GALVANIC BATTERIES.—No. 1.

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THE principal galvanic batteries now in use will be described and illustrated in this series of articles. In the present article a number of simple batteries are figured and described.*

The Earth Battery, Fig. 1.—This consists of a zinc and copper plate buried in earth that is continually moist. The wire that extends from the plates to the surface of the ground must be insulated. The surface of the plates must be large, to insure good results; from 25 to 50 square feet are required to produce even a weak current. This battery furnishes a continuous current for a long time.

Zamboni's Dry Pile, Fig. 2.—In this battery the electro-motors are tin or silver and binoxide of manganese. To construct one of these a piece of paper silvered or tinned on one side is taken; the other side of the paper is coated with finely powdered binoxide of manganese by slightly moistening it, and rubbing the powder on with a cork. Having placed together seven or eight of these sheets, they are cut by means of a punch into disks an inch in diameter. These

FIG. 2.—ZAMBONI'S DRY PILE.

disks are then arranged in the same order, so that the tin or silver of each disk is connected with the manganese of the next. Having piled up 1,200 to 1,800 couples they are placed in a glass tube, which is provided with a brass cap at each end. The lower cap is connected with the binding post on the base. In the upper cap there is a rod and knob by which the leaves may be pressed together, so as to produce a better contact. The knob in contact with the manganese corresponds to the positive pole, while the cap at the other end, which is in contact with the silver or tin, is the negative pole.

The dry piles are remarkable for the permanence of their action, which may continue for several years. Their action depends greatly on the hygrometric state of the air. Two thousand couples give neither shock nor spark, but can charge a Leyden jar and other condensers.

The Voltaic Pile, Fig. 3. consists of several compound pairs of zinc and copper plates put up in layers, always in the same order, and between each pair a moist conductor is inserted, such as a disk of felt, cloth or pasteboard, so that a succession of the bodies arranged on each other from top to bottom is as follows: Copper, zinc, felt, copper, zinc, felt. One end of the series terminates with zinc, and the other begins with copper. The pasteboard or felt disks are soaked in water mixed with common salt or sulphuric acid. The cut is about $\frac{1}{2}$ actual size.

The Simple Zinc and Copper Battery, Fig. 4. consists of strips of zinc and copper bent at the upper end and soldered together, as indicated in the engraving. The jars, which are about the size shown in the cut, are filled with water slightly acidulated with sulphuric acid. The expense of this battery is so slight that it may be used a few times, and then thrown away.

* For several of the engravings used in these articles we are indebted to *Electricity and the Electric Telegraph*, by Prescott.

FIG. 5.—TOM THUMB.

The Tom Thumb Battery, Fig. 5.—This simple battery is constant for several days, and is sufficiently powerful to work the smaller electrical machines.

It may be constructed as follows: Take a piece, C, of common sheet zinc—stove zinc—six inches long, and four inches

FIG. 1.—EARTH BATTERY.

wide; bend it up at right angles two inches from the end. Attach a binding post, A, or nick it, and wind around it a copper wire. Cover the zinc with two thicknesses of common white printing paper. A piece, D, of sheet lead of the same size as the zinc is bent up in the same way, or it is provided with a binding post, B, as in the cut. In a common tea saucer place one ounce of sulphate of copper, and

FIGS. 7 AND 8.—NEW SINGLE FLUID.

fill the saucer two-thirds full of warm water. Let it stand until dissolved. Place the zinc in the saucer, and put the lead on the zinc.

Simple Single Fluid Battery, Fig. 6.—M. Onimus recently exhibited to the French Academy of Sciences a new and simple battery, in which he substitutes a diaphragm of

FIG. 4.—SIMPLE ZINC AND COPPER BATTERY.

parchment paper for the porous vase. The zinc cylinder, A, being enveloped in the paper, B, copper wire, C, is wound over all. The latter holds the paper against the zinc, and answers for a fastening. The whole is plunged in the sulphate of copper solution, and the battery soon works regularly. For some carbon batteries, the carbon is enveloped in parchment paper, and around this is placed either a zinc wire or a zinc cylinder. The battery thus constructed will, when moistened, work for some hours after being removed from the exciting liquid.

