For the Scientific American.

The Voltaic Battery.---Chemical Equivalents.

NUMBER IV.

We will now take a cursory view of the doctrine of chemical equivalents, after which we may form a true estimate of the cost of keeping any battery in action for doing a given amount of work. We have already stated that oxygen combines with zinc to form oxide of zinc, and that this oxide combines with sulphuric acid to form a sulphate of zinc; and likewise with copper—first, we have oxide of copper, and this, combining with sulphuric acid, forms sulphate of copper; and we have also spoken of water being oxygen in combination with hydrogen. Any person might suggest that there is just so much oxygen to so much zinc; and so also of the sulphate of copper, and likewise of the water—just so much oxygen to so much hydrogen. What is very wonderful, and which no person ever could have suggested, is, that the quota of any one element is the same in every compound in which it enters, or else it is two, three, or more times that quota. This has led chemists to conclude that the elements consist of minute particles, each of which has the same definite weight, and that when a chemical combination takes place between any two or more elements, the union is that of one particle of one element to a particle of another element, or else to two, three or more particles. It can now be perceived why chemical compounds are so precise in the proportions, for it is impossible for one particle to be in union with one and a quarter, or any other fraction of a particle, but the union must be always that of whole numbers. This also explains how it is that so many chemicals can be formed out of two or three elements.

These particles are called atoms, and chemists, by observing the relative weight of the components of chemicals, have constructed tables of the relative atomic weight of the elements, and from these tables we may calculate the proportions required to make any compound. By analyzing water we obtain 8 parts of oxygen, and 1 part of hydrogen this hydrogen is the least quota that chemists have yet observed, and they therefore conclude that its atom is the lightest of all the atoms, and take it as the unit of the scale of equivalents. It is moreover supposed that two or more elementary atoms, when in union, may behave precisely as though they were but one atom, and so unite with other atoms, and the compound atom will have the combined weight of its component atoms. This we will illustrate:—One atom of hydrogen, =1, combines with an atom of oxygen, =8, and forms an atom of water =9; and again, one atom of copper =32, atom of oxygen =8, atom sulphuric acid =40, and 5 atoms of water =45, all combine, and form an atom of sulphate of copper =125. It can now be comprehended what is meant by saying that 1 pound of hydrogen is equal to 33 pounds of zinc, or 40 pounds of acid, or 125 pounds of sulphate of copper. Let us apply this to calculate what quantity of material will be required, and also the cost for making 1 pound of gas from zinc and sulphuric acid. In the first place we have water composed of 1 part of hydrogen to 8 parts oxygen, and consequently 1 pound of hydrogen to 8 pounds of oxygen. We want to liberate the hydrogen, which we must do by absorbing the oxygen; the 8 pounds of oxygen will combine with 33 pounds of zinc, and this with 40 pounds of real acid: we now have the quantity of material, and have only to multiply by the cost per pound, and we see that 1 pound of gas made in this way costs $3,78.

It can be seen of what great importance tables of chemical equivalents are; and the person who would use the battery to profit should have them in command like the fingers of the right hand.

Below is a table of equivalents of some elements and compounds used in electrotyping:

Ammonia	17
Chlorine	36
Copper	32
Gold,	199
Oxygen,	8
Nitrogen	14
Platinum	98
Chloride, platinum,	170
Chloride, gold,	307
Sulphuric acid (real)	40
Sulphuric acid (commercial)	67
Cyanide, silver	134
Zinc	33
Iron	28
Silver	108
Hydrogen	1
Sulphur	16
Carbon	6
Muriatic acid (real)	37
Muriatic acid (commercial)	127
Nitric acid (real)	54
Nitric acid (commercial)	99
Sulphate, copper, (cryst.)	125
Cyanide, gold,	278

When we come to treat of the application of the battery we shall have frequent use for this table. For want of a knowledge of these tables the most woful experiments are sometimes made. By merely glancing at the table, the reader may perceive the value of schemes for making gas by the battery, using Drummond lights for illumination, and also of water gas, produced by red hot chains, jets of steam on ignited coals, &c., &c.

