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A FORM OF DANIELL CELL

CONVENIENT AS A

STANDARD OF ELECTROMOTIVE
FORCE.

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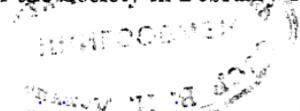
[Plate I.]

ALTHOUGH a volt is the formal unit of electromotive force, yet it happens in practice that differences of potential get stated as equal to so many Daniell cells more frequently than any thing else, showing that there is some decided convenience in this mode of statement, a convenience partly owing, no doubt, to the fact that a freshly set-up Daniell is a tolerably uniform and easily reproduced standard. An ordinary Daniell, however, is by no means suitable as a standard, because of the diffusion of the copper-liquid through the porous cell. This defect must obtain in any cell where two liquids separated by a porous partition are employed; and hence attempts have been made to construct standard cells with solid electrolytes, or with mercury instead of copper salts, as in the little cell devised by Mr. Latimer Clark, which, though not absolutely constant, is still, I suppose, the best for its special purpose. But all cells with solid electrolytes are extremely inconstant, in the sense that they suffer greatly from short-circuiting and take some time to recover themselves; and there are some other inconveniences attending the use of a large number of Clark's cells.

A convenient Daniell Cell with high internal Resistance.

Of all known cells, a Daniell charged with sulphate of zinc and sulphate of copper seems to be the most perfect—in this

* Communicated by the Physical Society, one of the cells having been exhibited at a meeting of the Society in February 1877.



respect, that the materials remain always the same during action except that the sulphate of zinc gradually increases in quantity, a difference which scarcely affects the electromotive force. Almost the only defect in the constancy of a cell so charged is due to the fact that the two liquids diffuse into each other, for which reason the battery cannot retain its original state after it has stood for some time. Any thing equivalent to a porous partition is quite useless for keeping the liquids separate; and the only plan seems to be to provide as long a column of liquid as possible for the copper salt to diffuse through.

This is done in a compact and simple manner in the cell represented in fig. 1 (Pl. I.). A wide-mouthed bottle (or a tall jar) is fitted with a cork through which passes a wide glass tube open at both ends. To the lower end of this tube a short closed tube (like a test-tube) is tied with silk thread; a long strip of sheet zinc is put down the open tube; and a copper wire, recurved at the bottom and coated with sealing-wax except at its two ends, is passed through the cork to the bottom of the closed tube, where it is imbedded in a few crystals of copper sulphate. The bottle is then nearly filled with dilute sulphate of zinc, and the cork with the tube is inserted, the latter being so arranged that the end of the zinc strip and the mouth of the short tube are both below the surface of the liquid. In a short time a strong solution of sulphate of copper forms at the bottom of the closed tube where the copper wire is bare, and it gradually diffuses upward; but in order to reach the zinc it has to diffuse itself all through the water of the bottle and then up the long tube containing the zinc; and this takes a long time, though it certainly does take place to some extent in a week or so.

But when I want to put the cell by for any length of time, I pull the long tube a little higher up through the cork, so that the mouth of the short tube emerges above the liquid and thus entirely prevents diffusion. The zinc strip is also raised out of the liquid by the same action. It is convenient to have the cork fitting pretty air-tight; or else evaporation may go on from the edges of the tube, and the salts which crystallize there may continue the diffusion slowly.

The copper wire need not be covered with wax or any thing; but if it were not, its upper parts would assist in the action until they were polarized; and hence the internal resistance would be liable to vary, which is not desirable. The internal resistance of such a cell is always rather high: for instance, in the one of which fig. 1 is a portrait, the bottle stands about 6 inches high, and the internal resistance is about 500 ohms