New Single Fluid Battery.—Figs. 7 and 8 represent a new cell invented by M. Pulvermacher. The accompanying figures speak almost for themselves. They show a porous jar surrounded by a silver thread. This thread is rolled to take a spiral form, and is used as the negative pole of the element. The exciting fluid placed in the unglazed jar percolates through the innumerable pores, and makes the electric contact with the cell complete. Externally the electric circuit is completed in the ordinary way. The positive pole is a rod of zinc, and the exciting liquid is dilute sulphuric acid, a solution of caustic potash or sal ammoniac. The

FIG. 3.—VOLTAIC PILE.

small spirals of silver or platinum wire are far enough apart not to cause capillary attraction to take place between them, but the wire makes an infinite number of contacts with the liquid that oozes from the pores of the jar. It is upon all these contacts that the air exerts its oxidizing action, and effects the depolarization of the cell. The top of the zinc is covered with caoutchouc in order to avoid accidental contacts which might short circuit the battery. The porous cell is surrounded by a ring of hard rubber, so that the whole cell is carefully guarded against harm.

The electro-motive force of a couple charged with a solution of caustic potash is about 1.5 volt; with dilute sulphuric acid—one of acid to ten of water—it is nearly 2 volts. The resistance of a cell with silver wire as the negative pole, and a porous jar of good quality, 14 centimeters high and 55 millimeters diameter, was 1.3 ohm. In a circuit having a resistance of 10 ohms, in ten minutes the electro-motive force diminished about 16 per cent., and returned to its normal value after three minutes' rest.

Chloride of Silver Cell.—Fig. 9 represents a small form of De la Rue's chloride of silver cell, which is remarkably well adapted for electrical testing either on shore or at sea. The engraving is about $\frac{1}{2}$ the actual size. Its very

FIG. 6.—SIMPLE SINGLE FLUID.

constant electro-motive force from time to time, and especially during the taking of insulation resistance tests; its freedom from variation in electro-motive force when shaken or otherwise disturbed; its small portable form and cleanliness; and its comparative economy in the end, are special qualities in its favor. We hear that it is already coming into use as a testing battery.

In the diagram, A is a glass vessel, closed at the top to

Fig. 9.—CHLORIDE OF SILVER.

keep out dirt by a stopper of cork or solid paraffine, D, but preferably of cork, because it can be handled with more ease and fits the cell more tightly than paraffine, which is apt to work loose when fitted to glass.

The negative pole, C, consists of a cylindrical rod of chemically pure zinc supported by the cork stopper, which is perforated to receive it. The zinc rod has a hole in the

Fig. 10.—SMEE'S.

top to allow the silver connecting wire or electrode which goes to the next element to be soldered in.

The positive pole consists of a cylinder of silver chloride, B, having a silver wire or electrode, b, cast into it. This chloride rod is usually inclosed in a hollow cylindrical diaphragm of fine parchment paper.

Fig. 13.—GRENET.

The solution for charging the cell is made by dissolving 23 grammes of pure sal-ammoniac or ammonium chloride in one liter of water.

The electro-motive force of each element is about 1.10 volt, and the internal resistance is about 8 ohms. Both of these qualities are very constant.

In the action of the cell, pure silver is reduced and deposited on the floor of the cell. To prevent the short-circuiting of the poles by this metallic deposit, it is best to keep the zinc rod raised about three-eighths of an inch above the floor of the cell. This pure silver deposit can be readily turned into chloride of silver again by means of a small quantity of chlorine, and it is then only necessary to melt the chloride so formed, and recast it into rods for use over again, otherwise the pure silver may be sold as it is.

Fig. 11.—SMEE'S.

Twenty, fifty, or even a hundred of these cells can be fitted with solid paraffine into a small box easily carried in the hand, so as to form a convenient portable testing battery for the use of electricians abroad. For medical men employ-

Fig. 12.—LECLANCHE.

ing the feeble current cure this cell is also highly convenient.

The *Smee Battery* is shown in Figs. 10 and 11. In Fig. 10, W is a wooden strip which rests upon the jar, A, and supports the platinized silver plate, S. The zincs, Z, are clamped to the sides of the strip, W, by a clamp, b, which is provided with a binding post for receiving a wire. A binding post is also connected with the silver plate, S.

