

Thesis

Efficiency of Storage Batteries

for the degree of

B. S.

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Efficiency of Storage Batteries.

In order to conduct a series of tests, similar to those of Messers Waterman and Hazleton of last year, we constructed six cells.

In general construction we followed the E.P.S type, but the details of construction and insulation were our own designs.

The plates were cast in cast iron moulds planed to the proper form. Some little difficulty was experienced in casting at first, but by heating the moulds to near the melting point of lead, and at the same time keeping the lead at a red heat the work was done quite satisfactorily. The moulds were held together by iron clamps which were secure against

leakage unless the moulds were heated too high.

The positive plates were pasted with red lead (Pb_3O_4) mixed to a paste with dilute sulphuric acid with a specific gravity of 1.1 and allowed to dry before setting up the cell. The negative plates were treated with a paste of litharge (PbO) and sulphuric acid of a specific gravity of 1.2 and allowed to dry as the positives.

The cells when completed consisted of four positive plates and five negatives insulated by hard rubber strips $\frac{1}{4}$ " thick. The plates were held firmly together by $\frac{3}{8}$ " hard rubber rods, one on each side, through holes cast in the plates. These rods also passed through the rubber strips which were of sufficient length

to raise the cell $\frac{5}{8}$ " from the bottom of the jar. The ends of the rods were threaded and fitted with nuts of the same material.

To prevent the cell from canting, $\frac{3}{16}$ " hard rubber rods were passed through the lower corners extending through the strips.

The like plates were connected at the upper part of the lugs by $\frac{3}{4}$ " lead washers and all held firmly together by a $\frac{1}{4}$ " brass rod with nuts on the ends. By screwing these tightly a good contact from plate to plate was formed. While at the same time if one cell offered a high resistance the current could pass through the brass rods. To prevent the acid spray from affecting the joints, the washers, nuts and lugs were coated with asbestos paint.

On setting up the cells the electrolyte of dilute sulphuric acid had a specific gravity of 1.15 which fell to almost 1.00 during formation. Concentrated H_2SO_4 was added from time to time till the cells were charged when the liquid showed a specific gravity of 1.175.

The formation included about 24 hours with a current of 11 amperes and a voltage of 15. During the first three or four hours of the charge a few of the negative plates flaked considerably but none of the plugs dropped down. The positive plates exhibited no such tendency.

The cells were charged in series from a Weston six light shunt wound machine. The ammeter used was a Weston direct

reading one placed in the circuit near the battery. An Ayrton and Perry voltmeter was connected across the terminals.

The discharge was through a variable resistance box and the current was kept as near constant as the adjustment would permit. Discharge was carried on till the voltage dropped to ten volts for the six cells or 1.7 volts per cell.

In experiments (3) and (4) the charging current was gradually reduced from 15 to 7 amperes. In all cases charging was continued until "boiling" commenced.

— Chemistry. —

Until recently comparatively little has been known of the chemical action of

secondary batteries. Much light however, has been thrown on the subject by Prof. H. C. Ayrton and his associates during the year 1890.

A portion of the active material was removed from the plates at different stages of charge and discharge, and a careful quantitative analysis made. The tests show that nothing but lead peroxide and lead sulphate are to be found in the active material of the positive plates during either charge or discharge.

At the beginning of a charge the lead peroxide formed about 40% which on complete charging was raised to about 95%. The tests of the negative plates were only qualitative but they indicate without question

that lead sulphate and lead were the only constituents if a slight indication at one or two stages of lead peroxide may be excepted.

The experiments show very conclusively that the following are the chemical reactions.

Charge.

Positive plate.



Negative plate.



Discharge

Positive plate.



Negative plate.

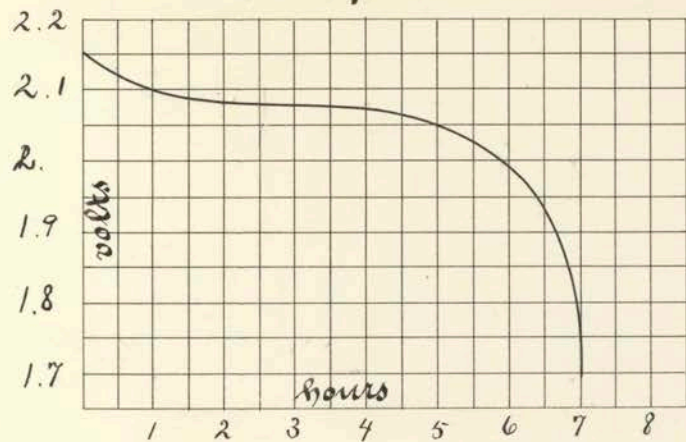


Group of six Cells

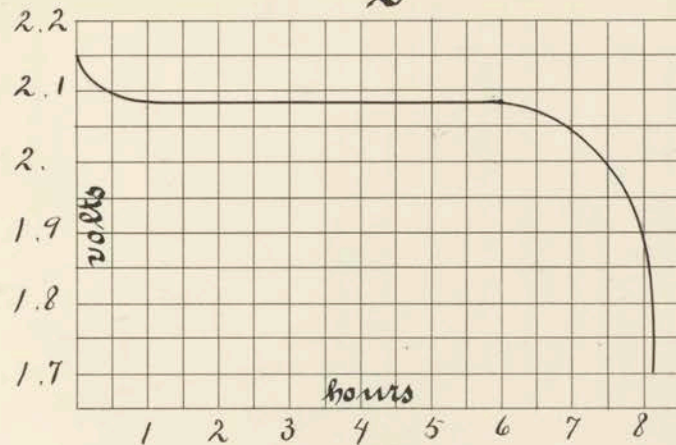
	Charge		Discharge		Efficiency	
	Ampere hours	Watt hrs per cell	Ampere hours	Watt hrs per cell	Quantity	Energy
1	264.0	580.8	73.5	147.0	28 %	25 %
2	152.0	334.4	86.4	172.8	56 "	52 "
3	119.5	262.9	81.4	162.8	68 "	62 "
4	106.5	234.3	78.7	157.4	74 "	67 "

Discharge with 10½ Amperes

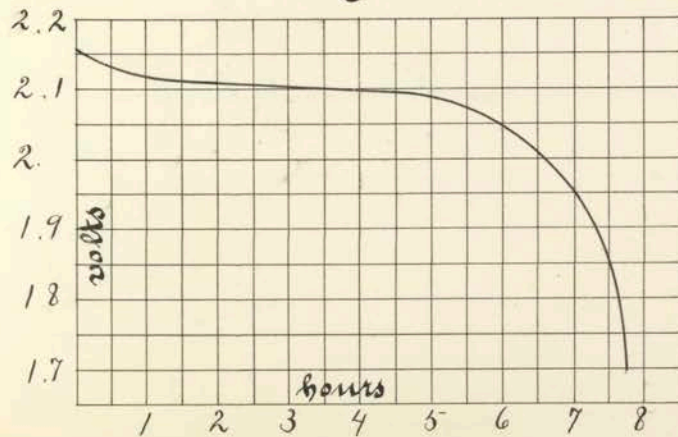
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2



3



4

