase shifter or by a variable speed servo motor. The proposed actuation system offers the same level of flexibility as camless valvetrains while its reliability repeatability and robustness are comparable with cam driven systems. In this system the engine valve opening and closing events can be advanced or retarded without any constraint as well as the final valve lift. Transition from regenerative braking or air motor mode to conventional mode in air hybrid engines can be easily realized.

using the proposed valvetrain The proposed VVA system as a stand alone unit is modeled designed prototyped and successfully tested The mathematical model of the system is verified by the experimental data and used as a numerical test bench for evaluating the performance of the designed control systems The system test setup is equipped with valve timing and lift controllers and it is tested to measure repeatability flexibility and control precision of the valve actuation system For fast and accurate engine valve lift control a simplified dynamic model of the system average model is derived based on the energy and mass conservation principles A discrete time sliding mode controller is designed based on the system average model and it is implemented and tested on the experimental setup To improve the energy efficiency and robustness of the proposed valve actuator the system design parameters are subjected to an optimization using the genetic algorithm method Finally an energy recovery system is proposed designed and tested to reduce the hydraulic valvetrain power consumption The presented study is only a small portion of the growing research in this area and it is hoped that the results obtained here will lead to the realization of a more reliable repeatable and flexible engine valve system

Industrial Valves. Multi-Turn Valve Actuator Attachments British Standards Institute Staff,1917-05-26 Servomotors Torque Flanges Dimensions Designations Joints Industrial Actuators Valves **TRG for Limitorque Model SMB-000 Valve Actuators Revision 1** Electric Power Research Institute,1994

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