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Contents:

(Illustrated articles are marked with an asterisk.)

CAVEATS.

Whenever an inventor is engaged in working out a new improvement, and is fearful that some other party may get ahead of him in applying for a patent, it is desirable, under such circumstances, to file a caveat, which is good for one year, and during that time will operate to prevent the issue of a patent to other parties. The nature of a caveat is fully explained in our pamphlet, which we mail free of charge.

EUROPEAN PATENTS.

More than three-fourths of all the patents taken by American citizens in Europe have been secured through the Scientific American Patent Agency. Inventors should be careful to put their cases in the hands of responsible agents, as in England for example, the first introducer can take the patent and the rightful inventor has no remedy. We have recently issued a new edition of our Synopsis of European Patent Laws.

COMPARISON AND RELATION THE ONLY CRITERION OF SIZE.

The "mechanical eye," so valuable in mechanical operations, is educated wholly by the comparison of one object with another; it has no absolute virtue, or power of determining the real dimensions of any object. If it were so there would be small necessity for accurate rules and gages, by which the eye determines any dimensions. Let the most experienced mechanic be shown a piece of say three-quarters inch iron, in connection with other pieces of iron of one inch, and one and a quarter, and of three quarters and less, and he may find no difficulty in determining by his eye the diameter of either one of these pieces, it being considered, of course, that the diameter of some one or more of these pieces are known. Yet let this piece of three-quarters inch iron be shown in connection with bars of from two inches diameter to six inches, and it would puzzle the most educated eye to determine whether the three-quarter inch iron was of that size or whether it was seven-eighths or eleven-sixteenths of an inch in diameter. The reason is that the eye is insensibly misled or diverted from the object to be viewed, or rather is so occupied by the surroundings that an accurate estimate is impossible.

So distance, as all know, interferes with the exact action of the educated eye. No two mechanics, however skillful, will agree, for instance, on the exact size of a cross on a church steeple. Why? because there is no object near by which the relative hight or size of the cross may be gaged.

Yet even when there are means of comparing relative dimensions, it is sometimes difficult to determine size and position. In no case is this seen more plainly than in the work of the proof-reader who wishes to know if a letter is turned. Take the letters S, s, X, Z, and the figures 3 and 8. To the ordinary sight, the lower and upper half of these are identical in form and size; but let the reader reverse them—turn the page upside down—and he will see at once that there is a difference, so great that even the careless reader will be aware of it, although perhaps not able to decide where the discrepancy exists or to point out the remedy. The proof-reader, however, has educated his eye to such a nicety in ascertaining and comparing forms in the relations of contiguous objects that what would escape the notice of others arrests his attention, and he sees at once the trouble without the necessity of reversing the page for the purpose.

There is no fallacy so fallacious, no saying less an axiom, than that one may depend upon the evidence of his senses, especially the one of vision. To use this correctly the eye must be educated, and not only educated, but confined to the observation of a certain set of objects to acquire the skill which is the offspring of discrimination. The astronomer is not a chemist, who can detect the presence of the minutest portion of a foreign element in the substance he examines by the microscope. The sea-going man, used to peering through long distances, would be as much out of his sphere in the watchmaker's shop as a girl would be with the cares of a country on her brain. His eyes are as uneducated to the microscopic niceties of the watchmaker's art, as is the woman's brain to the responsibilities of government.

SELF-EDUCATION.

All men of distinction are self-educated men in one sense. The early possession of what are commonly termed educational "advantages," is of little value unless those who enjoy them have in themselves the elements without which such advantages are worthless. Given these elements and the "advantages" are not indispensable, although valuable. Circumstances have much to do in developing taste for study, which is the common characteristic of all thoroughly educated men. Many a young man who now looks upon the study of books as a dry and irksome task, would, if his attention were fixed upon some subject adapted to his tastes and moderate acquirements, entirely change his views. Without underrating the value of proper instruction, the fact that so many men have been able to achieve scientific eminence without it, is sufficient encouragement to such as are perforce deprived of it. To such, and there are not a few among the youth of this country, we offer a few suggestions as to the best course for self-training.

