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which served them as a vehicle, did not at first alter its purity, being intimately connected with it; but they nevertheless existed, and produced in its highest regions the multiplied halos, parafelena and parhelia observed that year. The heat increasing, and the earth continuing to furnish exhalations in proportion to the preceding humidity, these were communicated to the atmosphere in a manner almost insensible: but the atmosphere being at length saturated, these exhalations underwent new decompositions; storms were formed, the atmosphere was cooled, and suffered to escape a part of these exhalations, which fell again towards the earth, and in one day Europe was covered with a dry fog*. Local circumstances, in regard to moisture, winds, and clouds, exempted certain places from it for some time. The earth, however, continuing to furnish exhalations, and these being united to those which the atmosphere, as we may say, had deposited, descending and ascending thunder were seen till the exhalations of the earth and the atmosphere were consumed. The atmosphere being gradually purified, and the source of the exhalations exhausted, the earth ceased to be convulsed.

XVIII. *Report on the Conversion of Soft Iron into Cast Steel by means of the Diamond. Read in the French National Institute, Thermidor 26, Year 7. By C. GUYTON†.*

THE Class will recollect the account which I gave of the grand experiment of the combustion of the diamond in oxygen gas in the focus of the lens of Tschirnhausen, and the new facts which I thence deduced respecting the true nature of the diamond; plumbago, which is its oxyd in the first degree; carbon, which is its oxyd in the second degree; and the carbonic acid, which is the produce of its complete oxy-

* The same fog, I presume, took place in America, where there had been great complaint of drought for eight years. It was not seen in the open sea, because it was absorbed by the water: for this reason it did not appear in countries where the sky was overspread with clouds.

† From the *Annales de Chimie*, No. 92.

generation. They suggested to our brother, C. Clouet, the idea of searching for a confirmation of a new kind, by trying to make soft iron pass to the state of steel by cementation with the diamond.

It has hitherto been considered as certain, that iron does not melt but by passing to the state of steel or cast iron. But in what state does the carbon enter into that combination? It might be conjectured, that it is in the state of plumbago, or oxyd of the first degree; since that which is separated by acids exhibits the brilliant blackness and incombustibility which form its principal characters. Hence some were inclined to conclude, that the carbon entered into this union in the state of an oxidule; that consequently the carbon employed in the cementation of steel began by deoxydating itself to a certain degree. This was even in some measure proved; as the carbon employed for this operation was indeed found to have a more brilliant aspect, and nearly resisted incineration, like carbon in a mass burnt in close vessels. But if carbon really burns in the cementation of iron, it ought to disengage from it oxygen gas. This is a question which I have endeavoured to resolve by experiment.

I cemented small bits of iron in a porcelain retort, which in the preceding operation had received a vitreous coating, and which consequently was no longer permeable to air. These fragments were all surrounded, on every side, by charcoal of beech pulverised, and very dry. The retort was put into the reverberating furnace, and a tube connected to it and carried under a receiver filled with mercury. There was disengaged a quantity of elastic fluid, composed of carbonated hydrogenous gas and carbonic acid gas, the last of which was at first only 0.11 in bulk; towards the middle of the experiment, 0.13; and at the end, 0.15.

The conversion of iron into steel being found only little advanced, after three hours and a half exposure to the fire, we put the same iron and the same carbon again into the retort, and exposed it to the heat of a three-blast-furnace. This time there was only a very small quantity of gas; but it was still carbonated hydrogenous gas mixed with carbonic acid gas, and always with the same progression of the latter; which

which made at first only 0.07 of volume, while the last portions contained 0.12. The iron on this occasion was converted into steel, and even the fragments had united by a commencement of fusion.

It was very probable that a part of the carbonic acid, collected in this operation, might have been formed at the expense of the remaining carbon and with disengaged oxygen; but the constant presence of the hydrogen only served to indicate the difficulty of freeing the carbon entirely from the last portion of water it contained. I shall here take occasion to observe, that this experiment seems not at all reconcilable with the opinion of some chemists, that hydrogen has more affinity than carbon for oxygen: an opinion which they found on this circumstance, that carbon is precipitated, in Volta's eudiometer, when a mixture of oxygen gas and carbonated hydrogen gas is made to detonate, if a quantity of oxygen sufficient to acidify the two bases has not been employed. I say, that this affinity was not exerted in my experiment: for it cannot be doubted that the temperature was high enough to reproduce water by the union of the oxygen and hydrogen; and we can here see nothing which could decide a preference of the oxygen for the carbon.

