Faraday's Lecture on Platinum

THE CENTENARY OF A CLASSIC

In the course of his long researches Michael Faraday more than once turned his attention to platinum and its properties, and on February 22nd 1861—when in his 71st year—he delivered his famous 'Lecture on Platinum' to the members of the Royal Institution. An abridged version of this address is reprinted here for the historical interest it will undoubtedly have for the metallurgist of today and for the picture it conveys of a great but modest scientist

When I was tempted to propose this subject for your attention this evening, it was founded upon a promise, and a full intent of performing that promise, on the part of my friend Deville, of Paris, to come here to show before you a phenomenon in metallurgic chemistry not common. In that I have been disappointed. His intention was to have fused here some thirty or forty pounds of platinum, and so to have made manifest, through my mouth and my statement, the principles of a new process in metallurgy in relation to this beautiful, magnificent, and valuable metal; but circumstances over which neither he nor I, nor others concerned, have sufficient control, have prevented the fulfilment of that intention, and the period at which I learned the fact was so recent, that I could hardly leave my place here to be filled by another, or permit you, who in your kindness have come to hear what might be said, to remain unreceived in the best manner possible to me under the circumstances. I therefore propose to state as well as I can what the principles are on which M. Deville proceeds by means of drawings, and some subordinate or inferior experiments.

The metal platinum, of which you see some very fine specimens on the table, has been known to us about a hundred years. It has been wrought in a beautiful way in this country, in France, and elsewhere, and supplied to the consumer in ingots of this kind, or in plates, such as we have here, or in masses, that by their very fall upon the table indicate the great weight of the substance, which is, indeed, nearly at the head of all substances in that respect. This substance has been given to us hitherto mainly through the philosophy of Dr. Wollaston, whom many of us know, and it is obtained in great purity and beauty. It is a very remarkable metal in many points, besides its known special uses.

Now, with regard to this substance, let me tell you briefly how we get it. The process used to be this. The ore was taken, and digested in nitro-muriatic acid of a certain strength, and partly converted into a solution, with the leaving behind of certain bodies.

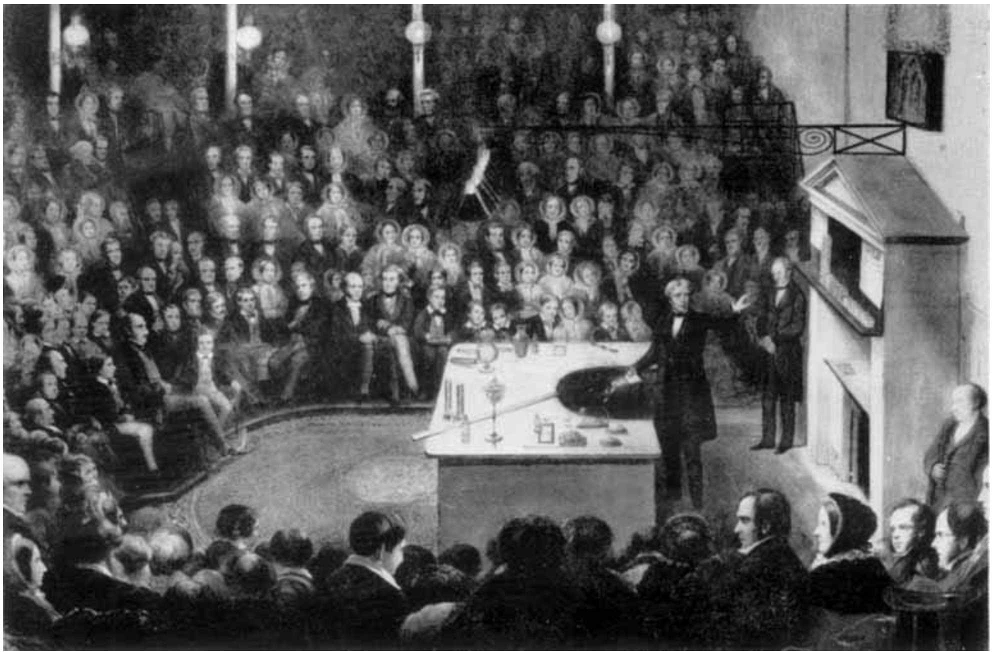
The platinum being dissolved with care in acids, to the solution the muriate of ammonia was added, as I am about to add it here. A yellow precipitate was then thrown down, as you perceive is the case now; and this, carefully washed and cleansed, gave us that body [pointing to a specimen of the chloride of platinum and ammonium], the other elements, or nearly all, being ejected. This substance being heated, gave us what we call platinum sponge, or platinum in the metallic state, so finely divided as to form a kind of heavy mass or sponge, which, at the time that Dr. Wollaston first sent it forth, was not fusible for the market or in the manufacturers' workshops, inasmuch as the temperature required was so high, and there were no furnaces that could bring the mass into a globule, and cause the parts to adhere together. These divided grains of spongy platinum having been well washed and sunk in water for the purpose of excluding air, and pressed together, and heated, and hammered, and pressed again, until they come into a pretty close, dense, compact mass, did so cohere, that when the mass was put into the furnace of charcoal, and raised to a high temperature, the particles, at first, infinitely divided—for they were chemically divided—adhered the one to the other, each to all the rest, until they made that kind of substance which you see here, which will bear rolling and expansion of every kind. No other process than that has hitherto been adopted for the purpose of obtaining this substance from the particles by solution, precipitation, ignition, and welding.