In higher institutions of learning it is usual to say one *reads* Latin or Greek, or mathematics or mechanics, rather than he studies this or the other subject. The word read is here a synonym for study. That is right; to read properly is to study in its highest sense. It is a much more difficult thing to read than most people think. For the most part that which is called reading is mere skimming. It occupies an idle hour by placing a variety of images before the mind in rapid succession, like a kaleidoscope, but like the images of that amusing toy, each is forgotten as a new one is presented; and after all is done nothing remains but a dim recollection of a jumble of colors. Nothing definite, nothing valuable is retained. But, says one, I read for amusement, and so long as I get that, I wish nothing more. To him we reply that our suggestions are not to him, at least until his tastes are radically changed. Only this much we will say to him; he greatly mistakes if he supposes that even the highest degree of amusement is to be obtained in such reading.

We affirm that when a youth has acquired the power to *read his own language* in the full meaning of the term, he is nine-tenths educated. We care not if he has never looked into a work on mathematics, or conjugated a Greek verb. He may know little or nothing of the sciences, but he has acquired the power to know any thing that any other mind can know, because he has mastered the means by which all knowledge is accessible to him—his mother tongue. Not obtained such a critical knowledge of its etymology as he will obtain by a classical course of reading, or of the niceties of grammatical construction; but mastered it in that he holds the keys that will unlock all the storehouses of learning. He is a mental gymnast who, although he has never attempted to raise the heavy weights of knowledge and science, need have no fear that he will fail in his attempts when he essays it.

Young men who are desirous to educate themselves, should select elementary treatises at first; such as treat of their subjects in a familiar manner. Having thus selected, they should set about reading them with the stern determination, not to let a single page, or line, or word, pass uncomprehended. Geographical names should be properly pronounced and the places they indicate carefully located, not on a map merely, but in the mind. Allusions to men and events should be at once followed by research into the histories of the men and the events themselves. The writer of this article once, upon commencing to peruse a volume found before he had got over the first page, that he must read up two or three biographies, and several other collateral matters before he could go on intelligently. Such occurrences will frequently happen, but the labor involved must not be shirked: if labor at first, it will soon become pleasure.

The habit of fixed attention is also of the utmost importance. A wandering mind is essentially a weak mind. If anything is unworthy attention, renounce it altogether, do not acquire that bad habit of at once half listening, and half pondering, so common, and so enervating to mental vigor. Remember always, that *to get* is not so important as the *power* to get. Strive to obtain strength of mind rather than many ill-digested facts. Don't swallow facts whole any more than you would your food. Chew and digest. Overloading is as bad for the mind as for the stomach, therefore avoid cramming. Seek to learn the general principles of science rather than the bare details; the details will come upon application of the principles. Cultivate the habit of closely observing everything you see. Every natural thing is worthy the closest inspection. Works of art and mechanical construction are good studies whether meritorious or otherwise. If good, seek to know the elements of their worth; if bad, criticise their faults. If your tastes incline to any particular field of study, let them run. Don't seek to stop them. You will succeed best in that field. Above all, avoid the pernicious habits of listlessness and day-dreaming, and remember that the chief attribute of genius, if there is anything can be called genius, is the disposition to study anywhere and everywhere, with or without book, to think not hap-hazard, but to think fixedly and connectedly upon what you will. You can study while you are working at a vise, or at the lathe, or pegging a shoe but it must be thought that is subject to your will; kept within prescribed bounds, or it becomes the day-dreaming which we have cautioned you against.

Lastly, while we do not condemn indiscriminately the reading of works of fiction, we assert that until you have ripened and improved your tastes by a different class of literature, you can not be judges of what is good or bad in fiction; so that if you read such works at all, you should do it under the direction of some one who is competent to advise you what is meritorious and what is to be avoided.

"GOLD! GOLD! HARD TO GET AND HEAVY TO HOLD."

The above line was written at a time when the sources of gold were less numerous than at present, when fewer men were employed in digging it—when the supply was very much less than now. Notwithstanding, gold is harder to get now than in Hood's time, and still harder to keep when got. The reason for the firmness in the price of gold seems to be a universal topic, just now, among papers devoted to finance. Very little light is thrown upon the subject by the essays which we have perused. The fact that the supply has largely increased, is urged to show that present rates are too high. The collateral fact, that gold is used up very slowly, at best, by wear, losses at sea, etc., is also strongly urged to prove that there must be a large increase in the amount of gold in circulation.

The gold fields of California, Australia, Colorado, Idaho, and Montana, have been successively developed during the last twenty years, and have poured an enormous amount of gold into the general current. Since 1850, one billion of dollars' worth of gold has been mined, yet the relative value of gold to other precious metals remains essentially unchanged.

