XV. *A Method of drawing extremely fine Wires.* *By* William Hyde Wollaston, *M. D. Sec. R. S.*

Read February 18, 1813.

It is recorded by Musschenbroek, that an artist of Augsburg drew a wire of gold so slender, that five hundred feet of it weighed only one grain; but the method by which this was effected is not mentioned, and indeed it has been doubted, whether it could really have been done. I shall however shew, that a wire of gold may, without much difficulty, be obtained finer than that spoken of by Musschenbroek, and that wires of platina may be drawn much more slender, with the utmost facility.

Those who draw silver wire in large quantities for lace and embroidery, sometimes begin with a rod that is about three inches in diameter, and ultimately obtain wires that are as small as $\frac{1}{500}$ of an inch in thickness. If in any stage of this process a rod of silver wire be taken, and a hole be drilled through it longitudinally, having its diameter one-tenth part of that of the rod, and if a wire of pure gold be inserted, so as to fill the hole, it is evident that by continuing to draw the rod, the gold within it will be reduced in diameter exactly in the same proportion as the silver; so that if both be thus drawn out together till the diameter of the silver is $\frac{1}{5\,00}$ of an inch, then that of the gold will be only $\frac{1}{5000}$; and of such wire five hundred and fifty feet would be requisite to weigh one grain.

For the purpose of removing the coating of silver that surrounds it, the wire must be steeped for a few minutes in warm nitrous acid, which dissolves the silver without danger of doing any injury to the gold. And though it might be difficult in this manner to preserve any considerable length of such wires, it is of little importance for any of those uses to which it is likely to be applied.

In my endeavours to make slender gold wires by the method above described, the difficulty of drilling the central hole in a metal so tough as fine silver, was greater than I had expected, and I was induced to try whether platina might not be substituted for the gold, as in that case its infusibility would allow me to coat it with silver without the necessity of drilling.

Having formed a cylindrical mould $\frac{1}{3}$ of an inch in diameter, I fixed in the centre of it a platina wire previously drawn to the $\frac{1}{100}$ of an inch, and then filled the mould with silver. When this rod was drawn to $\frac{1}{30}$, my platina was reduced to $\frac{1}{1000}$, and by successive reduction I obtained wires of $\frac{1}{4000}$ and $\frac{1}{5000}$, each excellent for applying to the eye-pieces of astronomical instruments, and perhaps as fine as can be useful for such purposes.*

Since this had been the primary object that I had in view, I should have thought my time ill bestowed in pursuing farther the practical application of a method to which there seems no limit, except the imperfections of the metal employed. But as I found by trial the tenacity of these wires to be greater than was to be expected in proportion to their substance, that

* No very accurate observations can be made with a telescope shorter than thirty inches, and at that distance $\frac{1}{7500}$ of an inch subtends only one second of a degree.

circumstance excited some doubts regarding the correctness of the estimate by which their diameter had been deduced. Other wires were consequently drawn with the utmost care, as to the quality and substance of the platina employed, and as to the proportional reduction of its diameter in the process of wire-drawing.

The extremity of a platina wire having been fused* into a globule nearly $\frac{1}{4}$ of an inch in diameter, was next hammered out into a square rod, and then drawn again into a wire $\frac{1}{253}$ of an inch in diameter. One inch of this wire duly coated with silver was drawn till its length was extended to 182 inches, consequently the proportional diminution of the diameter of the platina will be expressed by the square root of 182, so that its measure had become $\frac{1}{253 \times 13,5} = \frac{1}{3425}$. The specific gravity of the coated wire was assumed to be 10,5, and since the weight of 100 inches was 114 grains, its diameter was inferred to be $\frac{1}{42,8}$ of an inch, or just eighty times that of the platina contained in it.

With portions of the platina wire thus obtained, and successively reduced in diameter, I had an opportunity of repeating the trials of its tenacity with greater confidence in the justness of the estimate, and the results shewed generally (though with some accidental exceptions) that the process of wire-drawing, which is well known to improve the strength of

* I am indebted to my friend Dr. MARCET for the simple and easy method by which the fusion was effected. A piece of wire, about six inches long, having been bent to an angle in the middle, one half of its length was held in the flame of a spirit lamp impelled by a current of oxygen, and its extremity was thus fused in about half a minute.

metals within moderate limits, continued also to add something to the tenacity of platina even as far as $\frac{1}{18,000}$ of an inch, which supported $1\frac{1}{3}$ grain before it broke; but the wire on which these experiments were made began then to be impaired by repetition of the operation: so that although I afterwards obtained portions of it, as small as $\frac{1}{30,000}$ of an inch in diameter, it was in many places interrupted, and I could place no reliance upon any trials of its tenacity.

There are some little circumstances in the management of these fine wires, which it may be of advantage to describe for the assistance of those who would apply them to any useful purpose. When the diameter is not less than $\frac{1}{2000}$ or $\frac{1}{3000}$ of an inch, the difficulty of seeing and applying them in short pieces is not considerable; but when their diameter is farther reduced, and their length as much as an inch or more, the slightest current of air is sufficient to defeat all attempts to lay hold of an object so difficult to see, and so impossible to feel. It is therefore necessary to retain a part of the silver coating at each extremity, which, at the same time that it assists in finding the end, also serves to stretch the wire with a certain moderate tension, and affords the means of attaching it in any required position.

The method that I have found most convenient is to bend a portion of the coated wire into the shape of the letter U, with small hooks at its upper extremities. In this form it will conveniently hang upon a wire of gold or of platina, with the lowest part immersed in nitrous acid, till the coating of silver is removed from that part. It may then, without difficulty, be

lifted from its place, by one of the hooks alone, to any other situation, or suspended by it, with the other hook downwards, as the means of attaching a small chain, or other series of equal weights in trials of its tenacity.