

ed to a pair of electrodes, in the solution formerly described as being generally recommended. Each electrode had five square inches of face, and was coated on the back to prevent radiation. They were placed one inch apart, and had thin plates of wood bound against their edges to prevent any lateral spread of the current in passing between them. The following was then obtained:

Battery plates in contact gave 300 cubic inches gas per hour.					
Electrodes in contact	do.	216	do.	do.	do.
Current through electrolyte, at 58°, gave 16 cubic in. gas per h. 23.15					
do.	do.	63°	do.	27	do.
do.	do.	100°	do.	27	do.
do.	do.	175°	do.	37	do.
					8.96

The last column of figures shows the value of the resistance of the solution, as compared with B of the formula. This column was obtained by first uniting the battery plates, and afterwards the electrodes.

From the above table it appears that heat may be made to diminish the resistance in the decomposition cell in the proportion of 2.58 to 1; and the whole resistance by 2.25. And as  $\frac{2E}{R+r}$

$\frac{E}{R+r}$ ; therefore, by heating the electrolyte, we may with a single electrical equivalent make a plate as rapidly as by working at atmospheric temperatures with two batteries in consecutive order, with double surfaces, (four times the battery and twice the expense.)

But as Smee's laws require that, in forming a plate, certain mutual conditions of apparatus be maintained, it follows that alterations in one element or condition must be attended by corresponding changes in the others. Hence, if the temperature of the electrolyte be raised to a certain point, and the apparatus correspondingly adjusted, it is evident that, to avoid inessential adjustment, the original temperature must be maintained.

Thus, to avail ourselves of the advantages experimentally found from heating the solutions, an apparatus for steadily maintaining a high temperature in the electrolyte through several successive days becomes indispensable.

As the electrolyte operations are not suspended at night, it is important that the heating apparatus should perform its office for at least twelve hours without supervision or replenishing its fuel; and its action should be sensibly uniform, during all the time, between successive replenishings.

Such an apparatus I have devised, and is now in use. A peck of charcoal furnishes fuel for twelve hours, and maintains 100 gallons of copper solutions steadily, at any required point between 100° and 200°.

With the above arrangement in use, I have made a large reverse or alto, and returned the original to the engraving department in 55 hours from its being placed in my hands. This time included trimming the edges and the preparations to prevent adhesion.

Again recurring to Ohm's formula, the relative value of R to r was once more experimentally found. This gave  $R:r::1:4$  or  $Q=\frac{1}{1+\frac{1}{4}}=0.20$ , a great improvement as compared with the first determination of  $R:r::1:19$ , or  $Q=\frac{1}{1+\frac{1}{19}}=0.05$ . Having now made r so small compared with R, the size of the battery can be profitably increased until the result is about 0.24. Moreover, using a double arrangement of cells with the double surfaces, for a double effect, we now have  $2\left(\frac{1}{1+\frac{1}{4}}\right)=\frac{2}{2+\frac{1}{4}}=0.40$ .

As the relative resistance of the electrolyte becomes now still

smaller, we may yet more increase the battery surface, until the result is nearly 0.5.

The electrolyte has now ceased to be a mere experiment, uncertain, expensive, and slow. I have lately formed plates of most excellent quality, at the rate of three pounds to the square foot, in 24 hours. This rate will require but two days to form one of our largest plates, having ten square feet surface, and one-eighth of an inch thick.

*Actions in the electrolytic solution.*—The quality of the deposited metal is governed solely by the relations between the quantity of the electricity passing through any solution and the amount of metal the solution contains. The usual supposition is, that the acid of the salt goes to one electrode and the metal to the other, but it is now ascertained that no such mutual transfer takes place; for, while the acid is carried to the positive electrode, the metal is *not* carried to the negative electrode. Hence, however strong the solution on commencing the process, the negative electrode, by abstracting the metal in its vicinity, is soon surrounded with a weak solution. With a simple wire electrode, the exhausted solution surrounding the electrode is readily renewed by mere difference of specific gravity producing a flow. But, with large parallel plate electrodes, this rapid renewal of dense solution becomes impossible, and the electrode is soon surrounded with a weak solution. This state of things must be recognized in adjusting our battery arrangements. Electrotypists not aware of this fact find themselves much perplexed by failing to accomplish with large plates what is so easily done with medals or small plates.

It would, at first sight, appear that, by strengthening the solution of sulphate of copper, a more rapid supply of metal to the electrode would be obtained. Unfortunately, the effect of this is to diminish the solvent capacity of the water in the solution for the sulphate formed on the positive electrode by the action of the transferred acid. The grand essential in electrolysis is liquidity. Thus, if the quantity of free water surrounding the positive electrode be small, this electrode is soon enveloped in a saturated solution, and the newly-formed salt remains undissolved upon it. This salt, being a non-conductor, virtually excludes the electrode from the solution, and thus arrests the current, except when the efflux of saturated solution permits the salt to dissolve, and so reopens the passage for the current in irregular quantities. From this spasmodic action result plates of copper-sand, or sometimes copper as soft as lead.

By applying heat to the solution when this state of things exists, the solvent capacity of the water for the salt is increased, rapid diffusion takes place, the salt is carried to the negative electrode, and the exhausted water to the positive electrode; the dormant batteries rush into uninterrupted action, and in a short time a plate is deposited, having all the hardness and elasticity of hammered or rolled copper. Smee's conditions, then, seem to maintain themselves. The electrotypist's axiom of "work slowly," requires to be reversed into "the quicker the work, the better the quality."

#### Notice of the "Mastodon Giganteus" of Dr. J. C. Warren.\*

We have already briefly announced the publication of the magnificent volume on the "Mastodon Giganteus," by the eminent surgeon and scholar, Dr. Warren. Turning aside from the profession which he has honored by his profound knowledge and successful labors, he here enters the arena of Science, and substantiates his claims to a distinguished place among the Zoologists of the age.

\*Description of a Skeleton of the Mastodon Giganteus of North America, by John C. Warren, M.D., &c. 219 pp 4to, with a frontispiece and 27 plates in 4to. Boston: 1852. J. Wilson & Son, 22 School Street.—*Sill Jour.*