It was predicted, ten years ago, that the price of gold must become permanently depreciated by the large increase in production. To-day that prediction remains unfulfilled; yet today the prediction is as confidently reasserted, as it was ten years ago. The quite general distribution of gold, in mountain ranges everywhere, is an admitted fact. At present, it is only profitable to mine for it under circumstances of comparatively little difficulty, so that many large deposits remain unmolested. New deposits are constantly coming to light, so that the supply annually increases rather than diminishes. Accounts reach us of mines of extraordinary richness in Southern Africa. The mines of Italy are just beginning to pay, while the mines of Frontino and Bolivia seem to give specimens of remarkable richness.

Are, then, the predictions of which we have spoken about to be realized? We think not. We believe that, in 1878, gold will be found to have still maintained its relative value, in spite of the large amount that may reasonably be expected to be taken out before that time.

Briefly, our reasons for this opinion are these: First, gold is a commodity as much as iron, and is subject to the same laws of supply and demand. Second, the demand has increased, in the past, and, we are confident, will increase in the future as fast or faster than the supply. The uses of gold in the arts are increasing in number and extent. Compare the number of gold watches, the amount of gold employed in jewelry, dentistry, gilding, bookbinding, etc., with the same, twenty years ago, and it will at once be evident that the demand has increased without resort to statistics. The population of the world is increasing, and, more important still in its effects upon a demand for gold, is the rapid march of civilization, and the consequent spread of a taste for general ornament, in which gold is so largely used.

Here we have elements of increased demand to compensate for increased supply. Those who only think of gold as currency must of course be misled, in their opinions upon this subject. There is probably far more gold in this country today applied to ornamental uses than exists in coin. Nearly all above the lowest walks of life have more or less of it upon their persons and in their houses. So long as this is the case, so long as population continues to increase at its present rate, and civilization advances, so long will gold maintain its standard of value, if indeed it does not rise above it.

EXPANSION OF ICE.

A discussion upon the expansion or contraction of ice by the action of cold is exciting much interest in England, both on account of the subject itself, and the high authorities which are parties in the discussion. Prof. Tyndall takes the ground that it expands. Other eminent philosophers dispute the accuracy of the experiment from which Dr. Tyndall draws his conclusions. The experiment is as follows: Around nicely fitted blocks of ice he places bands of cast iron; upon submitting the whole to the action of a freezing mixture the bands soon burst with a loud report. Those who doubt the correctness of Dr. Tyndall's conclusion, argue that the experiment does not prove that ice expands, as the contraction of the iron is sufficient to account for the bursting of the bands. They further confirm their opinions by the fact that the ice which forms upon the surface of the British American Lakes, often to a thickness of several inches during a single cold night, will, upon the recurrence of severe cold, crack open widely. This is thought to indicate contraction instead of expansion. It certainly seems that the experiment of bursting iron rings by refrigeration is not altogether conclusive of the expansion of ice, still although it may be defective, we are inclined to the opinion that ice does expand as the temperature diminishes. If such should be the case, it appears to us that it would easily be determined by a specific gravity test, weighting the ice with platinum,and using mercury as a means of making the test, that substance remaining fluid at low temperatures, and having no solvent power on ice. It would be easy to make a proper allowance for the increased specific gravity of the mercury as the temperature diminishes.

TRANSPORTATION OF CATTLE---REID'S PATENT CATTLE WAGONS.

Some years since, while we were standing in the depot of the New York Central Railroad, at Amsterdam, awaiting the arrival of an express train from the East, there passed the station two enormous trains from the West, each requiring two locomotives to draw them, and laden with live cattle for the New York market. Live cattle, did we say? We must qualify that statement, for, on either train, there were some dead,others in a dying state,while all were greatly distressed, as was evident by their violent panting and protruding tongues. Some were prostrate under the feet of the rest, powerless to rise. The causes for this state of things was obvious. The weather was intensely hot, and the cattle crowded together as close as they could possibly stand, and not having been allowed to drink since they left Buffalo,were dying of thirst. We remarked, at the time, that it seemed an easy task to provide water for cattle thus transported, but a fellow traveler remarked that, were a proper apparatus constructed, no railroad in this country would adopt it unless compelled to do it. We, however, hoped, and still hope, that the greed of railroad corporations will not prevent the universal adoption of any simple method for securing such a humane object.

Our attention has been called to a simple and effective mode of supplying cattle with water while being transported in railway cars, invented by Wm. Reid, of Granton Harbor, near Edinburgh, Scotland, which seems admirably adapted to the purpose. The cars are provided with troughs, to which water can be readily supplied while the trains are stopped for taking in water for the use of the engine.

