Brushless Alternators

Introduction

Several different technologies are used in the generator portion of wind turbines (wind generators). One of the older, more reliable technologies is the brushless DC alternator. The operation of them is often poorly understood by the owners and in some cases, poorly described by the turbine manufacturers. I was prompted to write this after reading one particularly bad circuit description on the Internet. (Name withheld to protect the guilty.) I'm not an expert on brushless alternators, but when I acquired a damaged Dunlite wind turbine, I became seriously interested in how they work.

Basic Theory

When an electric current is passed through a coil of wire, a magnetic field is produced (an electromagnet). Conversely, when a magnetic field is moved through a coil of wire, a voltage is induced in the wire. The induced voltage becomes a current when the electrons have some place to go such as into a battery or other load. [See Word~Power in issue ___] Both of these actions take place in alternators, motors and generators or dynamos.

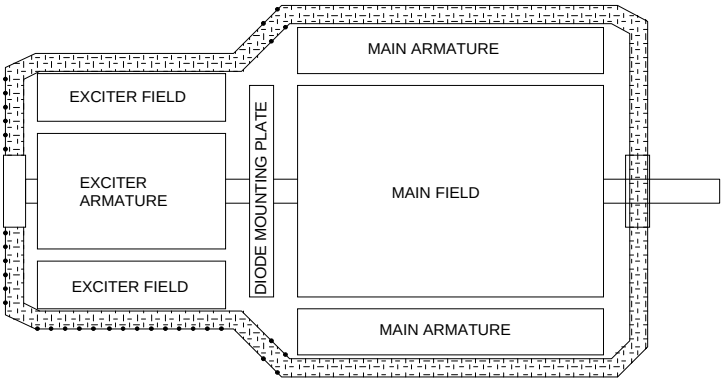
Voltage is generated when a coil of wire is moved through a magnetic field. It doesn't matter whether the coil is moving or the magnetic field is moving. Either configuration works equally well and both are used separately or in combination depending on mechanical, electrical and other objectives. The old DC generators (dynamos) used a stationary field and rotating armature. Automotive alternators use the opposite configuration with a rotating field and stationary armature. In a brushless alternator, both configurations are used in one machine.

Terminology

The stationary part of a motor or alternator is called the **stator** and the rotating part is called the **rotor**. The coils of wire that are used to produce a magnetic field are called the **field** and the coils that produce the power are called the **armature**.

This can be confusing because most of us equate the armature with the rotor. Traditionally, the armature was on the rotor but this is not necessarily the case. The two terms are not synonymous. For example, in the common automotive alternator, the field is on the rotor and the armature is on the stator. The rotor and stator are the mechanical configuration. The field and the armature are the electrical components. Either electrical component can be located on either of the two mechanical parts.

The coils of wire that are used to create the field and the armature are sometimes referred to as the "windings".



Construction

A brushless alternator is composed of two alternators built end-to-end on one shaft. Smaller brushless alternators may look like one unit but the two parts are readily identifiable on the large versions. The larger of the two sections is the main alternator and the smaller one is the exciter. The exciter has stationary field coils and a rotating armature (power coils). The main alternator uses the opposite configuration with a rotating field and stationary armature.

Exciter

The exciter field coils are on the stator and its armature is on the rotor. The AC output from the exciter armature is fed through a set of diodes that are also mounted on the rotor to produce a DC voltage. This is fed directly to the field coils of the main alternator, which are also located on the rotor. With this arrangement, brushes and slip rings are not required to feed current to the rotating field coils. This can be contrasted with a simple automotive alternator where brushes and slip rings are used to supply current to the rotating field.

