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Camless piston engine

A **camless** or **free-valve** piston engine is an engine that has poppet valves operated by means of electromagnetic, hydraulic, or pneumatic actuators instead of conventional cams. Actuators can be used to both open and close valves, or to open valves closed by springs or other means.

Camshafts normally have one lobe per valve, with a fixed valve duration and lift. Although many modern engines use camshaft phasing, adjusting the lift and valve duration in a working engine is more difficult. Some manufacturers use systems with more than one cam lobe, but this is still a compromise as only a few profiles can be in operation at once. This is not the case with the camless engine, where lift and valve timing can be adjusted freely from valve to valve and from cycle to cycle. It also allows multiple lift events per cycle and, indeed, no events per cycle—switching off the cylinder entirely.

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Camless development

Camless valve trains have long been investigated by several companies, including Renault, BMW, Fiat, Valeo, General Motors, Ricardo, Lotus Engineering, Ford, Jiangsu Gongda Power Technologies and Koenigsegg's sister company FreeValve.^{[1][2][3][4][5]} Some of these systems are commercially available, although not yet in engines in production road vehicles. In the Spring of 2015, Christian von Koenigsegg told reporters that the technology pursued by his company is "getting ready for fruition", but said nothing specific about his company's timetable.^{[6][7]}

In November 2016, Chinese automobile manufacturer Qoros Auto displayed the Qoros 3 hatchback at the 2016 Guangzhou Motor Show, which showcased a new Qoros 'Qamfree' engine. The engine's Swedish designer FreeValve claims that the 1.6-litre (98 cu in)

turbocharged engine will produce 170 kW (230 hp) and 320 N·m (240 lb·ft) of torque. They also claim that, compared to a similar traditional engine, it offers a 50% reduction in size (including a 50 mm (2.0 in) lower height), 30% reduction in weight, 30% improvement in power and torque, 30% improvement in fuel economy, and a 50% reduction in emissions.^[8] Christian von Koenigsegg claims in a video that the Qamfree engine with the PHEA camless technology is based on an existing Qoros engine that was "...developed in Germany and Austria five, six years ago...".^[9]

Christian von Koenigsegg also claims that the PHEA camless technology allows the elimination of the pre-catalytic converter, because the standard catalytic converter can be brought up to temperature quickly by manipulating the exhaust cycle.^[9]

Camless engines in marine and power stations

Advantages

Because camless engines have no camshaft, they may have fewer moving parts. In these systems, the camshaft rollers and pushrods have been replaced by an electro-hydraulic actuator system which uses the existing fuel pumps, thus reducing development risks of the new system by employing existing technology.^[10] Direction changing on older B&W MC engines was engaged by changing the direction of the cam roller, whereas with the new camless engine, it is controlled by a computer. This eliminates the risk of mechanical failures that could damage the engine if there was a malfunction while changing directions. Additionally, because there is no chain connection between the crank shaft and the camshaft, the engine is lighter with fewer points of failure. The absence of a camshaft also means that the parasitic load on the engine is lower, which is particularly useful in large marine engines, as it can equate to a large amount of power savings. With a camless engine, fuel injection and exhaust timing are directly controlled by an engine control unit and can be constantly changed and adjusted without stopping the engine. This allows for the engine to run at a lower RPM, a feature useful in ships as it allows better low speed maneuvering while docking. Additionally, when a ship is maneuvering, the computer controlled fuel injection and valve timing allows for faster RPM control, hence faster stopping in emergency situations.

Emissions

Camless engines are able to produce less emissions than their equivalent camshaft counterparts because they are able to more precisely control the combustion procedure, allowing for more complete combustion of all hydrocarbons. The computer is able to sense when not all of the fuel is being consumed and immediately relax valve timings to supply less fuel to a cylinder. The ECU can constantly adjust valve timing, height and fuel/air mixtures to optimize efficiency for a given RPM/torque load. It can sense when there is a high amount of NOx and SOx (Sulfur oxide) emission and change the timing to make the exhaust gas hotter or cooler. Since the engine is run electronically and not mechanically, camless engines can be updated to meet new emission regulations without mechanical modifications.

Fuel Injection

Camless engines can further reduce NOx emissions with the use of fuel staging. Instead of simply injecting a constant stream of fuel, fuel staging injects the fuel at the optimal time for the most complete combustion. Fuel injection can shut off when there is sufficient pressure and add more fuel when there is less pressure allowing the engines to run closer to a perfect diesel cycle. This allows the engine to run as efficiently as the environment and heat capacity of the metal will allow.

Long term effects

Because these new engines can diagnose themselves and run efficiently without an operator changing settings, these engines require less crew to maintain them when at sea. This crew reduction equates to cheaper shipping for companies and hence more and cheaper global trade^[11].

Camless engines in cars

The British company Camcon Technology^[12] is developing a camless engine for passenger vehicles based on their proprietary Intelligent Valve Actuation (IVA) system. Camcon has collaborated with Jaguar Land Rover to fit IVA onto an Ingenium 2.0l 4 cylinder petrol engine and they jointly published results at the 2017 Aachen Kolloquium^[13]; their paper is available on the Camcon website^[12]. Camcon also discussed features and benefits in an article and video that was published in Autocar magazine^[14] "New Valve Technology gives Petrols the Efficiency of Diesels"

The Swedish company Freevalve AB (formerly Cargine), a sister company to Koenigsegg Automotive AB, is developing a camless system on an existing SAAB car engine.^{[15][16][17][18]}

In April 2016, the Chinese car manufacturer Qoros presented a concept car incorporating Freevalve technology.^[19]

In March 2020, Koenigsegg Automotive AB announced its first four-seater megacar, the Gemera, which is powered by a sequentially turbocharged 2.0l inline-three engine in conjunction with three electric motors. Two of those electric motors, each of which makes 600 bhp and 738 lb-ft of torque, are on the rear wheels. The third motor is attached to the engine crankshaft and makes 400 bhp and 369 lb-ft of torque. Working with the motor to propel the front wheels is what Koenigsegg calls the Tiny Friendly Giant (TFG) engine. It is rated at 600 bhp and 443 lb-ft of torque and uses the camless Freevalve technology.^[20] (<https://www.koenigsegg.com/gemera/tiny-friendly-giant-engine/>)

See also

- Helical camshaft
- Multiair

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