

XV. *Easy Methods of measuring the Diminution of Bulk, taking place upon the Mixture of common Air and nitrous Air; together with Experiments on Platina.* By John Ingenhoufz, M. D. F. R. S. Physician to their Imperial Majesties at Vienna. In a Letter to Sir John Pringle, Bart. P. R. S.

TO SIR JOHN PRINGLE, BART. P. R. S.

S I R,

Vienna,
Nov. 3, 1775.

R. Feb. 15, 1776. **S**OME time ago I amused myself with some experiments relating to nitrous air. Having received from the learned Abbé FONTANA a copy of a pamphlet, which he published this year under the title, *Descrizione e usi di alcuni stromenti per misurare la salubrità del aria, di Felice FONTANA. In Firenze, l'anno MDCCCLXXV: per Gaetano Cambiagi Stampatore granducale*, which most probably will already be known to you; I imitated some of them, and found them very useful for the intended purpose of measuring the quantity of air absorbed or diminished by mixing the nitrous with the common air; by which *criterion* the degree of the salubrity of common air may be ascertained according to the discovery of Dr. PRIESTLEY. Abbé FONTANA first produces nitrous air in a separate vessel, and then forces it into the glass, or other vessel, in which it is to remain, till a communication be opened between this vessel and the

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other which contains common air. I found it a difficult matter to force always just the same quantity of nitrous air into the vessel; because I could never be sure that the nitrous air had dislodged all the common air out of it, or had dislodged always the same quantity of common air. If this quantity is not always just the same, some variety must happen in every experiment; and thus an exact valuation of the quantity of air absorbed cannot well be made. To obviate in some measure this difficulty, and to abridge the experiment by mixing suddenly the two airs together, I contrived the instrument of which I send you here a drawing. It is a strong glass vessel, nearly two inches and a half in diameter, and about as much in height: a conical figure would perhaps be better. A brass cover, which embraces the glass about half an inch downwards, is cemented to it, and has a hole in its middle, corresponding with the hole in the glass vessel. This hole of the brass cover has a female screw fitted to receive the male screw of a brass tube, about seven inches long and about an inch in diameter, terminating at one end in a male screw (adapted to the abovementioned copper plate) and at the other, in a neck adapted to enter the mouth of an elastic gum bottle, otherwise called *boradchio* or *caout-chouc*, to be tied to it with a strong ribbon. This brass tube has towards each extremity an air-tight cock, by which the communication between one extremity and the other may be opened or shut. Between these two cocks, about the middle of the tube, is a short lateral tube, communicating

nicating with the canal of the other tube. This lateral tube has also an air-tight cock, which opens or shuts up the communication with the long tube, and has a female screw to receive the male screw of another short tube, which serves to receive a glass tube bent at right angles and of two feet or more in length; the diameter somewhat more than that of a large quill. This glass tube is to be divided into any number of equal parts. I use the instrument in the following manner. The elastic gum-bottle being well tied to the brass tube, all the cocks shut, and the glass tube fixed to its place, I pour a certain quantity of *aqua fortis* (v. g. 3℥) into the glass vessel, taking care that none of it touches the brass cover: then I put into it a certain quantity of iron filings (v. g. 3j) wrapt up in a bit of paper to prevent its being immediately corroded. This being done, I screw the glass vessel to the brass tube, so that no air can get out. When the red fumes begin to rise, I open the two cocks of the brass tube, which open the communication between the glass vessel and the elastic gum-bottle. By squeezing the elastic gum-bottle, I force the two airs to mix together. The diminution of the air is soon perceived by the elastic gum-bottle becoming flaccid. When I judge the air is as much diminished as it can be, I put the extremity of the glass tube into a vessel with water, and open the cock of the side tube: the water immediately rises in the glass tube to a height proportioned to the diminution of the two airs. By repeating several times the experiment in the same place, I found the