The form of battery generally used for telegraphic purposes is shown in Fig. 11. It consists of a strip of platinum, one inch wide by ten in length, and a plate of amalgamated zinc fastened to a beam of wood by brass clamps both are

Fig. 14.—PLUNGING.

plunged into a glass vessel. In arranging a series of cells the zinc of one cell is connected with the platinum of the next.

A is an insulated wooden bar; B, brass clamps; Z, zinc plate; P, platinized silver plates or strips of platinum; T, glass cells.

The liquid generally used to charge the battery is 1 part of sulphuric acid to 10 of water.

The *Leclanche Battery*, Fig. 12.—The positive pole is composed of a plate of carbon set into a mixture of powdered peroxide of manganese and carbon, and hermetically sealed in a porous vase.

The negative pole is composed of a plate or pencil of

amalgamated zinc. The two poles are set in a solution of sal ammoniac and water, contained in a glass jar.

As the zinc is indefinitely preserved without alteration in the sal ammoniac, and as the peroxide of manganese is insoluble in this liquid, no internal chemical action takes place when not in use.

The electro-motive power of Grove being 100, this is 75, and Daniell's 50; or three cells of this battery are equal to four cells of the Daniell.

Will last without renewal from one month to several years, according to use, at the end of which time the porous cells can be renewed at a moderate expense.

Fig. 15.—MARIE DAVY SULPHATE OF LEAD.

The *Grenet Battery*, Fig. 13.—This is a very good form of an experimental battery where constancy of current is not required, as, for example, in the laboratory and mechanical work rooms. The cell is in the form of a bottle, and contains a mixture of two parts of bichromate of potash dissolved in twenty parts of water and one part of sulphuric acid. The top is provided with a brass frame, to which is fastened a wooden cover, to which are attached two carbon plates, which dip permanently into the fluid; and between the carbon plates a zinc plate is suspended by a rod, by means of which it may be plunged into the fluid or withdrawn at pleasure. When the zinc is withdrawn the action ceases. This battery gives a powerful current for a short time, but it rapidly polarizes. The length of time during which the fluid will retain its power depends on the use which is made of the battery.

The *Plunging Battery*.—Where it is designed to have a battery for occasional service during a long time, the series represented in Fig. 14 is probably the simplest and most efficient yet devised. When not of service the plates are drawn up out of the influence of the acid, but always ready,

upon turning the crank, to descend, and, after immersion, produce the required current. The smaller plunging battery employs glasses about one and one eighth inch diameter and four inches long, and the larger employs oval glasses of about three times the capacity. The plates are also made either of platinized silver plated lead, opposing zinc, or of carbon with zinc. With the former only dilute sulphuric acid can be used, but with the latter the bichromate solution may be used, thus giving very great electro-motive force—quite sufficient to ignite platinum at the distance of several miles, or to produce temporary but brilliant electric light. The cleanliness of the dilute sulphuric acid combinations, and the great length of time they can be held ready for service, make them extremely valuable.

When carbon and zinc plates are used, the bichromate solution given in description of the Grenet battery may be employed as an exciting fluid.

The *Sulphate of Lead Battery*, Fig. 15, is the invention of Marié Davy. It is constructed in the form of a column, and occupies but little room. It consists of a series of tinned iron pans, a, a, a, provided with three arms placed horizontally at equal distances apart. The bottom of each pan rests upon a zinc disk, and is coated inside with pulverized sulphate of lead moistened with water. The pans are piled one above another between three wooden posts, D, D, D, provided with iron screw heads, on which the pans rest by their three horizontal arms, e, e, e. The wooden posts are placed on a wooden frame, E, F.

The battery is charged by pouring water into their iron pans. The sulphate of lead is almost insoluble in water, but it is a good conductor of electricity. The zinc is attacked, the lead in the salt is reduced, and zinc sulphate and metallic lead is deposited on the bottom of each pan. The electro-motive force is inferior to that of Daniell, but its internal resistance is less.

The battery is easily kept in order, it being only necessary to add water from time to time, to supply the losses occasioned by evaporation.

[To be Continued.]