XIV. *On the cutting diamond.* *By* W. H. Wollaston, *M. D. Sec. R. S.*

Read May 2, 1816.

When we consider how long the diamond has been in common use for the purpose of cutting glass, it is rather surprising that no adequate explanation has been given of that remarkable property, and that even the conditions on which the effect depends have not been duly investigated.

Many persons, indeed, are not aware of the distinction that is to be drawn between scratching and cutting. In the former, the surface is irregularly torn into a rough furrow; in the latter a smooth fissure, or superficial crack, is made, which should be continued without interruption from one end to the other of the line in which the glass is intended to be cut. The skilful workman then applies a small force solely at one extremity of this line, and the crack which he forms is led by the fissure almost with certainty to the other.

Any other substance harder than glass, possesses the power of *scratching* in common with the diamond. But the power of *cutting* has been thought confined to the diamond; and it is true that its peculiar hardness certainly contributes to the duration of that power.

I was informed that persons employed in setting diamonds for the use of the glazier, always select natural diamonds distinctly crystallized, which they term sparks; but upon what

circumstance this supposed superiority of the natural diamond over that which has been cut by art, could depend, I was not able to gain any information.

Having procured a common glazier's diamond ready set, and such a quantity of glass as I thought would be sufficient for learning by experiment the art of cutting, I endeavoured first by forcible pressure on the point in different directions to effect my purpose. But although I could thus tear the surface to a considerable depth, I could by no means command the direction of the fracture.

When I placed the diamond more inclined to the surface, I could occasionally, and in part, obtain what I thought to be a proper cut; but I was unable to continue the stroke with steadiness, and so incapable of repeating it a second time with a similar effect, that I was convinced the precise direction necessary for cutting was confined within very narrow limits.

Having found that the diamond required to be moved in the direction of one of its edges, and having by repeated trials formed a judgment of the requisite inclination of its handle, I mounted it in a frame, in which I could fix it at any angle of elevation that appeared suitable, and could turn it round its axis to adjust the direction of its edge. By this arrangement I had no difficulty in repeating any successful trial, or of varying it according to hints derived from such imperfections as were observable; and I soon discovered that difference in the form of the natural diamond, from that of diamonds cut by art, on which I believe the power of cutting to depend.

When a diamond is formed and polished by the lapidary, all the suafaces are *plain* surfaces, as far as it is in his power to make them so, and consequently the edge or line in which

they meet is straight. But in the natural diamond there is this peculiarity in those modifications of its crystals that are chosen for this purpose, that the surfaces are in general all *curved*, and consequently the meeting of any two of them presents a curvilinear edge. If the diamond be so placed, that the line of the intended cut is a tangent to this edge near to its extremity, and if the two surfaces of the diamond laterally adjacent be equally inclined to the surface of the glass, then the conditions necessary for effecting the cut are complied with. The curvature, however, of the edge is not considerable, and consequently the limits of inclination are very confined; for if the handle be either too much or too little elevated, then one or other extremity of the curve will be made to bear angularly upon the glass, and will plough a ragged groove by pressure of its point. But on the contrary, when the contact is duly formed, a simple fissure is effected as if by lateral pressure of the adjacent surfaces of the diamond directed equally to each side. By that means, adjacent portions at the surface of the glass are forced asunder farther than the mere elasticity of the parts beneath will allow, and a partial separation or superficial crack is produced.

The effects of inequality in the lateral inclination of the faces of the diamond to the surface of the glass, are different according to the degree of inequality. If the difference be very small the cut may still be clean; but as the fissure is then not at right angles to the surface, the subsequent fracture is found inclined accordingly. But when an attempt is made to cut with an inclination that deviates still more from the perpendicular, the glass is found superficially flawed out

on that side to which the greater pressure was directed, and the cut completely fails.

It might be thought that the weakness of the glass in this part would nevertheless occasion it to break in the desired direction; but the bottom of a flaw is in fact of very great breadth when compared to the simple crack produced in a proper cut. In one case the force applied to break the glass is dispersed over a space of some extent, and may be diverted from its course; in the other the whole force is confined successively to the mere points of a mathematical line, which may be conceived the bottom of the fissure, and is directed onward by the facility with which the adhesion of each particle in succession yields to its progress.

The depth to which the fissure made by the diamond penetrates, need not be greater than $\frac{1}{200}$ of an inch, for I found that the fracture might be completely turned from its course, at any part of the intended line, by grinding away a portion of the surface; and by an average of several experiments the thickness of the glass was not found to be diminished so much as $\frac{6}{1000}$ths of an inch.

Since the form of the cutting edge appeared from the above trials to be the principal circumstance on which the property of cutting depends, I thought it not improbable that other stones possessed of the requisite hardness, might be found to produce the same effect, if brought to a similar curvilinear edge. By a little pains I succeeded in giving this form to a sapphire, a ruby, a spinell ruby, to rock crystal, and some other substances, and found that each of these bodies has the power of cutting glass for a short time with

a clean fissure. But notwithstanding the hardness of the ruby was such as to occasion a great deal of labour in giving it the form I wished, the edge of this stone was by no means proportionally lasting. I am inclined to ascribe this defect in part to the grain or position of its laminæ having been unluckily oblique. And it seems highly probable that the singular durability of the edge of the cutting diamond, is owing in some measure to this circumstance, that its hardness in the direction of the natural angle of its crystal, is greater than in any other direction, as we find to be the case in other crystals of which the various degrees of hardness in different directions can be more easily examined.