3.16.4.1: A CHANGING Magnetic Field Can Cause Current to Flow

If a *changing* magnetic field is present near a wire that is part of a circuit it will cause current to flow in the circuit. This is known as ***Faraday's law*** and is the basis for a lot of modern technology. Electric generators, traffic detectors embedded in the road, metal detectors, the read head on a computer hard drive, credit card readers, cassette tape readers, and transformers (both the ones on the utility pole outside your house and the little boxes that plug into the wall to run electronic gear) all use Faraday's law to operate. We will see several applications for sound reproduction in the next chapter.

One important application of Faraday's law is an electrical transformer. A transformer consists of a piece of iron with two separate coils wrapped around it. One coil is called the primary, the other coil is called the secondary. If there is an alternating current (AC) in the primary there will also be a changing magnetic field. This changing field will induce a current in the secondary due to Faraday's law. Although the wires of the primary are not physically connected to the wires of the secondary, a current flows in the secondary if an alternating current flows in the primary.

Why have a transformer? Why not just connect the secondary to the primary directly? The voltage and current can be adjusted between the primary and secondary by changing the number of loops in each. If the primary has 100 loops and the secondary 10 loops the voltage in the secondary will be $1/10$ of the voltage in the primary but the current in the secondary will be 10 times that of the primary. The voltage ratio between primary and secondary is proportional to the ratio in the number of turns of wire in each. This makes it easy to step up voltage (while stepping down current) or step down voltage (while stepping up current).

Why change voltage with a transformer? Electricity is delivered to your neighborhood at high voltage low current. Low current means less loss to resistance between the power plant and your neighborhood. Another transformer near your house steps the voltage down and the current up so that more of current is delivered to your home. You want more current but less voltage so that more energy is available for your electrical appliances.