This is the process adopted by Messrs. Johnson and Matthey, to whose great kindness I am indebted for these ingots and for the valuable assistance I have received in the illustrations.

The treatment, however, that I have to bring before you is of another kind, and it is in the hope that we shall be able before long to have such a thing as the manufacture of platinum of this kind that I am encouraged to come before you, and tell you how far Deville has gone in the matter, and to give you illustrations of the principles on which he proceeds.

Deville's process depends upon three points—upon intense heat, blowpipe action, and the volatility of certain metals. We know that there are plenty of metals that are volatile, but this, I think, is the first time that it has been proposed to use the volatility of certain metals, such as gold and palladium, for the purpose of driving them off and leaving something else behind. He counts largely upon the volatility of metals which we have not been in the habit of considering volatile, but which we have rather looked upon as fixed.

Let me now tell you briefly what Deville proposes to do. First of all, he takes this ore

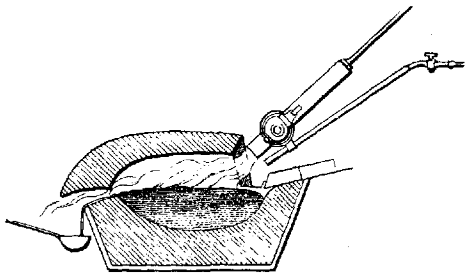


Faraday delivering a lecture at the Royal Institution. The illustration, from a painting by Blaikley in the possession of the Royal Institution, shows him giving the first of a series of lectures on 'Metals' in 1855. In the centre of the front row is the Prince Consort with his sons the Prince of Wales (afterwards King Edward VII) and Prince Alfred on either side with its impurities and mixes it (as he finds it essential and best) with its own weight of sulphuret of lead—lead combined with sulphur. Both the lead and the sulphur are wanted; for the iron that is there present, as you see by the table, is one of the most annoying substances in the treatment that you can imagine, because it is not volatile; and while the iron remains adhering to the platinum, the platinum will not flow readily. It cannot be sent away by a high temperature—sent into the atmosphere so as to leave the platinum behind. Well, then, a hundred parts of ore and a hundred parts of sulphuret of lead, with about fifty parts of metallic lead, being all mingled together in a crucible, the sulphur of the sulphuret takes the iron, the copper, and some of the other metals and impurities, and combines with them to form a slag; and as it goes on boiling and oxidising, it carries off the iron, and so a great cleansing takes place.

Now you ought to know that these metals, such as platinum, iridium, and palladium, have a strong affinity for such metals as lead and tin, and upon this a great deal depends. Very much depends upon the platinum throwing out its impurities of iron and so forth by being taken up with the lead present in it.

When he (Deville) has melted these substances and stirred them up well, and so obtained a complete mixture, he throws in air upon the surface to burn off all the sulphur from the remaining sulphuret of lead; and at last he gets an ingot of lead together with platinum—much lead comparatively, and little platinum.

He gets that in the crucible with a lot of scoriæ and other things, which he treats afterwards. It is that platiniferous lead which we have to deal with in our future process. Now let me tell you what he does with it. His first object is to get rid of the lead. He has thrown out all the iron, and a number of other things, and he has got this kind of compound. He may get it as high as 78 per cent. of platinum, and 22 of lead; or 5, or 10, or 15 of platinum, and 95, or 90, or 85 of lead (which he calls weak platinum), and he then places it in the kind of vessel that you see before you. The combustible metal—that is, the lead—and the part that will oxidise, are thoroughly oxidised; the litharge flows out in a fused state into a vessel placed to receive it, and the platinum remains behind.

