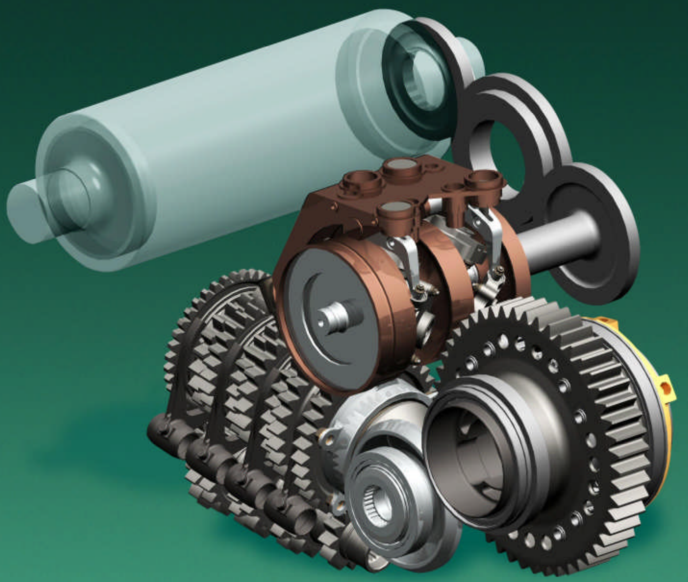
TOROTRAK TOROIDAL VARIABLE DRIVE CVT



Torotrak and Xtrac transmission expertise will help F1 teams develop new, highly efficient, mechanical kinetic energy recovery systems … technology also applicable to road cars

Toroidal traction drive specialist Torotrak plc and vehicle transmission design and manufacturing company Xtrac Ltd are pleased to announce that on 4 June 2007 they entered into a licence agreement to enable Xtrac to develop highly efficient and compact continuously variable transmissions (CVTs) for use in the new kinetic energy recovery systems (KERS) proposed for Formula One (“F1”) motor racing.

In 2009, F1 is introducing new rules that will lower the environmental impact of the sport. Part of this is to recover deceleration energy that can be stored for acceleration. Xtrac will exploit Torotrak’s full-toroidal traction drive technology, for use in kinetic energy recovery systems within the motorsport industry, to assist its customers in meeting these new obligations.

Commenting on the co-operation between the two companies, Peter Digby, managing director of Xtrac, said: “The transfer of world-class transmission technology from Torotrak, combined with the added value of Xtrac’s expertise in the design and manufacture of transmissions for motorsport – and with clear potential to feed the resulting technical solution back into mainstream automotive use – is a good example of what I believe FIA president Max Mosley had in mind when he announced that Formula One should embrace an energy efficient future and open up the world of motorsport to new manufacturers.”

Dick Elsy, chief executive at Torotrak, added: “We are delighted to be working with Xtrac on this exciting new application of our transmission technology, to provide a highly efficient KERS solution for initial application in motorsport, but with a clear opportunity to apply the system in mainstream road cars to provide performance, economy and greenhouse gas emission benefits.”

Background

Some of the new KERS systems under development will be mechanically based and will utilise a flywheel to recuperate, store and subsequently discharge a moving vehicle’s kinetic energy, which is otherwise wasted when the vehicle is decelerated. The kinetic energy is stored during a braking manoeuvre and is then released back into the driveline as the vehicle accelerates.

The toroidal traction drive variator, being developed with Torotrak and using Torotrak’s patented technology, is a central element in these mechanical flywheel-variator KERS systems as it provides a continuously variable ratio connection between the flywheel and the vehicle driveline, via the vehicle’s gearbox. Torotrak has granted a licence to Xtrac to design, manufacture, assemble and distribute components or complete variator systems incorporating Torotrak’s technology to its F1 customers.

The innovative combination of a Torotrak variator – providing mechanical efficiency that should be in excess of 90 per cent – with a flywheel of advanced construction, results in a highly efficient and compact energy storage system. Whilst Xtrac will supply variator units to its customers, the flywheels for these energy recovery systems are being developed separately by the Formula 1 teams themselves and their specialist suppliers. Torotrak will provide the control system expertise.

Torotrak and Xtrac believe that the variator-flywheel solution provides a significantly more compact, efficient, lighter and environmentally-friendly solution than the traditional alternative of electrical-battery systems.
"The variator weighs less than 5kg in these applications and provides a high level of mechanical efficiency, enabling the overall mass of the mechanical KERS systems to be minimised," says Chris Greenwood, technology director at Torotrak. "This mechanical efficiency, combined with the variator's ability to change ratio very rapidly, helps to optimise flywheel performance."

The two companies consider that the system is applicable to other motor sports and everyday vehicles and see the potential for wider applications – particularly on high-performance road cars – as an aid to performance and also as a means of developing future vehicles with reduced CO_2 emission levels.

The system supports the current trend in powertrain design for engine downsizing by providing a means of boosting acceleration, overall performance and economy independently of the vehicle's engine and without the need for complex electrical-battery hybrid architectures.

A CVT-controlled flywheel is particularly suited to stop-start driving situations when real-world fuel economy is often at its worst. In these conditions, the variator-flywheel system can assist the launch of a vehicle which has slowed down or come to a standstill, by utilising the kinetic energy stored in the flywheel. In heavily congested traffic, where a car is frequently stopped and restarted, the system can help alleviate the heavy fuel consumption and emissions of greenhouse gasses normally associated with these conditions.

For the F1 applications, the stored kinetic energy can be applied by the driver on demand whenever required – at a rate and for a time period set by the regulations – to boost performance for rapid acceleration. The device is particularly beneficial when exiting corners or for tricky overtaking manoeuvres.

"The mechanical efficiency, compactness and mass of the variator system is critical since it directly influences the size and the ability to package such a system into an F1 car, or into a road vehicle," says Adrian Moore, technical director at Xtrac. "The size, torque capacity and response of the unit is critical to take the full advantage of having a flywheel KERS system."

Technical notes on Torotrak's toroidal variable drive technology

The components within each variator include an input disc and an opposing output disc. Each disc is formed so that the gap created between the discs is 'doughnut' shaped; that is, the toroidal surfaces on each disc form the toroidal cavity.

Two or three rollers are located inside each toroidal cavity and are positioned so that the outer edge of each roller is in contact with the toroidal surfaces of the input disc and output disc.

As the input disc rotates, power is transferred via the rollers to the output disc, which rotates in the opposite direction to the input disc.

The angle of the roller determines the ratio of the Variator and therefore a change in the angle of the roller results in a change in the ratio. So, with the roller at a small radius (near the centre) on the input disc and at a large radius (near the edge) on the output disc the Variator produces a "low" ratio. Moving the roller across the discs to a large radius at the input disc and corresponding low radius at the output produces the "high" ratio and provides the full ratio sweep in a smooth, continuous manner.

The transfer of power through the contacting surfaces of the discs and rollers takes place via a microscopic film of specially developed long-molecule traction fluid. This fluid separates the rolling surfaces of the discs and rollers at their contact points.

The input and output discs are clamped together within each variator unit. The traction fluid in the contact points between the discs and rollers become highly viscous under this clamping pressure, increasing its 'stickiness' and creating an efficient mechanism for transferring power between the rotating discs and rollers.

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