In a previous number we stated that *quantity* was the voltaic action considered simply as more or less, and that *intensity* was the capacity of the battery to induce its effect on other bodies. We will now take another view and consider quantity as the number of atoms of any one element affected by the battery action. We will now consider intensity simply as the intensity with which the two bodies of the battery decompose the compound fluid. We stated before, that by connecting a number of batteries together the intensity was increased, while the quantity was the same; the cause of this will be apparent when we consider that one battery communicates its chemical energy to the next—and in this the energy of both are united on the same atoms which would have been effected by only one instrument—and so of any number of batteries in a series. In Smee's instrument, of the two bodies which eliminate the elements of the compound fluid, there is only one—the zinc—which can exert any chemical action on the fluid, and consequently the silver plate must get its power to eliminate the hydrogen from the chemical action of the zinc and oxygen; but in Daniell's instrument there is a chemical action between the sulphate of copper and the hydrogen: here are two chemical actions going on, just as if we had two Smee's apparatus joined together—thus we see that a Daniell's battery is two batteries in disguise. In Grove's battery there is a vigorous action between the nitric action and hydrogen—and we are let into the secret of a Daniell's battery having twice the intensity of a Smee's, and a Grove's three times the intensity. We may now form a true estimate of the cost of the voltaic power, as obtained from the three instruments. In the first place the same quantity will be obtained from each one by the solution of a like quantity of zinc; let this be 33 ounces, then we must have the equivalent of sulphuric acid, 67 ounces; but it is obvious that every particle of the acid cannot be used up in practice. After using up a good many thousand pounds, I find that 33 ounces of zinc require 90 ounces of good commercial acid for profitable work. The zinc must be amalgamated, and this will cost in the end 2 cents per pound. Taking the cost of amalgamated zinc castings at 10 cents, and acid at $3\frac{1}{2}$ cents, we have $(33\times10)+(90\times3\frac{1}{2})=645\div16=40$cts, which electricians say will be the cost of an equivalent of quantity in Smee's battery. In the apparatus of Daniell, in addition to the 40 cents, there will be the cost of an equivalent of sulphate of copper, this, at 9 cents, will be $125+9\div16=70$ cents, making in all 110 cents; but here we obtain 32 ounces of copper from the salt—this, at 1 cent per ounce, will give 32 cents to be taken from the 112; but if we take in view the extra cost for porous diaphrams, remains of solution of sulphate of copper, ultimate loss of the copper cup and the increased local action, the 32 cents will be taken up, and we shall have 110 cents for the cost of an equivalent of quantity in Daniell's battery. In Grove's battery the hydrogen converts the nitric acid into hypo-nitric and nitric acid, which serve as well as the nitric acid for eliminating the hydrogen—consequently only one-third of an equivalent of nitric acid will be required; taking the cost at 12 cents, we have $99\times12\div3=396\div16=25$ cents. But here, again, all the acid cannot be used up; the local action is also very great compared with Smee's: practically I am not able to say what is the amount of these losses, but I am sure that 20 cents will not be far out of the way, which will give 85 cents for the cost of an equivalent of quantity in Grove's battery.

We will sum this up in a tabular form—thus, for an equivalent of quantity in

Smee's	40 cents.
Daniell's,	110 "
Grove's,	85 "

But we said that the power of a battery was its intensity multiplied by the quantity, and that the intensity of Daniell's was twice that of Smee's, and of Grove's three times that of Smee's, therefore an equivalent of power will cost, in Smee's

Smee's	40 cents.
Daniell's,	55 "
Grove's,	28 "

As the superior intensity of Grove's battery will send its influence through a wire three times as long as what a Smee's can penetrate, it is perceived that for telegraphing, and the working of magnetic engines, a Grove's battery is the cheapest; but for electrotyping, where quantity is what is wanted, Smee's battery is always to be preferred. VOLTA.

New Rotary Engine.

MESSRS. EDITORS—As I have been for several years a constant reader of your valuable journal, I have of course received from a perusal of its columns much valuable information, and, I must also say, that I have formed strong prejudices in favor of or against machines of various kinds, prominent among those for and against which I had formed a very poor opinion, was the Rotary Engine, and from a careful examination of the various kinds which you laid before your readers, I had become a perfect skeptic, in all things relating to a rotary steam engine, which would ever be of real value, (by real value I mean an engine which with the same chance and with the same cost would earn as much or more money) and had placed rotary engines in the same class with perpetual motions and what I looked upon as grand humbugs.

Since December, 1849, I have had good reason to change my views and opinions in regard to the invention of rotary engines entirely. At that time, my attention was called in the course of my mechanical duty, to an engine, the invention of Mr. James A. Stewart, of Tennessee. So little faith had I in the good qualities of this engine, as set forth to me by persons who had seen the engines in operation, that to fully satisfy myself in regard to the matter, I made a trip from this city to Nashville, expressly to see and examine into the merits of said engine. In order to give it a thorough investigation I went to Tyrees Spring, Robertson County, Tennessee, where I found the first engine which was put into practical use, and which had then been in operation three years.