These considerations seemed to me sufficient to create a new interest in regard to the experiment proposed by C. Clouet. I did not hesitate, therefore, to employ in it one of the diamonds preserved in the cabinet of the Polytechnic school, according to the leave granted by the Council; being persuaded that if it disappeared in the operation, merely by exposure to a high temperature, in contact with iron, without the accession of the air or any other oxygenating substance, the fact thereby established would leave no room to regret having sacrificed it.

Citizen Clouet had himself prepared a small crucible of soft iron, forged on purpose out of picked heads of nails. Its form was a solid of eight planes. (Plate II. fig. 3). It was shut by a stopper of the same iron well adjusted. (Fig. 4.)

This crucible was to be placed in a Hessian crucible, furnished with a cover well luted. This was all the apparatus for the experiment. I cannot give a better idea of the

result than by the report drawn up by C. Clouet, Welter, and Hachette.

Report of the Experiment made at the Polytechnic School, Thermidor 25, Year 7, respecting the Conversion of Iron into Steel by the Diamond.

“ The diamond employed weighed 907 milligrammes. As it did not entirely occupy the crucible, we filled it with filings of the same iron as that of which it was formed. The crucible was shut by its iron stopper, which was forcibly thrust home, that as little air as possible might remain in the inside.

	Grammes.
“ The crucible and stopper weighed together -	55.8
“ The iron filings which covered the diamond -	2
	<hr/>
“ Total weight of the iron surrounding the diamond	57.8

“ After having cut off the excess of the stopper *, the crucible was placed alone, and without the addition of any surrounding matter, in a very small Hessian crucible, and the latter in a second crucible of the same earth; but the space between the two latter crucibles was filled with siliceous sand free from all ferruginous particles. In the last place, the large crucible was luted with earth arising from pounded crucibles and unbaked clay, and the whole was exposed about an hour to a three-blast-forge fire.

“ The whole being cooled, we found, in the interior Hessian crucible, the iron converted into an ingot of cast steel. (See fig. 5) It formed, with the stopper and filings, but one round mass well terminated, some few globules excepted, which were detached, and which weighed only 884 milligrammes.

	Grammes.
“ The ingot of cast steel weighed - - -	55.500
“ The detached globules - - -	0.884
	<hr/>
“ Total weight of the steel obtained - -	56.384

* This portion of the stopper, as well as the remainder of the ingot of which the crucible was formed, were subjected to the Clafs for inspection, in order to ascertain the nature of the iron employed.

“ The

“ The iron and the diamond weighed, before the operation, 58.707 grammes ; from which it follows that there was a loss of iron about 2.423 grammes. This iron had given to the Hessian crucible the colour of plumbago.

“(Signed) CLOUET, WELTER, HACHETTE.”

The fusion of the iron being so far perfect as to shew on its surface the rudiments of the most beautiful crystallisation, it is not possible to think that any part of the diamond could have remained in the inside untouched, or that it was not in the most intimate state of combination. The difference of the specific gravity opposes such an idea *.

Thus the diamond disappeared by the affinity which iron exercised on it by the help of the high temperature to which they were both exposed, in the same manner as a metal disappears in the alloy of another metal.

The diamond, therefore, has furnished here the same principle as carbon, since the product of the union has the same properties.

The conversion into steel is not doubtful. The ingot having been polished on a lapidary's wheel, a drop of weak nitrous acid immediately produced a dark-grey spot, absolutely like that exhibited on English cast steel, and on cast steel produced by the process of C. Clouet. Those who have often tried steel by this kind of proof, long ago pointed out by Rinmann, had occasion to remark, that the spot of cast steel, though very sensible, is however less black than that of steel made by cementation, which depends perhaps on the different degree of oxydation of the carbon which they have taken in.

Explanation of the FIGURES.

A, fig. 3, (Plate II.) is the plan of the iron crucible. B, a section of this crucible. C, fig. 4, the stopper of the crucible. D,E, fig. 5, ingot of cast steel seen in perspective. The spot formed by the nitric acid on the polished part is represented at *a*.

* Some persons having expressed a desire to see the inside of the ingot, it was broken on the anvil, which was not effected without several blows from a very large hammer. It divided itself into two fragments, which were exhibited at the next sitting. The fracture appeared perfectly uniform, and of the most beautiful grain.