Automobile Start-Stop Systems

One of the ways to reduce the fuel consumption of a vehicle is to turn off the engine when it stands still, even if it's only for a short time. In modern cars this function is realized by Start-Stop systems.

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A few decades ago, German scientists conducted traction tests of an Audi LS with an engine power of 55 kW. The tests showed that the car consumes 0.35 cc's of fuel while idling and 1.87 cc's while starting. So, it is clear that turning off the engine during a standstill which lasts more than 5 seconds allows you to saves you some fuel.
The possibility of reducing fuel consumption by switching off the engine during even a very short stop and then restarting it, led to the development of control systems that perform these operations automatically.

The solution introduced by Volkswagen at the beginning of the 80's provides a good example of such systems. The engine could be turned off by the driver or automatically, depending on the vehicle's speed, the engine's temperature and the position of the gear-change lever. It was turned over by a starter when the driver put the car in the first or second gear and pressed the accelerator pedal without releasing the clutch. When the vehicle's speed fell below 5km/h, the system stopped the engine by closing the idle run air duct. If the engine was not sufficiently heated, the temperature sensor prevented it from turning off. It was done in order to reduce starter wear, because starting a heated engine requires much less time than the start-up of a cold one. Furthermore, the control system reduced the load of the accumulator by switching of the heating of the rear window.

Now it's more frequent that cars are equipped with similar control systems, responsible for starting and stopping the engine. These systems are usually called Start-Stop, Start&Stop or Stop-and-Go.

Starter in Start-Stop systems

In the majority of Start-Stop system solutions used in cars, the engine is turned over by a conventional starter. However, as the car is started very frequently, the starter has to be more durable than a regular starter. That is why it is equipped with a more powerful electric motor and brushes that are more resistant to wear. Moreover, they changed the one-way clutch in the coupling mechanism and corrected the shape of the pinion teeth.

All these innovations translate into a lesser amount of noise emitted by the running starter, which is of no small importance for the driving comfort if taking into account the fact that we start the engine very often.

Reversible alternator

Even a modernized and strengthened starter isn't adapted for continuous operation. Nevertheless, the situation is different for an alternator whose rotor is rotating from the moment the engine turns over, till it stops. This is probably the origin of the idea that one could rotate the alternator with crankshaft during the start-up, so that it would transform into the electric motor. The Valeo company developed such a starter-alternator for Start-Stop systems, called StARS (Starter Alternator Reversible System).

The system is based on a reversible electric motor that serves the functions of both starter and alternator. The reversible alternator can easily be mounted in the place of the classical one. It permits a very gentle start-up. In comparison with the conventional starter, there is no coupling process, so no additional sounds connected with this operation are emitted.

During the start-up, the reversible alternator becomes an electric motor. Therefore, its armature windings have to be supplied with alternating voltage, while the direct current has to be delivered to the excitation winding (of the rotor). In order to obtain the alternating voltage from an on-board alternator, the use of a so-called inverter is required.

Furthermore, the armature windings cannot be supplied with alternating voltage through the voltage regulator and diode bridges, because at this time they have to be removed from the windings. In the moment of starting, the reversible alternator becomes the electric motor of an output not exceeding 2-2.5 kW and developing a torque of 40 Nm. This allows the engine to be started within 350 to 400ms.

The moment the engine is put in motion, the alternating voltage stops flowing through the armature windings. The reversible alternator again becomes an alternating current generator with the voltage regulator and diodes connected to the armature clips in order to be able to supply the vehicle's electrical system with constant voltage.

Additionally, other manufacturers equip the engine with a extra conventional starter and reversible alternator to turn over the engine for the first time after a longer standstill.

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