ELECTRONICS FOR BEGINNERS

CHAPTER 1: Electrons, Conductors, Insulators, Resistors

Electrons. You know what they are. Those little negative-charged particles that orbit around the nucleus of an atom. Almost everyone knows that current is electron flow. Actually that's too simple, but we won't worry now about ions (in fluids) and holes (in semiconductors). To be a little more precise, current *in metals and conductive solids* is electron flow. How do they flow? Let's not worry about that – it would get us into atomic structure and quantum mechanics which are way beyond this article! Just think of them as hopping from atom to atom.

Electric *signals* flow at the speed of light (more precisely, *almost* the speed of light in wires). This does not mean that the *electrons* flow that fast. Rather, if you "push" on the electrons at one end, the push or force (signal) will travel down the wire at the speed of light. It's sort of like a hose filled with electrons. If you apply pressure (voltage) at one end, water (electrons) will start flowing out the other almost immediately. It takes a lot longer for an actual drop of water – or an electron – to get from one end to the other.

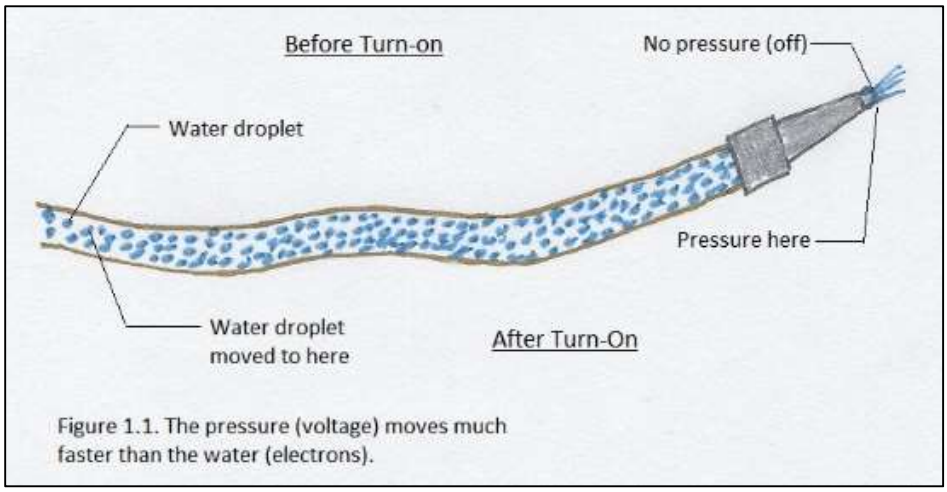

Figure 1.1. The pressure (voltage) moves much faster than the water (electrons).

What pushes the electrons? Voltage! Where does voltage come from? Electrons! OK, more seriously, electrons have a negative charge. A shortage of electrons produces a positive charge. Like charges repel, unlike attract, just like the north and south poles of a magnet. Voltage is produced by things like batteries, photo cells and generators. We won't be getting into how they work.

Which way does electricity flow? Since electricity is flowing electrons you would think it flows from minus to plus. The truth is, it does. However, plus and minus were assigned way back before people fully understood electricity so people just assumed it flowed from plus to minus. Almost all circuit equations, calculations and symbols use plus to minus. We'll do the same here. All we can do is get used to it.

Conductors. In a *conductor* the electrons are free to move easily from one atom to the next. Metals are conductors, some better than others. Copper is among the best, aluminum is almost as good.

Insulators. In *insulators* the electrons are tightly bound to their atoms and cannot hop from one to the next. Ceramics, dry wood, glass and most plastics are familiar insulators.

Resistors. *Resistors* allow electrons to flow but not as easily as conductors. You could say they resist the flow. Think of it as a pipe with restrictions inside, like maybe a mesh or other partial obstruction. Carbon is a familiar example. Even the best metals are not perfect conductors – they resist the flow a bit. If you try to force too high a current through a small copper wire it will get hot or possibly even melt. One way of saying it – conductors have very low resistance (but not zero).

Water pressure and flow are easier to visualize than electrons. In the next chapter we'll use water to illustrate the basic concepts such as volts, amps and ohms.