

## DC Motor Operation

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Industrial Electronics, Second Edition, Prentice Hall PTR

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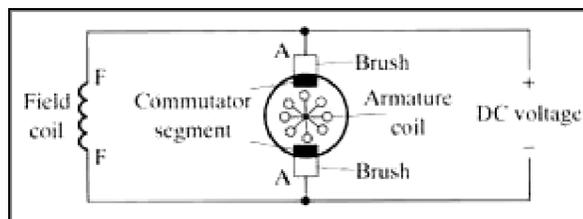
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### Electrical Diagram of a DC Motor

The DC motor you will find in modern industrial applications operates very similarly to the simple DC motor described earlier in this chapter. Figure 12-9 shows an electrical diagram of a simple DC motor. Notice that the DC voltage is applied directly to the field winding and the brushes. The armature and the field are both shown as a coil of wire. In later diagrams, a field resistor will be added in series with the field to control the motor speed.

When voltage is applied to the motor, current begins to flow through the field coil from the negative terminal to the positive terminal. This sets up a strong magnetic field in the field winding. Current also begins to flow through the brushes into a commutator segment and then through an armature coil. The current continues to flow through the coil back to the brush that is attached to other end of the coil and returns to the DC power source. The current flowing in the armature coil sets up a strong magnetic field in the armature.



**FIGURE 12-9** Simple electrical diagram of DC shunt motor. This diagram shows the electrical relationship between the field coil and armature.

The magnetic field in the armature and field coil causes the armature to begin to rotate. This occurs by the unlike magnetic poles attracting each other and the like magnetic poles repelling each other. As the armature begins to rotate, the commutator segments will also begin to move under the brushes. As an individual commutator segment moves under the brush connected to positive voltage, it will become positive, and when it moves under a brush connected to negative voltage it will become negative. In this way, the commutator segments continually change polarity from positive to negative. Since the commutator segments are connected to the ends of the wires that make up the field winding in the armature, it causes the magnetic field in the armature to change polarity continually from north pole to south pole. The commutator segments and brushes are aligned in such a way that the switch in polarity of the armature coincides with the location of the armature's magnetic field and the field winding's magnetic field. The switching action is timed so that the armature will not lock up magnetically with the field. Instead the magnetic fields tend to build on each other and provide additional torque to keep the motor shaft rotating.

When the voltage is de-energized to the motor, the magnetic fields in the armature and the field winding will quickly diminish and the armature shaft's speed will begin to drop to zero. If voltage is applied to the motor again, the magnetic fields will strengthen and the armature will begin to rotate again.

### Types of DC Motors

Three basic types of DC motors are used in industry today: the series motor, the shunt motor, and the compound motor. The series motor is capable of starting with a very large load attached, such as lifting applications. The shunt motor is able to operate with rpm control while it is at high speed. The compound motor, a combination of the series motor and the shunt motor, is able to start with fairly large loads and have some rpm control at higher speeds. In the remaining sections of this chapter we show a diagram for each of these motors and discuss their operational characteristics. As a technician you should understand methods of controlling their speed and ways to change the direction of rotation because these are the

two parameters of a DC motor you will be asked to change as applications change on the factory floor. It is also important to understand the basic theory of operation of these motors because you will be controlling them with solid-state electronic circuits. You will need to know if problems that arise are the fault of the motor or the solid-state circuit.

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