There is no doubt that many cattle become diseased by confinement without water during transportation, and that their meat, rendered more or less unwholesome by it, is sold and eaten, to the detriment of public health. The knowledge of this fact will do more toward correcting the evil than an appeal to the humanity of individuals. If railroad corporations refuse to correct it, they should be compelled to do so by legislation.

NEW MEXICO, ITS NATURAL WEALTH.

The Honorable W. F. M. Arny, ex-governor of New Mexico, has presented to the geological and mineral museum of the United States Department of Agriculture, a collection of specimens of minerals, fossils, agricultural products, etc., from which an idea of the natural resources of that territory may be obtained.

Among these specimens are native copper from the Tijeris mountain, a short distance from Santa Fe; bituminous shale from Placer mountain; iron ore from the San Juan country; brown copper ore from the San Dio range, also but a short distance from Santa Fe; limonite from the vicinity of Placer mountain; purple copper and native copper from the Naciamento mountains; iron pyrites, drusic, quartz, felspathic trachyte, pumice, and trachyte from the San Juan. Indian country; argentiferous galena from Stevenson's mine in Dona Anna county, native copper from Hanover mine near Gila river; marble from near Santa Fe; argentiferous galena from Valencia county; dentritic manganese in felspar paste containing gold, from Placer mountain; gold bearing quartz and native copper from the vicinity of Abiqui, Rio Arriba county; conglomerate containing gold from the Ute creek on Maxwell's ranch stated to be unsurpassed in richness, various grades of wool, corals, and so forth.

Striking as is this exhibit of mineral wealth, there is little doubt that much remains yet to be discovered. The rapid development of these resources is however interfered with by the depredations of Indians who render mining operations, except in places near centres of white population, extremely hazardous. Governor Arny asserts his belief that the mineral wealth of the mountains of New Mexico would pay twice our national debt, if miners could be permitted to develop it in safety. His opinion is that "is is cheaper to feed than to fight Indians, and that the Indians of New Mexico can all be placed on reservations without a war, if Congress will make sufficient appropriations to feed them, and furnish the necessary machinery to enable them to make their own clothing and establish industrial schools, to be kept up at the expense of the Government till the Indians are made self sustaining, which, by faithful agents, can be done in a few years."

With these Indians such a plan might prove successful, as they are said to be already partially civilized, but so far as our knowledge of Indian reservations extends they are generally constant bills of expense to the Government; the Indians are not self-sustaining and the agents are far more interested in making money for themselves, than in caring for the trusts imposed upon them. We have always held the opinion that a race who will not become civilized, and who at the same time resist the onward sweep of civilization, must not only be inevitably swept before it to extinction, but that they deserve scarcely more sympathy than the other savage beasts of the forest whose ferocity they not only imitate, but surpass. We believe that although feeding may be cheaper—so far as money goes—than fighting, the only effectual remedy for Indian outrages on our frontiers, is the strong hand. The only way to conquer the American savage is to punish such outrages by almost total extermination of the tribes that perpetrate them. To exhibit mercy to these butchers is to waste powder.

ON A PROBABLE CONNECTION BETWEEN THE RESISTANCE OF SHIPS AND THEIR MEAN DEPTH OF IMMERSION.

By W. J. MACQUORN RANKINE, C.E., LL D., F.R.S.

1. It was pointed out some time ago, that when a wave in water is raised by a floating solid body which is propelled at a speed greater than the natural speed of the wave, the ridge of the wave assumes an oblique position, and the wave advances obliquely; so that while it travels at its own natural speed in a direction perpendicular to its ridge line, it at the same time accompanies the motion of the solid body at a greater speed. The angle of obliquity of the advance of the wave is such that its cosine is the ratio of the natural speed of the wave to the speed of the solid body. It was at the same time pointed out that under those circumstances there is an additional breadth of wave raised in each second, expressed by the product of the speed of the solid body into the sine of the obliquity; or, in other words, by the third side of a right-angled triangle, of which the speed of the solid body is the hypothenuse, and the natural speed of the wave the base; that in raising that additional breadth of wave per second, energy is expended; and thus that a rapidly increasing additional term is introduced into the resistance to the motion of the solid body, so soon as its speed exceeds the natural speed of the waves which it raises.

2. The waves taken into account in Mr. Scott Russell's theory of the resistance of ships, are waves whose speed depends on their length alone; and that theory accounts for a rapid increase in the resistance of a ship, when her speed exceeds the natural speed of certain waves of lengths depending on her length.