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rife of the water nearly the fame, though not fo exactly as I could have wifhed: the variation I afcribed partly to the elastic bottle not being always of the fame firmnefs or elasticity, which it lofes more or lefs by fqueezing. I contrived another method more fimple, and perhaps more accurate, which is the following: I took a glafs tube about two and a half feet long, and not quite a twelfth of an inch in diameter; fo that a column of quickfilver might flide through the whole without difperſing itſelf, filling always the whole cavity. I cemented to each extremity a brafs ring, that I might be able to ſhut the opening with my finger without hurting myſelf. This tube being divided into 100 equal parts, I uſed it in two different ways; *viz.* having poured ſome *aqua fortis* into a little phial, and put to it ſome filings, I thruſt the extremity of the glafs tube, into the neck of the phial. A column of quickſilver of about an inch in length occupied that end of the glafs tube which was in the neck of the phial. The whole was kept in ſuch a poſture that the tube was nearly in an horizontal line, the end which is put into the phial being rather the higheſt. Care was taken that the tube ſhould not touch the *aqua fortis*. The phial being filled with red fumes and the extremity of the tube ſurrounded with them, I open and ſhut alternately the oppoſite extremity of the tube, ſo as to allow the quickſilver to advance flowly towards the middle; as ſoon as the column of quickſilver is arrived at the middle, I take the tube out of the bottle, and ſhut each extremity with the fore-finger: thus moving the tube upwards and downwards as briskly as can be done with a certainty of keeping both extremities
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all the while exactly shut. The two airs being thoroughly mixed, I put one extremity into a vessel filled with quicksilver, and withdrawing the finger from the opening, the quicksilver rises immediately within the tube, and shews by its height the exact quantity of air diminished. The other method is this: I tie to the end of the same tube the neck of a small elastic gum-bottle, the bottom of which is cut away: having put some iron filings into a little phial, filled with *aqua fortis*, I put the end of the tube within the mouth of the phial, clapping my hand fast to the orifice of the phial, the loose part of the elastic bottle, so that the nitrous air, rising from the phial, must take its course through the tube. When the whole tube is filled with red fumes, I take it out, and shut the two extremities with my two fore-fingers. Then I put one end of the tube in a vessel with quicksilver, and withdraw both fingers for an instant, to make the column of quicksilver rise within the tube. I apply immediately both fingers; and holding the tube nearly in a horizontal direction, so that the extremity where the quicksilver is may be rather the highest, I open and shut at the same time both extremities, so that the column of quicksilver gradually advances towards the middle. The quicksilver advancing towards the middle, as much common air follows the quicksilver as it forces out nitrous air from the other extremity. As soon as the column of quicksilver is in the middle, I keep both extremities well shut with my fingers, and moving the tube in various ways, I force the two airs to come into mutual contact, and to mix intimately together. Then I put one
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extremity into a vessel filled with quicksilver, withdraw the finger from within the quicksilver, and observe to what height the quicksilver rises. It requires some practice to perform this experiment with dexterity.

Some time ago I got some ounces of fine *platina* from Spain, through the means of his excellency Count DIETRICHSTEIN, with which I made some experiments. Most writers assert, that a considerable part of the *platina* is attracted by the magnet, but not the whole of it: but by a nice inquiry I found, that every one of the particles obeyed the magnet more or less, except some transparent stony particles; and that even these were all magnets in themselves; or that each particle had two poles, which I could change at pleasure by the application of magnetical bars. Though their magnetical virtue is always much less than that of particles of iron, yet every one had more or less of it; but some so little as not to be perceived but by applying a strong magnet to them when floating upon water. Besides the flat, smooth, and shining bright particles, which are alone the true *platina*, I find two other kind of particles among them; *viz.* some very small black particles, most of which are of an irregular figure, resembling the iron sand found in some parts of North America; at Teneriffe; near some lakes in Italy; in some rivers in Transylvania, among the gold dust. which is taken out of them; and in many other places. Some of these black particles, though few in comparison with the number of the irregular particles, are of a very regular figure; and when seen through a good magnifier, somewhat resemble the figure of a melon.

These black particles of both sorts, I find, are attracted by the loadstone, and have each of them two poles, though those of an irregular figure have them more manifestly ^(a). The other particles are of a gold colour; having, in general, more or less of a paleness approaching to the colour of *platina*. Some of these gold particles have the figure of the rest of the *platina*, differing only from them in colour, and in not being so bright, or as it were polished. Others are irregular masses of indeterminate figure having generally a spongy appearance. The most part of these gold particles were evidently attracted by the magnet, and shewed upon the surface of the water their two distinct poles. These gold particles being put upon a piece of charcoal, and the flame of a candle directed upon them by the blowpipe of the chemical pocket laboratory, described by GUSTAVE VON ENGESTROM, published in the English translation of CROWNSTED'S *Mineralogie*, run easily into round balls, which have all the appearance and quality of real gold, except their being in general magnetical or having two distinct poles. I make no doubt but this magnetical quality is owing to some *platina* mixed with the gold. I could never melt a single particle of true shining *platina* by blowing strongly upon it with the blowpipe; the only change they underwent by this operation was to lose their brightness and the greatest part of their

