

ELECTRICAL LESSONS FOR STUDENTS.

THE first question invariably asked by a student is: "*What is electricity?*" To this no more satisfactory answer can be given than to the questions, what is heat, light, gravity, etc.?

If electricity, light and heat are not the same, they are very closely related. The question with us should be not what is electricity, but how best to apply it.

As we know how to obtain and apply artificial light and heat, so also do we know in a measure how to obtain and apply artificially produced electricity.

The simplest and most direct way to generate electricity is by means of the voltaic cell or battery, but the method of generating electricity to operate devices coming more within the range of our lessons is by the dynamo machine.

A voltaic cell consists of two metallic plates of different metals, submerged in a solution which will very readily and rapidly attack one plate without affecting the other.

By connecting a wire to each of these electrodes and attaching the free ends of the wires to a galvanometer, the indicating needle thereof will instantly be deflected and show that a current of electricity is passing through it.

A *voltaic cell* is, then, an appliance for artificially producing electric energy from chemical action. The metal plates of the battery are called the *electrodes*, the one attacked being the *positive* and the one not attacked the *negative*.

The battery solution or exciting fluid is called the *electrolyte*. For powerful currents such as are required for light and power, the solution is composed of some of the acids diluted more or less with water. When the wires from the cell are joined together, through the galvanometer, it is said that the *circuit* is complete or closed, *i. e.*, that there is no break in the chain of conductors.

The *circuit* is said to be open when the chain is severed at any point throughout its entire length. Simply connecting together the battery wires without the galvanometer or other device in *circuit* would be called *short circuiting the battery*. The result of such short circuiting would result in the rapid destruction of the battery.

By the *opening* and *closing* of the electrical circuit by means of a suitable lever called a *key*, the telegraph operator transmits his message. A short depression of this key will indicate at the distant end of the telegraph line a *dot*, while a longer depression will indicate a *dash*; these dots and dashes are grouped together to represent the alphabet.

The galvanometer is an instrument for indicating the presence of electricity. It is to the electrician what the mariner's compass is to the sailor. The galvanometer, like most other electrical instruments, is exceedingly simple. It consists essentially of a freely suspended or pivoted *magnetic needle* around which is wound a number of convolutions of fine *insulated* wire. The deflection of the needle, with the same power, may be increased by increasing the number of convolutions of wire. Instruction for making a simple form of galvanometer will be given when the subject is reached.

The galvanometer is simply an instrument employed to show the presence of an electric current, or to show when electricity is passing through the circuit of which it forms a part.

The circuit is the path over which the current flows. The ordinary galvanometers are graduated simply in degrees, which by themselves have no actual value. The galvanometer in all its various forms consists of a coil of *insulated* wire having a magnetic needle freely pivoted or supported within, and so that

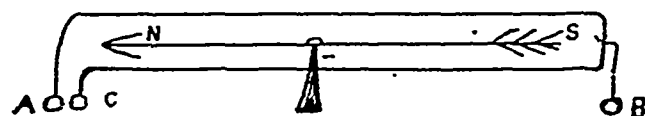


FIG. 1.

when a current passes through the wire it will have the greatest effect upon the needle. The best results are obtained when the coil and magnet are close, and when each convolution of the coil lies in a plane perpendicular to the needle.

The magnets of the class of galvanometers called *Detectors*, are pivoted in a vertical plane having one end made slightly heavier than the other, so that it hangs with the pointer perpendicular. A current passing through the hollow coil will

cause the needle to be deflected to the right or left, according to the direction of the flow.

The principle of construction of the galvanometer may be understood better by reference to Fig. 1, in which N S represents the freely pivoted needle, and A B C the connectors to an insulated wire which surrounds it. When the two wires from a battery are conducted to A and B, the current will flow only through the upper wire and the magnetic needle will be deflected only slightly. On removing the battery wire from A and connecting it with B, and the other battery wire from B and connecting it with C, the current will flow through the lower wire only, and under like conditions the action on the needle will be the same, so that when the current passes in the same direction the action is the same through the upper or lower wire. On removing the battery wire from B and connecting it with C, the deflection of the needle will be considerably increased, as the wire below will exert a like influence on the needle and in the same direction as the wire above, and the deflection of the needle will thereby be increased; and so on, will the deflection of the needle be increased for each and every additional turn of the wire forming the hollow coil which surrounds it.

By connecting one battery wire to both A and C, and the other battery wire to B, we will, so long as the wire above and below the needle are equal, obtain no deflection. The reason for this is that the current is divided equally between the two wires and the influence of one wire on the needle is counteracted by the influence of the other, which is reversed. Galvanometers constructed on this principle are called differential. By increasing, decreasing, or in any way altering the resistance of one of the wires only, we again get a deflection. This fact is taken advantage of and will be fully explained when dealing with the construction of the apparatus for testing.

The needle tends, at all times, on the passage of the electric current through the wire, to set itself at right angles to the wire, and this it does in proportion to the number of turns of the wire and the strength of the current.

If we reverse the position of the battery wires by connecting the one removed from A to C and the one removed from C to A, we shall also reverse the direction of the deflection of the needle, and this action will be due to the change made in the direction of the passage of the current.

The current in passing through the hollow coil of the wire, produces in the space surrounding it a *magnetic field*. It is this temporary magnetic field which acts upon the *permanently* magnetic needle and causes it to be deflected.

From the above you have learned that a current passing through a fixed wire which is supported parallel to a magnetic needle, will cause the needle to be deflected or to take up a position at right angles thereto, in proportion to the strength of the current flowing, and that by increasing the number of wires or convolutions of the insulated wire around a freely pivoted magnetic needle, it will, with the same current, likewise increase the deflection of the needle.

We have learned also that the electric current, as it flows through the insulated wire, causes each turn, half turn or complete convolution, to act for the time being as though it were itself a magnet, and that the space around the wire thus influenced is called the magnetic field. Further, that when a freely suspended magnetic needle is at rest it will have its ends directed to the North and South pole of the globe, and that when thus influenced it is said that the action is due to the earth's magnetism.

In all horizontal forms of galvanometers, before the current is allowed to pass for taking a reading, it is necessary to place the instrument so that the needle comes to rest at zero under the influence of the earth's magnetism. The deflection of the needle caused by the passage of the current will determine its strength.

The word *poles* is, in general, applied to the ends of magnets, to the ends of batteries, to the terminals or ends of the armatures on dynamo machines, electric motors, etc.

It is a fact no doubt well known to all our readers that one *pole* of a magnet will repel the like *pole* of another magnet, and that unlike poles will attract each other: and that the expression *poles* is generally understood as meaning the ends of magnets, batteries, etc.

The poles of an artificial magnet are generally designed to be