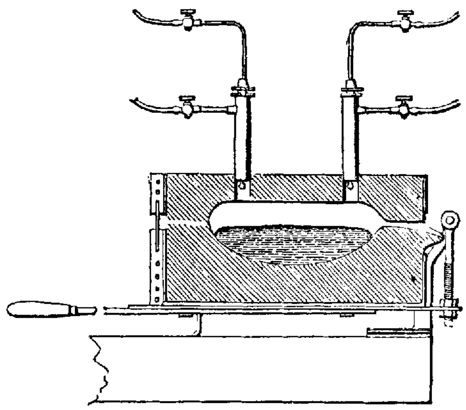


Removing the litharge in a fused state from the surface of the molten platinum

Here is the process which Deville adopts for the purpose of casting off the lead after he has got out the platinum from the ore. (Having made use of your friend, you get rid of him as quickly as you can.) He gets his heat by applying the combination of oxygen and hydrogen, or of carburetted fuel, for the purpose of producing a fire. Having obtained heat like this, the next consideration is, what vessel is he to employ which could retain the platinum when so heated, or bear the effects of the flame? Such vessels are happily well supplied at Paris, and are formed of a substance which surrounds Paris; it is a kind of chalk (called, I believe, by geologists *calcaire grossière*), and it has the property of enduring an extreme degree of heat.

I am now going to get the highest heat that we can obtain. First, I show you the combustion of hydrogen by itself. If I put a piece of lime obtained from this chalk into the gas, you see we get a pretty hot flame which would burn one's fingers a good deal. But now let me subject a piece of it to the joint action of oxygen and hydrogen. I do this for the purpose of showing you the value of lime as a material for the furnaces and chambers that are to contain the substances to be operated on, and that are consequently to sustain the action of this extreme heat.

I have two or three rough drawings here representing the kind of furnace which Deville employs. It is made of a piece of lime below and a piece of lime above. You see how beautifully lime sustains heat without altering in shape; and you may have thought how beautifully it prevents the dissipation of the heat by its very bad conducting powers. While the front part of the lime which you saw here was so highly ignited, I could at any moment touch the back of it without feeling



The lime-block furnace designed by Deville

any annoyance from the heat. So, by having a chamber of lime of this sort, he is able to get a vessel to contain these metals with scarcely any loss of heat. He puts the blow-pipes through these apertures and sends down these gases upon the metals, which are gradually melted. He then puts in more metal through a hole at the top. The results of the combustion issue out of the aperture which you see represented. If there be strips of platinum he pushes them through the mouth out of which the heated current is coming, and there they get red-hot and white-hot before they get into the bath of platinum. So he is able to fuse a large body of platinum in this very manner.

When the platinum is melted he takes off the top and pours out from the bottom piece, like a crucible, and makes his cast. This is the furnace by which he fuses his forty pounds or fifty pounds of platinum at once. The metal is raised to a heat that no eye can bear. There is no light and shadow, no chiaroscuro there; all is the same intensity of glow: you look in and you cannot see where the metal or the lime is; it is all as one. We have, therefore, a platform with a handle, which turns upon an axis, that coincides with the gutter that is formed for the pouring of the metal; and when all is known to be ready, by means of dark glasses, the workmen take off the top piece and lift up the handle, and the mould being then placed in a proper position, he knows that the issue of the metal will be exactly in the line of the axis.

I have said that Deville depends upon intense heat for carrying off vapour and proposes to throw out in this way all those extraneous things except two, namely iridium and rhodium. It so happens that iridium and rhodium do make the metal more capable of resisting the attacks of acids than platinum itself. Alloys are compounded up to 25 per cent of rhodium and iridium by which the chemical inaction of the platinum is increased and also its malleability and other physical properties.

I have now finished this imperfect account. It is but an apology for not having brought the process itself before you. I have done the best I could under the circumstances, and I know your kindness well, for if I were not aware that I might trust to it, I would not appear here so often as I have done. The gradual loss of memory and of my other faculties is making itself painfully evident to me, and requires, every time I appear before you, the continued remembrance of your kindness to enable me to get through my task. If I should happen to go on too long, or should fail in doing what you might desire, remember it is yourselves who are chargeable by wishing me to remain. I have desired to retire, as I think every man ought to do before his faculties become impaired; but I must confess that the affection I have for this place, and for those who frequent this place, is such that I hardly know when the proper time has arrived.