

more than the original chemical action and thus produce perpetual motion. But this rule does not prove a correct deduction in this case any more than in the case of that of nitro glycerine, where the force produced is so much greater than that exhausted in its production. And thus in evaporating the small quantity of water into steam and the small percentage of heat required in the tuyeres of the cupola to decompose the steam into its elements, hydrogen and oxygen, we have obtained heat 4.28 times greater than that of carbon, and therefore the heat so utilized in production is far more than compensated by the hydrogen. I am quite willing to admit that a man cannot lift himself up by his boot straps and that motion cannot be conceived on general principles without parallax change of position, for we must admit that the evolution of one force or mode of force into another has induced many to regard all the different natural agencies as reducible to unity, and as resulting from one force which is the efficient cause of all others; and one theory tries to prove that electricity is the cause of every change in matter, while another theory says chemical action is the supreme cause, and still another that heat alone is the universal order, and so on. But these questions we will, for the present leave to the philosophical mind to discuss and theorize upon and return to the point and state only what we know to be true, believing it to be so, because we have proved it.

Reference has already been made to the many difficulties in accepting in its entirety the atomic law of fixed and definite proportions, and the application to iron, and while the law does not hold good in this respect it does in many respects. In the average cupola it takes from twenty-eight to thirty thousand square feet of air to melt a ton of iron, four-fifths of which is nitrogen and one-fifth oxygen, and both these elements when in the nascent state do obey the law of combination, for if we endeavor to burn 30 parts of carbon in 60 parts of oxygen the elements will assert themselves of their own accord and refuse to unite in these proportions, and the 30 of carbon will only take up with 40 of oxygen and form 70 of carbon monoxide, and this gas, had it the opportunity, would combine with 40 more of oxygen and form 70 of carbon dioxide, but finding only half that amount, 20 of oxygen contents itself by one-half, that is 35 of carbon monoxide. And again if 30 parts of carbon (coke) be burnt in more than, say 85 of oxygen, only 80 will be used, the other 5 remaining as oxygen merely mixed with the resulting dioxide. Or if an attempt to burn say 30 of carbon in less than 40 of oxygen, the oxygen will take up three-fourths its weight of carbon and form carbon monoxide and the excess of carbon will remain as carbon. Thus we see how important it is from a scientific standpoint to use the