confinement to a long conductor, and leaps from one metallic conductor to another. It is therefore galvanic electricity alone which is adapted to the operations of the electro-magnetic telegraph.

Let us next inquire into the means by which this electricity is generated and applied in working the telegraph. This is twofold—the *Galvanic battery* and the *Electro-magnet;* the former the motive power of the telegraph, the latter involving the basis and merits of MORSE's American invention.

The Galvanic or Voltaic battery,—which is one of the most valuable acquisitions of modern science,—originated in GALVANI (an Italian anatomist of Bologna) having observed the contractions which ensue when a metallic communication is made between the *nerves* and *muscles* of a dead frog. He found, that, when a single metal was employed as a line of communication, contractions of the *muscle* took place wherever the metal reached from the *nerve* to the *muscle;* and that when two pieces of different kinds of metal (such as zinc and copper) were employed, the contractions or spasms were much more violent. To explain this effect, GALVANI supposed that the *muscular* system of animals is constantly in a positively electrical state, while the *nervous* system is negative; and that the muscular contractions were to be accounted for on the same ground that a discharge takes place in the case of the Leyden jar when a line of communication is opened between the two coatings in opposite electrical states. But another Italian philosopher, VOLTA, conjectured that the cause of this remarkable result was not due to any peculiarity of the animal system, but to the *contact* of the *pieces* of *metals* employed by means of the moisture of the animal. This led to the invention of the Voltaic (and as it is also called Galvanic) battery—an instrument which has proved of the greatest importance to chemical science. Thus the convulsive spasms of a frog's leg have, in the hands of true philosophy, already resulted in showing that the entire crust of the earth is made up of metallic oxides; have unfolded the mystery of the Magnetic Needle's pointing to the North; have developed the wonders and benefits of the Electrical Telegraph, and revolutionized the science of Chemistry.

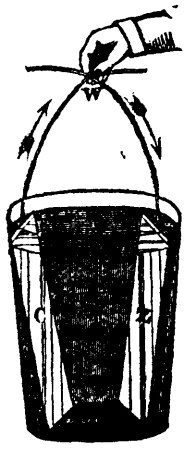
The simplest form of galvanic action may be tested by any person, who will place a piece of silver or copper—half-a-dollar or a penny—above his tongue, and a piece of some other metal, as zinc, below the tongue. As long as the two pieces of metal are kept apart, no effect will be perceptible; but whenever their outer edges are brought into contact, so that what is termed a "galvanic circle" is formed by means of the moisture of the tongue, that moment galvanic action takes place, producing a peculiar taste in the mouth.

Three elements are essential to produce galvanic electricity. The process usually adopted to obtain it, is to plunge two plates of different metals—copper and zinc, for instance—into the same liquid—say diluted sulphuric acid. The acid will combine with the zinc and give it a negative electricity, and be itself positive. The copper being less liable to be acted upon by the acid than the zinc, will, instead of being negative, receive positive excitement from the intervening liquid, and will, when the circle is completed by uniting the two unimmersed ends of the plates by means of a wire, act as a conductor to carry round the positive current.

The simple galvanic circle is best illustrated by the accompanying *Figure* 1.

The vessel is partially filled with diluted sulphuric acid, with a plate of zinc, Z, and another of copper, C, immersed into it. The plates are separated at the bottom of the vessel, and the circle is

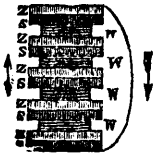
(*Fig.* 1.)



SIMPLE GALVANIC CIRCLE.

completed by connecting them on the outside by means of wires. Should the plates themselves be brought into contact on the outside of the vessel, instead of being joined by the wires, the same effect would be produced. Sulphuric acid having a stronger affinity for zinc than for copper, combines with it; and the zinc, communicating its natural share of the electrical fluid, becomes *negatively* electrified. The copper, attracting the same fluid from the acid, becomes *positively* electrified. Should therefore the plates, which are in opposite electrified states, be united by contact, or by the conducting rod W, a galvanic circle would be formed, and the electrical current would flow in the direction of the arrows; first from the zinc to the fluid, secondly from the fluid to the copper, and thirdly from the copper through the wires back to the zinc—thus passing from the zinc to the copper *in* the acid, and *out* of it from the copper to the zinc. The electrical effects of a simple galvanic circle—which are too feeble for practical purposes—may be increased to any degree by repeating the same simple combination—thus forming compound galvanic circles, which are called galvanic or voltaic piles or batteries, according to the manner of their construction.

(*Fig.* 2.)

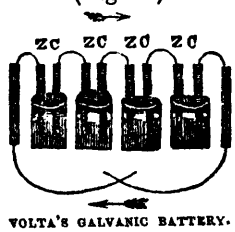


VOLTAIC PILE.

A voltaic *pile* is represented by *Figure* 2. It consists of several plates of silver (which is preferable to copper, though not equal to gold or platinum) and an equal number of zinc plates—each *pair* separated by pieces of woollen cloth, soaked in a solution of sal ammoniac in water. The order of these plates in the pile—as shown by the *Figure*, beginning at the bottom—is, zinc, silver, cloth, &c. The pile will afford a constant current of electric fluid, through any conducting substance, (such as the wire represented in the figure) proportioned in strength to the size and number of the pieces used. As the human body is a good electrical conductor, if one hand be applied to the lower plate of the pile and the other to the upper one, a shock will be felt, and will be repeated as often as the operation is renewed.

As the pieces of cloth between the silver and zinc in the pile of VOLTA are of no other use than to contain the acting substance, they may be dispensed with, and the same object may be attained by inserting the plates in a series of vessels containing the proper kind of liquid. VOLTA accordingly made an arrangement which he called the *couronne des tasses* (the crown of cups), which are represented by *Figure* 3.

(*Fig.* 3.)



VOLTA'S GALVANIC BATTERY.

This kind of galvanic battery is used in many of the intermediate stations of the telegraph lines. It consists of a row of glasses or jars filled with acidulated water, and each containing a couple of plates. Into the first is placed a zinc plate Z and a copper plate C. If these were connected, a current would arise, as was described in connexion with *Figure* 1. But instead of connecting these, let a wire pass from C to Z, a zinc plate in the second glass, which contains also a plate of copper connected with the zinc of the third glass, and so on with the fourth, and as many more as it may be thought proper to add in order to increase the power of the battery. The arrows denote the course af the electric fluid.

(To be concluded with additional illustrations in our next.)