



XLIX. On the effects of a voltaic battery charged with solution of sulphate of copper

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of two inches breadth, of plates (the size which we have taken above as an example), may be contained in a trough eight inches in length, and will evolve, when its terminal wires are soldered to a Faraday's volta-electrometer, six or seven cubic inches of the mixed gases in three or four minutes, with a charge of half an ounce of sulphuric acid and half an ounce of nitric acid, in twenty-four ounces of water, (all by fluid measure,) and is therefore amply sufficient to demonstrate the decomposition of water on a considerable scale.

It is proper to use the thickest sheet zinc which can be had, in the construction of the plates, although the thinnest sheet copper will suffice, from its being so well supported. When the zinc plates are worn out, the cross-bars may easily be pulled out of the solid ends, and the elements of the battery separated. New zinc plates being soldered to the old coppers, the whole may again be quickly rearranged in the old frame.

Glasgow, Jan. 4, 1837.

XLIX. *On the Effects of a Voltaic Battery charged with Solution of Sulphate of Copper.* By Mr. WARREN DE LA RUE.

[With Figures: Plate II.]

To the Editors of the Philosophical Magazine and Journal.

GENTLEMEN,

IN answer to your query (vol. ix. p. 484,) as to the relative effects of batteries charged with sulphate of copper or with acids, I beg to submit to your attention the following facts and deductions.

It is well known that in connecting the poles of a battery with a definite length of wire, the wire will become ignited, and continue so for an exceedingly short space of time after immersion in an acid; and if the battery be immersed without connecting the poles and allowed to remain for a few minutes, and the connection be then made,—with the same length of the same wire,—no ignition whatever is produced*. As in this latter case no zinc can have been deposited on the copper plate, prior to the connection of the poles, it follows that this decrease of power must result from some other cause. At the moment of immersion in dilute acid, say sulphuric, the electricity is produced by the combination of the acid with that portion of oxide which is in perfect contact with the zinc plate: when this thin coating of oxide is removed, the zinc plate is then oxidized at the expense of water, hydrogen be-

* A battery regains its former power by exposing the plates to the action of the atmosphere.

ing set at liberty; and as the hydrogen assumes the gaseous form, it annuls or carries off a large portion of the electricity*.

If sulphate of copper be used in charging the battery instead of acid, oxygen is supplied to the zinc by the oxide of copper; no evolution of gas, therefore, takes place†; and the action is thus rendered continuous, the effect being fully equal to that momentarily produced by immersion in acids. The fusion of metallic points of *very large dimensions*, the decomposition of fixed alkalis, &c. &c., cited in my former communication as the effects of a voltaic battery of 100 pairs on Cruickshanks's construction, cannot be produced by the same battery when charged with acid, the momentary power being exhausted before the battery can possibly be brought into action‡.

The following is an experiment to ascertain the effect on the battery produced by the deposition of copper on the zinc plate. Fig. 10 represents one of the zinc plates of the battery: round it at (a) are placed four copper wires one tenth of an inch in diameter; these are each attached to the plates by a drop of solder. Fig. 11 shows the zinc plate surrounded by the copper as in Wollaston's plan: the battery consists of twelve such series. It is clear that there are four small local currents in each cell; yet the power of the main current is increased, and not diminished as I conceived it would have been. From the proximity of the copper wires to the zinc plate, there is no deposition of copper on the zinc plate; it adheres to the copper wires so firmly that it is exceedingly difficult to remove.

I find that amalgamating the zinc greatly increases the power of the battery, and prevents the strong adherence of the copper to the zinc plates, which are therefore cleaned with facility§. I have a battery of 30 pairs of four-inch plates

* A similar effect takes place in the formation of steam, which causes the gold leaves of an electrometer to diverge with *negative* electricity.

Professor Faraday has shown that a voltaic current ceases to affect a magnetic needle if employed in the decomposition of a solution of iodide of potassium: hydrogen is given off in this case. Again, if a battery be employed in decomposing a solution of a metallic salt, an atom of it will be decomposed for the solution of every atom of zinc; but this does not destroy the current, for an atom of water is at the same time resolved into its elements.

† The exceedingly small quantity produced by the local action cannot be taken into account.

‡ This fact I am ready to prove by actual experiment to any scientific gentleman who will do me the favour to call for that purpose.

§ The zinc plates are amalgamated by rubbing them with dilute nitric acid and mercury; the mercury is allowed to be absorbed by the zinc plate, and the operation must then be repeated, which is a requisite condition.

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with amalgamated zinc, which is well adapted to the use of sulphate of copper; it is more economical in its construction* than any now in use, and possesses this great advantage, that the zinc when worn out may be easily replaced. Fig. 6 shows the zinc plate, which must be tinned on the top A† prior to the amalgamation of the rest of the plate; B B are two slips of wood grooved out to within three fourths of an inch of the bottom, and intended to retain the zinc plate in its proper position. The copper plates are formed into cells, as represented in fig. 7, five inches square and one inch wide: E E are two ears of copper, by which the cell is suspended in its place; A is a slip of copper to form a connection by means of solder to the zinc plate in the adjoining cell. The cells are painted on the outside to protect them from the action of acid. The zinc plates do not descend lower than within three fourths of an inch of the bottom of the cells, so that the space left may contain the deposit resulting from the decomposition of the sulphate of copper. The cells are supported in a long wooden frame by the ears E E and retained in their place by tacks driven through them as represented in fig. 9. Fig. 8 represents a contrivance by which the charge may be renewed while the battery is in action: at the top of each cell may be placed a lip or spout L, a quarter of an inch deep; these must overhang a wooden gutter running the length of the frame. The solution must be renewed with a funnel having a long neck, the long end being inserted nearly to the bottom of the cell; when fresh solution is poured in, the spent liquor will run out of the lip into the gutter.

Immediately after a series of experiments the battery must be emptied, and the plates well cleaned by dashing water between the cells. If this be not immediately attended to it will be exceedingly difficult to remove the deposit from the cells. A Cruickshanks's battery is best cleaned by laying it on its side.

I remain, Gentlemen, yours, &c.

110, Bunhill Row, Dec. 7, 1836.

WARREN DE LA RUE.

P.S. The fact related in your first note (vol. ix. p. 484) shows that Professor Daniell had no intention of employing sulphate of copper in an ordinary battery; he immersed a zinc plate in sulphate of copper and found that there was local action, from the deposition of copper; but he went no further.

* The one I have, cost altogether 3*l.*; but as I put this together myself, a similar battery constructed by workmen would of course be rather more expensive.

† This is effected by filing the top smooth, wiping it over with a little muriate of ammonia, and then dipping the top in a ladle of melted tin, a little tallow being placed on the tin to prevent the surface from oxidating.