Changing from ch

Part 1 - Traditional Charging Techniques

The 'current' demands made by modern vehicles on the charging system are considerable – and increasing. However, the charging system must be able to meet these demands under all operating conditions and still fast charge the battery.

42V electrical systems seem to have been on the horizon for some time now but in the meantime the existing 14V systems have been developed to cope with new loads such as heated seats, screens and other essential items.

Main component of the charging system is the alternator and on most modern vehicles, with the exception of its associated wiring, it is the only component in the charging system. The alternator generates AC but must produce DC at its output terminal as only DC can be used to charge the battery and run electronic circuits.

Traditionally the output of the alternator was regulated to a constant voltage regardless of engine speed and electrical load – but this is changing.

Figure 1: Alternator on a Vehicle (DigitalUP)

Basic operating principles

A generator, or alternator, is a machine that converts mechanical energy from the engine into electrical energy. The basic principle of an alternator is a magnet (the rotor) rotating inside stationary loops of wire (the stator). Electromagnetic induction caused by the rotating magnet produces an electromotive force in the stator windings.

For the output of the alternator to charge the battery and run other vehicle components, it must be converted from alternating current to direct current. The component most suitable for this task is the diode. In order to full wave rectify the output, of a three phase machine, six diodes are needed. These are connected in the form of a bridge in a rectifier pack. Many rectifiers now include two extra diodes that pick up extra power from a centre connection to the stator.

A regulator, which controls rotor current and therefore magnetic field strength, is used to control the output voltage of an alternator as engine speed and current demand change.

Manufacturers strive to produce ever more efficient machines. A modern alternator's high performance and efficiency are achieved primarily by a very dense winding of the copper wire in the stator grooves. To do so, the wires are first wound onto a flat stator core, which is easier to access, after which it is then bent into the usual rounded form.

Figure 2: Alternator and Stator Construction (Bosch Press)

arging to smart charging

As another response to the constantly growing demands that vehicle electrical systems place on their power supply, Bosch has developed a liquid-cooled alternator. It works extremely quietly due to the absence of a fan and its complete encapsulation; moreover, its lower operating temperature leads to a longer service life. This machine even has the advantage of reducing engine warm up time as initially it passes heat to the coolant. This is because after a cold start, the alternator will be working particularly hard to recharge the battery and hence be producing heat.

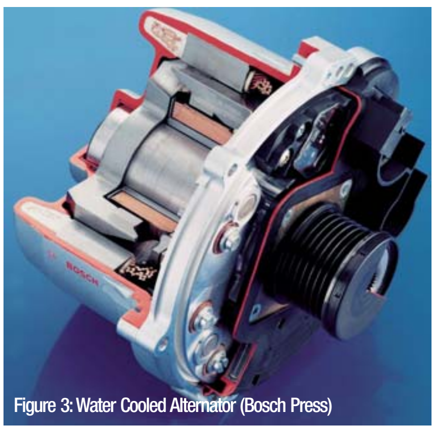


Figure 3: Water Cooled Alternator (Bosch Press)

Closed loop regulation of output voltage

To prevent the vehicle battery from being overcharged, the regulated system voltage should be kept below the gassing voltage of the lead acid battery. A figure of 14.2 ff10.2V was traditionally used for all 12V (nominal) charging systems. Accurate voltage control is vital with the ever-increasing use of electronic systems. It has also enabled the widespread use of sealed batteries, as the possibility of overcharging is minimal.

Traditionally the regulator base plate or heat sink temperature was used as a reference to estimate battery temperature. This is because the ideal maximum charge rate for a battery varies with its temperature. Further, if the regulator senses a significant change in voltage a function is employed to quickly recover this to the normal set regulation point.

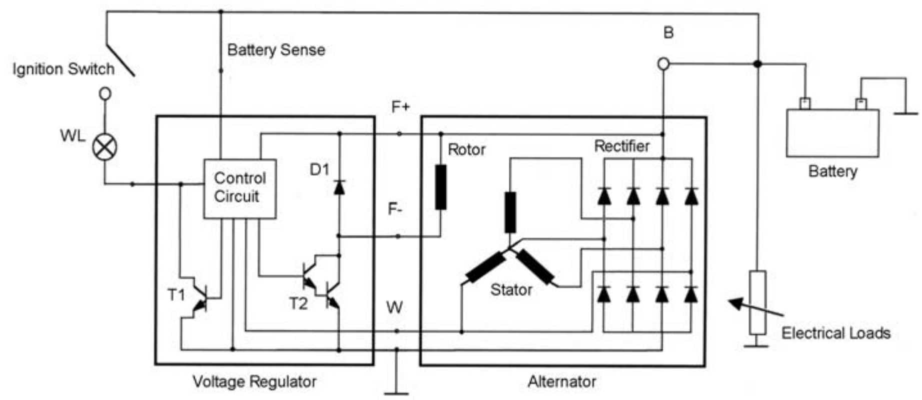


Figure 4: Modern Closed Loop Alternator and Regulator Circuit

In normal regulators this function is integrated into the regulator itself.

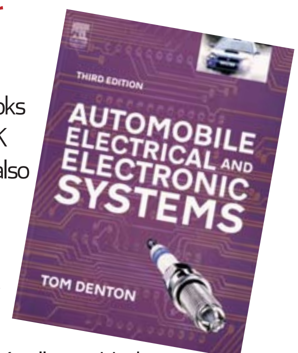
Summary

A range of alternator voltage control methods have been used in the past. Machine sensed alternators sensed the voltage output of the alternator, and battery sensed machines looked at the actual battery voltage. Some alternators had internal regulators and some were fitted externally. However, they all employed the same overall method of voltage control.

This method of closed loop control (regulator senses the output voltage and increases rotor field strength if the output is low, or decreases it if the output is too high) has worked well – up until now.

Next month's article will look at open loop control of charging systems.

About the author



Tom Denton is the author of several automotive textbooks published in the UK and USA. He has also written the multimedia series 'Automotive Technician Training', which is proving popular in many UK colleges. His best selling book, 'Automobile Electrical and Electronic Systems', is now in its third edition. Further information on www.automotive-technology.co.uk.