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A Convenient Voltaic Cell

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A CONVENIENT VOLTAIC CELL.

BY L. BEGEMAN.

I wish to discuss briefly a convenient form of the Lalande class of voltaic cells for which the government has recently allowed me a patent. While the cell possesses nothing startling in its newness, it yet has those advantages which make it better, I think, than any other for the purpose for which it was devised.

The old Lalande–Chaperon primary cell consisted of a steel jar with a sealed top from which was suspended a coiled rod of zinc. The electrolyte was either caustic soda or potash, and the depolarizer was copper oxide, a thick layer of which was placed in a copper pan resting on the bottom of the container. The cell was remarkable for its great capacity, but defective in that the depolarizer was not in firm contact with the positive electrode which resulted in a comparatively high internal resistance and a sluggish depolarization.

The well known Edison primary is a modified Lalande in which this defect is overcome by compressing the copper oxide into firm plates that serve both as depolarizer and positive electrode.

The Gordon is another familiar form of this class of cells. While it is true that the Edison and Gordon primaries are probably the best cells on the market for all purposes, yet their great cost almost prohibits them for general student use in the physical laboratory. Many experiments devised for students in secondary work demand a cell that delivers a constant current. The only primary cells that are capable of delivering a constant current for a period of time are those of the Lalande or Daniell class.

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The Daniell cell, owing to its simple construction and low cost, is generally used for student purposes. All teachers of physics will agree with me, however, that the Daniell cell in the student's hands is the source of many exasperating accidents. The cell as usually mounted with porous jar practically destroys itself when accidently left on open circuit for a period of time. To prevent this the cell must be dismounted and again be reassembled at each new use. The zincs must be repeatedly amalgamated. The electrolytes in this process of dismounting and reassembling are spilled upon the laboratory tables. The glass jars are frequently broken producing chaos indescribable.

In order to avoid the great cost of the Lalande type of cells and also the exasperating incidents arising from the use of the Daniell, I undertook some two years ago to devise a cell cheap in cost and efficient in action. The result is the following cell sketched below and constructed as follows:

The cell belongs to the Lalande class. It consists of a sheet steel container with double lapped seams. The seams are sealed by boiling into them a cement whose principal ingredients are old rubber and paraffine. This cement serves as a solder and prevents any leakage of the cell. The sides of the cell are either corrugated or plain and the interior is lined with a coil of netted elastic steel like

Fig. 1

ordinary window screen. Into the corrugations and the netted lining is firmly pressed the powdered copper oxide. To prevent the copper oxide from falling out its surface is lined with a piece of heavy muslin kept in its place by a piece of elastic steel netting. The bottom of the cell is finally covered with a thick layer of cement which prevents the copper oxide from leaking out from under the bottom of the lining. The sheet steel container with its netted linings and copper oxide constitute the positive pole electrode. The electrolyte is a thirty to forty
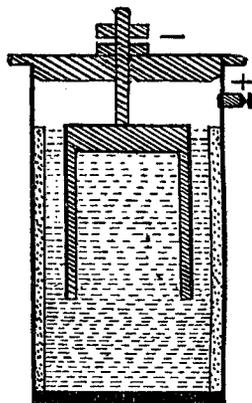
per cent solution of caustic soda or potash. Into the caustic soda is immersed the usual zinc electrode, suspended from the cover of the container.

The following comparative tests were made with the Edison, Gordon and the above described tin can cell.

The cells were placed successively in a closed circuit for a period of twenty-four hours. The external resistance of the circuit was .8 ohm. At stated intervals the internal resistance and E. M. F. of each cell were determined. The condenser method described on page 100, paragraph 55 of Carhart and Patterson Electrical Measurements was employed in these determinations. The apparatus used was a Rowland D'Arsonval galvanometer, a one-half microfarad condenser, a charge and discharge key, a resistance box and a standard Carhart-Clark cell. A diagram showing the connections of the apparatus will be found in Carhart and Patterson's work.

The E. M. F. of the Edison cell on closed circuit was .76 volts at the beginning. At the end of ten hours it reached .67 volts which it maintained during the entire run. It showed an initial internal resistance of .15 ohm which was reduced to its rated resistance of .05 ohm at the end of six hours at which it remained. The cell delivered a perfectly constant current of .8 ampere during the entire time. There were no observable changes in its E. M. F., resistance or current during the second twenty-four hours of its flow.

The E. M. F. of the Gordon cell sank at once to .7 volt at the beginning of the run and gradually lowered to .67 in three or four hours which it finally maintained. Its internal resistance at the beginning was .25 ohm which was gradually reduced to .08 ohm where it remained. The current was practically constant after the first four hours with a strength of .77 ampere.

The sheet steel cell started with an initial E. M. F. of .88 volts. It reached .76 volt at the end of four hours where it remained during the time of the test. Its initial internal resistance was .1 ohm which was reduced in a few hours to .05 ohm. After the first four hours the current reached .9

ampere and remained perfectly constant during the remaining time. This cell was allowed to run for three days longer. Its E. M. F. lowered slightly but was still .67 volt at the end of a four days' run. The cell delivered during that time about 80 ampere hours of electricity. At the end of four days its internal resistance was .04 ohm.

All three cells gave a voltage of .95 on open circuit before being used. All of them recovered to .8 volt inside of fifteen seconds when the circuit was broken after a twenty-four hour run. The Edison showed a higher efficiency than the Gordon. This, I think, is due to the fact that the copper oxide in the Gordon is rather loosely packed preventing as high a conductivity as the closely compressed plates of the Edison. The Edison was 150 ampere hour cell of the Q type and weighed seven and one-half pounds. The Gordon was the commercial 300 ampere hour cell and weighed fifteen pounds. The sheet steel cell was about the size of a pint measure and weighed about two and one-half pounds. Enough copper oxide was compressed into its netting to give it a capacity of 160 ampere hours for two discharges using the same zinc and but one renewal of the electrolyte.

The advantage of such a light sheet steel cell of high capacity is evident. It can be produced at less price than the Daniell. The container can not be broken. The lid can be sealed so as to prevent any spilling of the electrolyte. The cell is always ready for use. Local action in the cell is very small when the chemicals are comparatively pure. When working on low external resistance the wattage is always higher than that of a Daniell operating under similar conditions.

A very convenient thing about the cell, however, is its reversibility. When the capacity of the cell is exhausted as a primary, an amalgamated brass gauze electrode is substituted for storage purposes. When storing, the zinc is deposited on the amalgamated gauze and the reduced copper is converted into an oxide.

It is true that the two principal defects of the alkaline copper cell are first, that the zinc can not be deposited in

a firm coherent mass; and second, that the oxide of copper produced electrolytically slowly dissolves. I find, however, from experience, that these defects do not preclude the use of this class of storage cell for student laboratory work. In fact, I think they are much better than small lead cells. When the cell is not too highly charged, the zinc adheres quite firmly to an amalgamated brass electrode. Furthermore, when the sub-oxide of copper dissolves, it is probably at once reduced by the dense mesh of elastic steel netting which lines the can and which thus prevents it from affecting the deposited zinc. The result of the breaking down of the oxide, however, is to render the voltage unstable. A cell inactive for a period of time polarizes easily and its discharge efficiency is considerably impaired. Despite this, I find that a small-sized cell of this kind will give a better account of itself in continuous laboratory service than any lead cell of twice its weight.