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Chain drives new electric bike

The use of precision chains has been essential in the development of a hybrid bicycle. Justin Cunningham reports.

Hybrid bicycles are finding increasing popularity for consumers. As well as providing comical moments in the form of the struggling cyclists being passed by another cyclist apparently doing no work, the electrification of bicycles is gathering momentum.

At the centre of a recently developed hybrid bike electric drive system is a precision chain, which allowed a unique transmission system dubbed the direct dual drive (DDD). This layout sees the pedal crank and adjacent motor shaft connected with a three chain arrangements yielding a reduction ratio of 1:38.

The joint development project was undertaken by power transmission experts, Iwis, in conjunction with hybrid bike start up, Clean Mobile. The design specifications for the drive system included an exceptionally small but powerful electric motor running at high speed. To maintain optimum efficiency the motor was required to run at high speed, even at slow riding speeds. Additionally, the motor needed to be mounted near the pedals and power transmitted to the rear wheel.

It quickly became clear that this goal could not be achieved with conventional reduction gearing so Iwis technicians and Clean Mobile decided to split the gearing into a primary and a secondary transmission. They also decided that the primary reduction gearing should take care of the speed reduction to the pedal crank, and allow standard components to be used for secondary power transmission.

The combination of this three-chain arrangement means a reduction from a 3600rpm motor speed to normal pedalling speed. A freewheel hub ensures that the pedal force exerted by the rider is transmitted only to the wheel and through the drive system should the battery ever fail. A second idle arrangement disengages the pedals from the rear wheel, as on a conventional bicycle.

The innovative drive concept provides effortless acceleration without emissions or noise as well as yielding an excellent range both in town, and off-road. To the surprise of project partners, tests by the department of drive control and actuator technology at the University of the German Armed Forces in Neubiberg near Munich reported an exceptional efficiency of around 80% across a broad operating range.

A major contribution to the drives overall efficiency is made by the chains, through which the tensile forces are transmitted only in the direction of travel. A spur wheel with helical gearing, used for noise reduction, would induce additional, lateral forces and thereby reduce overall efficiency. The effect of the teeth of each sprocket on each chain, and the resulting overall transmission ratio were calculated in several stages, resulting in suitable chains with the required fatigue strength.

Following their successful cooperation, Iwis and Clean Mobile formed a strategic alliance in 2011, covering mainly industrial parts production and assembly for the DDD system. The company initially introduced the technology last year and continue to develop it toward mass-production.

Michael Frank, project manager at Iwis, says: "This is an ideal basis for future projects. We are developing both more powerful units and detuned versions that use plastic parts. Customer enquiries from the two, three and four wheel industries are showing a keen interest in the new drives."

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