3. In a paper read to the Royal Society in May, 1868, it was shown that for all waves whatsoever, there is a relation between the natural speed and the virtual depth of uniform disturbance, that is to say, the surface particles would have to extend in order to make a total volume of disturbance of the water equal to the actual volume of disturbance. That relation is, that the speed of advance of the wave is that due to a fall of half the virtual depth. In a paper read to the Institution of Naval Architects in 1868, it was pointed out that every ship is probably accompanied by waves, whose natural speed depends on the virtual depth to which she disturbs the water, and that, consequently, when the speed of the ship exceeds that natural speed, there is probably an additional term in the resistance depending on such excess.

4. The object of the present paper is to call the attention of the British Association, and especially of the committee on Steamship Performance, to the probable existence of this hitherto neglected element in the resistance of ships; and to suggest that suitable observations and calculations should be made in order to discover its amount and its laws. Among observations which would be serviceable for that purpose may be mentioned the measurement of the angles of divergence of the wave ridges raised by various vessels at given speeds, and the determination of the figures of those ridges which are well known to be curved; and among results of calculation the mean depth of immersion, as found by dividing the volume of displacement by the area of the plane of flotation; and that not only for the whole ship, but for her fore and after bodies separately, for it is probable that the virtual depth of uniform disturbance, if not equal to the mean depth of immersion, is connected with it by some definite relation.

Results of Observations.—In an appendix are given the results of the only three observations which I have hitherto found it practicable to make, of the speed of advance of the obliquely diverging waves raised by ships. The waves in each case were those which follow the stern of the vessel; the vessels were all paddle steamers, but care was taken to observe the positions of the wave ridges where they were beyond the influence of the paddle race. The virtual depth corresponding to the speed of advance of those waves is calculated in each case, and it is found to agree very nearly with the mean depth of immersion. It is to be observed, however, that the mean depth of immersion of one vessel only, viz., the *Iona*, has been measured from her plans. For each of the other vessels, a probable value of the mean depth of immersion has been obtained, by assuming that it bears the same proportion nearly to the total draft of water in them as the in the *Iona*. That assumption cannot be very far from the truth, for the three vessels belong to the same class of forms, being of shallow draft, and very flat bottomed amidships, but having very fine sharp ends. Few as those observations are, they seem sufficient to prove the existence of waves whose speed of advance depends on the depth to which the vessel disturbs the water. The connection between those waves and the resistance remains as a subject for future investigation.

Glasgow University, 15th August, 1868.

APPENDIX.

1. *Steam Vessel "Iona."*—Speed of vessel at time of observation. 15 knots=25·35 ft. per sec.; angle made by ridges of stern waves with course of vessel, 22½°; sine of that angle, 0·383; product, being velocity of advance of stern waves, 9·71 ft. per sec.; virtual depth corresponding to that velocity $9{\cdot}71^2 \div 32{\cdot}2 = 2{\cdot}93$ ft.; mean depth of immersion of vessel as measured on her plans, 3·18 ft. N B—The draft of water was 5 ft., so the mean depth of immersion was 0·64 of the draft, nearly.

2. *Granton and Burntisland Ferry Steamer.*—Speed of vessel at time of observation, 10 knots=16·9 ft. per sec; angle made by ridges of stern waves with course of vessel, 45°; sine of that angle, 0·7071; product, being velocity of advance of the stern waves, 11·95 ft. per sec.; virtual depth corresponding to that velocity, $11{\cdot}95^2 \div 32{\cdot}2 = 4{\cdot}44$ ft.; draft of water of the vessel, 6·67 ft; probable mean depth of immersion on the supposition that it is 0·64 of the draft, 4·3 ft.

3. *Steam Vessel "Chancellor."*—Speed of vessel at time of observation, 12·64 knots=21·36 ft. per sec.; angle made by ridges of stern waves with course of vessel, 22°; sine of that angle, 0·375; product, being velocity of advance of the stern waves, 8·01 ft. per sec.; virtual depth corresponding to that velocity, $8{\cdot}01^2 \div 32{\cdot}2 = 2$ ft.; draft of water of the vessel, 3·5 ft.; probable mean depth of immersion, on the supposition that it is 0·64 of the draft, 2·24 ft.

TABLE OF VIRTUAL DEPTHS CORRESPONDING TO DIFFERENT VELOCITIES OF ADVANCE.

