# Improving the seamless integration of small electric motors in modern hybrid vehicles

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**New ways to disconnect electric motors in hybrid drivetrains are vital for hybrid vehicles. Two intriguing ideas have been conceptualized; One using a frictionless solenoid plunger, the other a fast-acting hydraulic system.**

This project conceptualized and explored new ways of implementing a disconnect system in mild hybrid electric vehicles. The concepts were developed with the extensive use of the method outlined by [1].

The first concept, *First Pinion*, is placed at the pinion of the electric motor output axle. This helps reduce the force required for a disconnect operation, while also making the system as compact as possible. By utilizing a coaxial solenoid in which the plunger is free to rotate, the frictional contacts of the system have effectively been eliminated. Guiding surfaces make sure the construction is kept stable even at the maximum 20 000 rpm of the electric motor. See figure 1. The second concept developed is the *GenVI Hydro Sleeve* and can be seen in figure 2. It is placed next to the differential on the rear driveshaft of the vehicle. It utilizes a hydraulic pump to move the two halves of the dog clutch together with high force. This creates interference and torque is transmitted from the electric motor to the driven wheel. By placing the disconnect at this position, most parts of the drivetrain can be disengaged when not in use.

The seamless integration of electric motors in hybrid vehicles is an important step towards lowering the carbon emissions of personal vehicles. Well-functioning and smooth transitions between the two different drivetrains are essential for a convincing driving experience. Mild hybrids are an economic and straight-forward method for electrifying vehicles, utilizing a smaller electric motor only for assisting operations during driving. A downside of the smaller motor is the restrictions on its rotational speed, which amounts to the motor being damaged if used during the high velocities of modern vehicles. A driveline disconnect is a vital safety measure in modern hybrid vehicles. By disconnecting the electric motor from the driveline connecting the motor to the wheels, the electric motor is only used for its rated speeds. The disconnect also increases efficiency, as fewer parts of the driveline are spinning.

The concepts were developed using an iterative process

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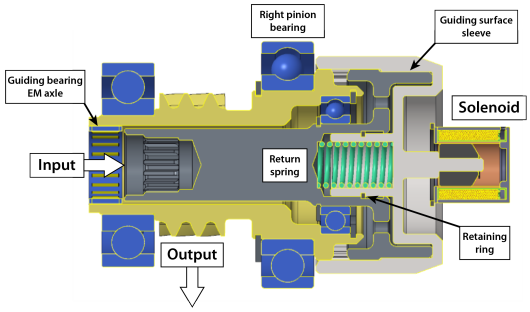


Fig. 1. Section cut of the First Pinion concept.

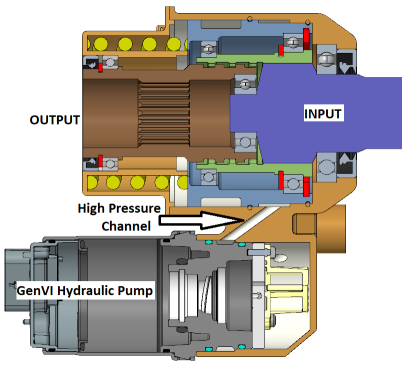


Fig. 2. Section cut of the GenVI Hydro Sleeve concept.

and were chosen after careful evaluation against a broad range of concept ideas. Over thirty concepts were generated. The concepts were first screened, using a comparison with a reference product, and finally scored against weighted criteria. A variety of actuator technologies were considered and evaluated during a scoring process. Hydraulic, solenoid, and electromagnetic systems were found to be attractive candidates. By choosing two different placements with their own respective designs, there is room for flexibility and customer-specific alteration during future development.

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## REFERENCES

[1] GK. T Ulrich and S.D Eppinger, "Product Design and Development", 5th ed. New York: McGraw-Hill, 2012.