

# Introduction

The function of the starter motor is to start up the combustion engine. An electric motor forms the basis of the starter motor. When the starter switch is turned on, the starter relay turns on the electric motor. This motor drives the starter gear ring via the pinion gear.

The rotating movement of the starter motor is created through the interaction of two magnetic fields. Starter motors come with permanent magnets or with electromagnets. Each of these configurations has its own specific characteristics.

The energy required by the starter motor is provided by the battery. The starter motor requires a lot of start-up power. The battery must therefore have sufficient capacity and any losses must be kept to a minimum. As the starter motor begins to turn faster, start-up power is reduced. This is caused by the inverse voltage generated.

Depending on temperature, diesel engines require starting assist systems. In case of passenger cars, these facilities consist of a preheating system that preheats the combustion chamber and the air it contains. Glow plugs serve as heating elements. The glow period is regulated using a glow timer.

## Start Systems

3

*Theory*

## Starter Systems

4

*Theory*

## Starter Systems

5

*Theory*

# 1 Function and Structure of the Starter System

The starter system (Fig. 1) is responsible for turning the crankshaft until the engine starts running.

The key components of the starter system are:

- Battery
- Starter (ignition) switch (part of the ignition lock)
- Starter relay
- Starter motor
- Starter gear ring mounted on the flywheel

The **battery** provides the required electrical energy during start-up. The battery's capacity and the power required for cold starts are key in this regard. The battery must deliver sufficient power to allow the engine to turn over for some time (several minutes maximum). In winter time, the chemical reactions in the battery are slowed down and the battery's capacity is therefore lower in winter. The oil in the engine is also thicker then, which means that it is more difficult to turn over the engine. This is why starting problems are more likely to occur when temperatures are lower. The battery is connected to the starter motor via thick cables. These wires must be thick, because the starter current is very high. When the starter motor is activated, the current can increase to several hundred amperes.

The **starter switch** is required to activate the starter system. When the starter switch is activated, current flows to the starter relay. The starter switch is often incorporated into the **ignition lock**. The starter position of the ignition lock uses a spring-back mechanism. When the starter switch is released it automatically reverts to its off position.

To be able to turn the engine, a gear ring has been mounted around the flywheel (the **starter gear ring**). The starter motor turns the engine using a

small gear (**pinion**) that grips the starter gear ring.

**Fig. 1 Starter System**

Ignition lock  
Starter gear ring  
Starter relay  
Starter Pinion  
motor

**Starter Systems**

6

*Theory*

The transmission ratio between the pinion and the starter gear ring is about 10 : 1 to 15 : 1. This provides the starter motor with sufficiently high torque to be able to turn over the engine.

The starter motor is activated by the **starter relay**. The starter relay is controlled by the starter switch. When the starter relay is activated, it first connects the starter motor with the starter gear ring. The starter current is then switched on so that the starter motor will start turning. The **starter motor** delivers the energy required to bring the engine up to the desired level of start-up revolutions. The starter motor as such is an electric motor. The capacity of a starter motor in a passenger car is about 800 W.