Knots.	Velocity of Advance. Feet per second.	Velocity of Advance. Meters per second.	Virtual Depth. Feet.	Virtual Depth. Meters.
1	1·69	0·515	0·09	0·27
2	3·38	1·03	0·35	0·108
3	5·06	1·54	0·80	0·243
4	6·75	2·06	1·41	0·433
5	8·44	2·57	2·21	0·676
6	10·13	3·09	3·18	0·973
7	11·8	3·60	4·33	1·325
8	13·5	4·12	5·66	1·73
9	15·2	4·63	7·16	2·19
10	16·9	5·15	8·84	2·70
11	18·6	5·66	10·7	3·27
12	20·3	6·18	12·7	3·89
13	21·9	6·69	14·9	4·57
14	23·6	7·20	17·3	5·30
15	25·3	7·72	19·9	6·08
16	27·0	8·24	2[illegible]·6	6·92
17	28·7	8·75	25·6	7·81

—*The London Artizan.*

CHEMICAL NOMENCLATURE.

[Continued from page 50.]

The combination of the different elementary substances takes place by a certain attractive power of their smaller particles (atoms or molecules), which is called chemical affinity. As may be expected *a priori*, it differs greatly in different substances, and even differs in the same two substances when the circumstances are changed. The principal modifying circumstance is heat.

Carbon and oxygen, at the common temperature, have no affinity, that is to say, they will not combine. A piece of carbon may lie for a century in oxygen gas without combination taking place, but when sufficient heat is applied the two substances combine with great energy. However, the amount of heat necessary to cause this combination differs according to the form of carbon used. Thus, lamp-black requires much less heat than charcoal, more heat will be required to ignite coke, more still for anthracite coal, yet more for diamond, and, as regards graphite, we can scarcely produce heat enough to ignite it. The comparative incombustible nature of the last named substance, renders it suitable for crucibles for melting brass and other metals or alloys. All these substances are only carbon in different states, called allotropic conditions.

At the same time that the combustion commences to take place, it develops new heat in abundance, heating up the adjacent parts to the temperature required for combination in their turn, and so keeping up the heat to cause the final combustion of any amount of carbon and oxygen present. In the place of carbon, sulphur or any other so-called combustible substance may be substituted.

Combustion, therefore, is nothing but a chemical combination of a so-called combustible substance (carbon, sulphur, hydrogen, phosphorus, etc.), usually with the oxygen of the atmosphere; all that is required to start it, is a sufficient rise of temperature, and any large conflagration gives a striking illustration of the considerable development of heat, which is the result.

By the combustion of carbon, every six parts thereof will unite with sixteen of oxygen, when plenty of oxygen is present; by a limited supply of this last substance, it will only combine with eight parts; and, as the symbol C stands for six parts of carbon and O for eight of oxygen, the product of this combustion is expressed in the first case by CO_2, in the last by CO; and as the first possesses acid properties it is called carbonic acid, and the last possessing no such properties is called carbonic oxide; the last being the generic name for all combinations with oxygen which possess no acid properties.

The combustion of sulphur has for result, the combination of sixteen parts of sulphur with sixteen of oxygen; formula, SO_2, named sulphurous acid.

Selenium and tellurium combine after the same law and with similar results as sulphur, except that the respective numbers of combination are 40 and 64, respectively with sixteen of oxygen; formulæ, SeO_2 and TeO_2.

The combustion of hydrogen has for result a compound of one part of hydrogen (always by weight) with eight of oxygen, forming water; formula, H O.

The combustion of phosphorus forms phosphoric acid; formula, PO_5, which means thirty-one parts of phosphorus and forty of oxygen.

The combustion of potassium forms potassa; formula, K O, which means thirty-nine parts of the metal and eight of oxygen.

Magnesium burning forms magnesia; formula, Mn O, or thirteen parts of magnesium and eight of oxygen.

Zinc burning forms oxide of zinc or zinc white; Zn O containing thirty-two parts of zinc and eight of oxygen.

Of all the substances mentioned above, there is none that has more affinity for oxygen than red hot carbon; for this reason carbon is used as the great reducing agent, and almost any oxidized substance mixed with carbon and heated, will give its oxygen to the carbon, and carbonic acid will be formed. On this principle depends the reduction of iron from its ores, the manufacture of potassium, sodium, etc.; and it shows that also in chemistry the law of the strongest prevails, just as in all nature, not excepting the human race. In savage nations, brute strength only prevails, but among civilized people, the strength of mind and knowledge subdues the mere material brute forces, and illustrates the superiority of mind over matter.