The engine consists simply in having two cog wheels running into each other and so brought into contact with the caps and end plates as to render them, without any packing whatever, steam and air tight. The machine is made entirely of cast iron, no other metal of any kind or description being used except for the pillow blocks, which are lined with Babbitt metal in the usual manner. The Tyrees Spring engine has steam wheels 10 inches diameter, from pitch circle, and 10 inches face, and has 10 cogs to each wheel, and the position which they occupy to the caps is such that they have 20 square inches effective surface. The boiler is a cylinder 20 feet long 32 in. dia., carries steam at a pressure of 65 lbs. per inch, and with what fuel the mill makes, (dust and slabs) cuts an average of 3,000 feet of oak lumber per day of 12 hours. This much for the Tyrees Springs mill, and I may say the same of the other mills which I visited while in Tennessee.

I will now give you my own experience with the Stewart Engine, one of which I put into the Carondelet mill to drive a single sash saw: the engine is the same size as the Tyree, the boiler is 22 feet long, 36 inches diameter, two 11 inch flues, pressure of steam 60 lbs. per inch, and with the saw dust and a half cord of green slabs, we saw 5,000 feet of inch square edge lumber per day of 12 hours. This engine has been in operation for three months, and had it not been necessary to have cleaned out our boiler or to have given due regard to the Sabbath, we might have run our engine every minute of the time. Not the least wear can be discovered except upon the Babbitt metal, and the arrangement for moving and adjusting the pillow blocks is such, that it is done while the engine is in operation. Since the Carondelet engine went into operation I should say that at least 5,000 persons have witnessed its performance, and I have heard but one person find fault with it, and at least one half of the visitors were practical millers, machinists, and engineers.

The great secret of this engine was to invent a pair of cog wheels which would work together steam tight. Mr. Stewart commenced his experiments at Hoe & Co.'s shops in New York, but did not succeed in getting the proper form of cog wheels. Mr. Hoe was so well pleased with the principle of the machine that he gave Mr. Stewart a certificate to the effect that if he succeeded in getting his wheels to work steam tight it would prove the most valuable engine in use.

After five years of hard work, hard thinking, and hard dollars, spent in making and throwing away wheels, the last finishing touch was given it, and everything went like a top, and now the thing is so simple it is the wonder of all who see it, that some Yankee didn't think of it years ago.

Columbus made the egg stand upon its end. Stewart makes a pair of cog wheels which will run steam tight without any packing or valves, and as a machinist and engineer, I challenge the whole mechanical and inventive talent of the world to bring forth an engine which will do the same amount of labor and earn the same amount of *almighty dollars* with, and at the same cost, every thing taken into consideration.

I have not, Messrs. Editors, the least idea of making you or any other person a convert to rotary engines merely upon my say-so, but if you could visit our mills and see with your own eyes the rotary in operation, with its single boiler, and then take a look at a piston engine along side, with its cylinder of four feet stroke and 13 inches diameter, together with its heavy shafts, ponderous ballance wheels, &c., two boilers to supply the steam, and doing less work, I rather think you would let us have your hat. Arrangements have been made for their manufacture at this place, and as soon as the proprietors get their engraving up explanatory of the machine, I will forward you a copy, from which you can get an idea of its merits. Our engine is held in its place by four wood screws three inches long, by ⅝ diameter, the largest shaft about it is three inches diameter, and of cast iron, and although we have driven our saw into oak logs with sufficient force to twist off a heavy saw pitman crank, yet the engine has not moved from its position one iota, although it is screwed into pine timber.

I shall do all that I can to have an engine sent to your place so as to give you unbelieving Gothamites a chance to become converted before you are called away to kingdom come.

Until you hear from me again I remain your's, F. R. DELANO,
Sup't Carondelet Mills.

St. Louis, Mo., Oct., 1850.

[We have seen so many rotary engines which, for a while, promised success, but at last faded away before the cylinder one, that we confess to a great amount of skepticism on the subject, that is, respecting their economic value—the amount of labor performed to the steam used. It is now about three years since the Rev Enoch Burt, of Manchester, Ct., a well known inventor and improver of the Gingham Power Loom, suggested to us an engine like that described by Mr. Delano. Our views were not favorable, but contrary to those of Mr. Burt.