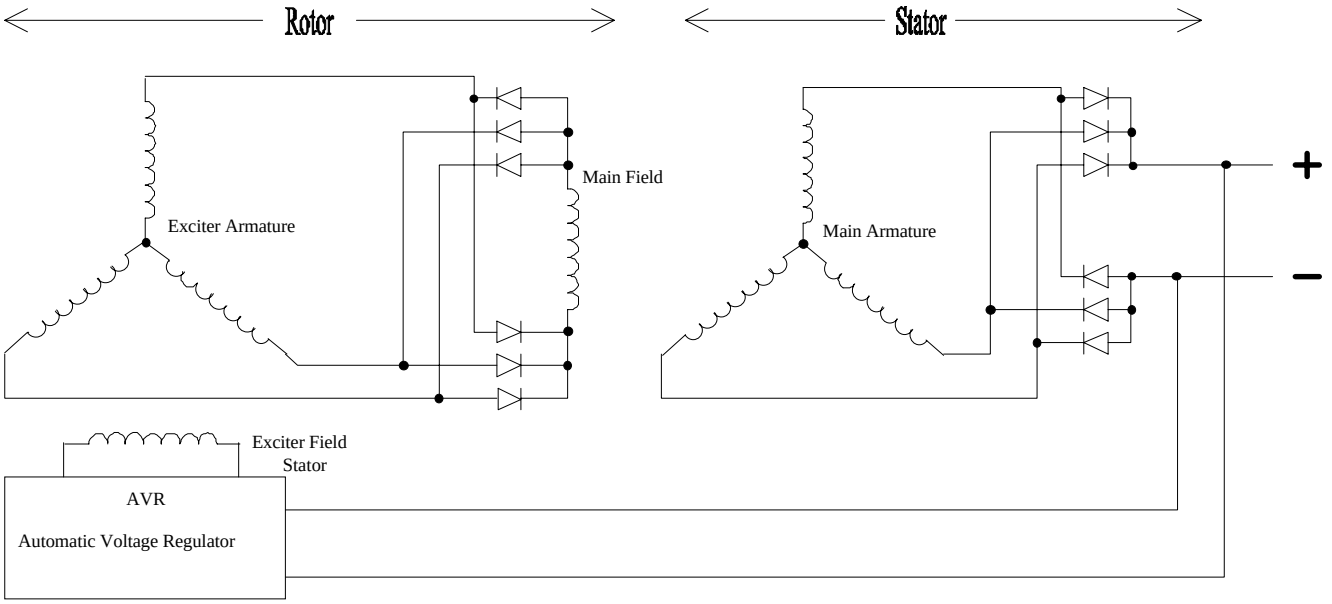
Main Alternator

The main alternator has a rotating field as described above and a stationary armature (power generation windings). This is the part that can be confusing so take note that in this case, the armature is the stator, **not** the rotor.

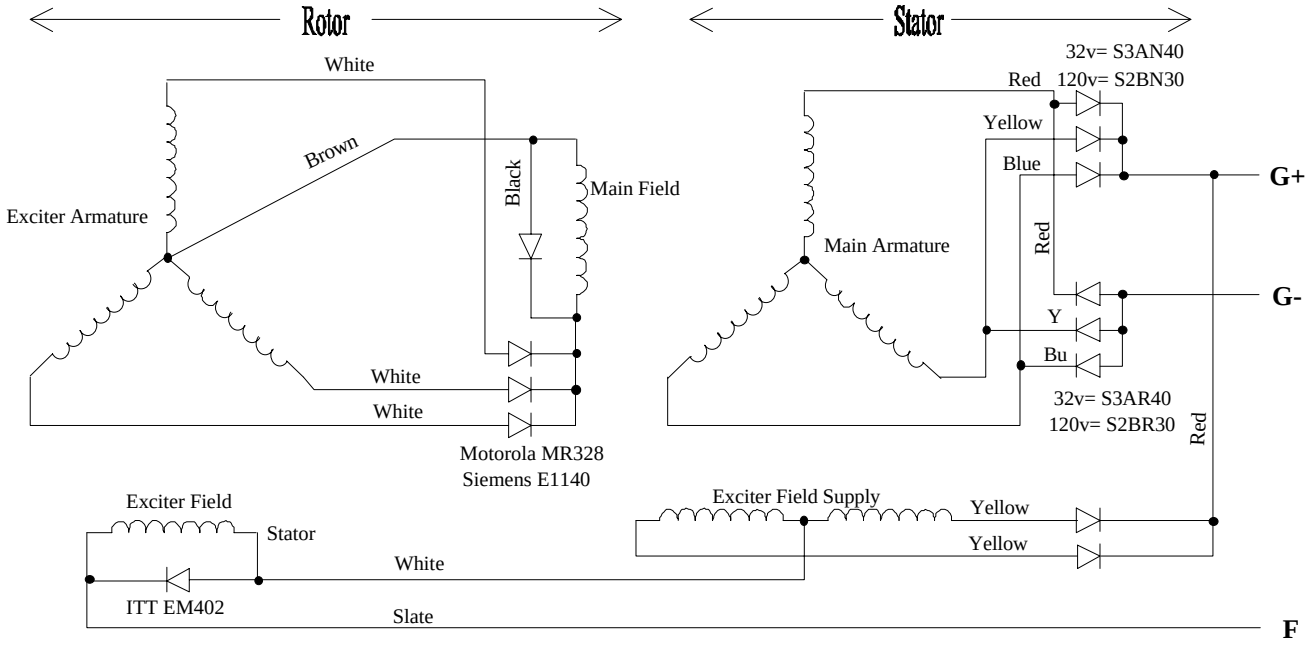
With the armature in the stationary portion of the alternator, the high current output does not have to go through brushes and slip rings. Although the electrical design is more complex, it results in a very reliable alternator because the only parts subject to wear are the bearings.

Control System

Varying the amount of current through the stationary



Basic 3-phase Brushless Alternator



Dunlite Type BL 2KW Wind Turbine Alternator