(a) If magnetism is a criterion of iron, there must be iron in the *platina*; but if the rest of this substance be gold, according to some, why should not this be precipitated together with the gold added to it, by the addition of a solution of green vitriol to the *aqua regia* in which the two metals are dissolved?

magnetical virtue. Having filled a small glass tube with that *platina*, I found each end of it attracted both poles of a compass indiscriminately; but being put to a set of magnetical bars, it became a real magnet, having two distinct poles, which I could change at pleasure. I filled another small tube with *platina*, the hollow of the tube being only of such a size, as to allow the particles of *platina* to go in freely. I stuck a pin in each end, and fixed the pins with sealing wax. I directed five or six electrical explosions from three very large jars through the tube; after which, I found the *platina* had acquired no polarity. By looking with a microscope at the outside of the tube, I found the *platina* was much changed, so as to appear one uninterrupted cylinder of metal, all the interstices between each particle being quite, in appearance at least, obliterated and filled with bright metal. The places which were not bright, were become of a black hue, and appeared to be parts of the *platina* not melted; which I found afterwards to be the case. I attempted to shake the particles out of the tube, but I could not succeed. I could only force out some few at the opening with a pin. I separated a little bit of the tube with a file, to push out the cylinder of *platina*; but could not succeed without employing a great force: therefore I beat some part of the tube to pieces with a hammer, and found each particle had undergone a remarkable alteration. All of them appeared in several places to have been melted, and some little ones seemed to have been intirely in a fluid state; they all adhered in lumps together so strongly, that many of them

them could absolutely not be rubbed asunder between the fingers. The inside of the tube exhibited marks of having received impreffions of the melted metal. By comparing the separated particles of this *platina* with particles not exposed to an electrical explosion, they were scarce to be known for the same substance. I had put some iron filings in a tube of the same size, and directed the same explosion through it, in order to compare the effect of electricity upon it with what happened to the *platina*. I found, by looking at the outside, somewhat of the same appearance of being melted. By cutting this tube in small bits, I could easily push out the filings with a pin, which I could not do in the other case but with great force. The filings stuck together, as the particles of *platina* had done; but with less force. By this experiment it should seem as if *platina* (which hitherto could never be melted by common fire by itself, but only in the *focus* of a very strong burning glass, such as was a little while ago made at Paris) were equally fusible, if not more so than iron, by electrical fire. I was somewhat surprized to find, that the particles of *platina* taken out of the afore-said tube, had got a remarkably stronger magnetical force, being attracted by a loadstone at a greater distance, and turning their poles more briskly upon the water than before, though the whole cylinder of these particles, still inclosed in the tube, gave no signs of having acquired polarity. Thus it appears, that common fire diminishes the magnetical virtue of *platina*, and that electrical fire increases it; which I thought the more pro-

bable, because those very particles, which had acquired by electricity their increased magnetical force, did lose it again after being heated upon a piece of charcoal, which did not happen in the particles of iron. *Platina* mixed with lead was put upon an ordinary cupel in a docimastic furnace strongly heated. When the metal came to a solid state, it was a flat rough lump, much heavier than the crude *platina*. I put fresh lead to it, and cupelled it again as before. I repeated it ten times, when I obtained a large lump, somewhat less flat, pretty smooth, but not bright; of about the same weight as after the first cupellation^(b). This lump did not give the least sign of magnetism, and even would not receive any by being applied to strong magnetical bars (I forgot to try this after the first cupellation) and the substance was very brittle, nearly of the same colour as *platina*, and took a fine polish. If it could tend to any useful purpose, I would repeat these experiments oftener, to be quite sure whether the event would be constantly the same.

Though a piece of soft iron attracts the two poles of a compass indiscriminately, and is incapable of acquiring polarity itself, yet I have never been able to separate a single particle of the softest iron, even when I separated it carefully with a flint, or other body containing no steel or iron, without its giving evident signs of two distinct poles when floating upon water, nay even upon paper. I could also never find iron filings of ever so soft

(b) I lost the paper that contained the exact weight before and after the cupellation.

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a substance, but each particle separately had evidently two poles. Such iron filings mixed with bees wax, as much as is sufficient to keep them together, got a strong polarity by being touched with magnetical bars, and had all the qualities of a magnet: the mass is easily cut with a warm knife, and is very convenient for magnetical experiments, such as Dr. KNIGHT made with similar loadstones made of pounded magnets. I found also, that each particle of those granulated iron ores of Sweden, which are placed among the *minera ferri retractoria*, separated iron from stone, and had two distant poles; and that a piece of the ore itself became a tolerable good magnet by being touched with the bars.

I am, &c.