particles of bodies, when stretched or compressed, are very nearly in the proportion of the distances to which the par­ticles are drawn from their natural positions. Now, al­though we are certain that, in enormous compressions, the forces increase faster than in this proportion, this makes no sensible change in the present question, because the body is broken before the compressions have gone so far ; nay, we imagine that the compressed parts are crippled in most cases even before the extended parts are torn asunder Muschenbroeck asserts this with great confidence with re­spect to oak, on the authority of his own experiments. He says, that although oak will suspend half as much again as fir, it will not support, as a pillar, two thirds of the load which fir will support in that form.

We imagine therefore that the mechanism in the *present* case is nearly as follows:

Let the beam DCK∆ (fig. 21) be loaded at its extre­mity with the weight P, acting in the direction KP perpendicular to DC. Let D∆ be the section of fracture. Let DA be about one third of D∆. A will be the particle or fibre which is neither extended nor compressed. Make ∆δ = D*d* = DA : A∆. The triangles DA*d*, ∆Aδ, will represent the ac­cumulated attracting and repelling forces. Make AI and A*i* = 1/3 DA and 1/3 ∆A. The point I will be that to which the full cohesion D*d* or *f* of the particles in AD must be applied, so as to produce the same momentum which the variable forces at I, D, &c. really produce at their several points of application. In like manner, *i* is the circle of similar effort of the repulsive forces excited by the com­pression between A and Δ, and it is the real fulcrum of a bended lever I*i*K, by which the whole effect is pro­duced. The effect is the same as if the full cohesion of the stretched fibres in AD were accumulated in I, and the full repulsion of all the compressed fibres in A∆ were accumu­lated in *i*. The forces which are balanced in the opera­tion are the weight P, acting by the arm *ki,* and the full cohesion of AD acting by the arm It. The forces exerted by the compressed fibres between A and Δ only serve to give support to the lever, that it may exert its strain.

We imagine that this does not differ much from the real procedure of nature. The position of the point A may be different from what we have deduced from Buffon’s expe­riments, compared with Muschenbroeck’s value of the ab­solute cohesion of a square inch. If this last should be only 12,000, DA must be greater than we have here made it, in the proportion of 12,000 to 16,000. For It must still be made = 1/3 A∆, supposing the forces to be proportional to the extensions and compressions. There can be no doubt that a part only of the cohesion of D∆ operates in resisting the fracture in all substances which have any com­pressibility ; and it is confirmed by the experiments of Μ. Duhamel on willow, and the inferences are by no means confined to that species of timber. We say, therefore, that when the beam is broken, the cohesion of AD alone is ex­erted, and that each fibre exerts a force proportional to its extension ; and the accumulated momentum is the same as if the full cohesion of AD were acting by the lever It = 1/3d of D∆.

It may be said, that if only one third of the cohesion of oak be exerted, it may be cut two thirds through without weakening it. But this cannot be, because the cohesion of the whole is employed in preventing the lateral slide so often mentioned. We have no experiments to determine that it *may not* be cut through one third without loss of its strength.

This must not be considered as a subject of mere specu­lative curiosity. It is intimately connected with all the practical uses which we can make of this knowledge; for it is almost the only way that we can learn the compressibility of timber. Experiments on the direct cohesion are indeed difficult, and exceedingly expensive if we attempt them in large pieces. But experiments on compression are almost impracticable. The most instructive experiments would be, first to establish, by a great number of trials, the trans­verse force of a moderate batten ; and then to make a great number of trials of the diminution of its strength, by cutting it through on the concave side. This would very nearly give us the proportion of the cohesion which really operates in resisting fractures. Thus if it be found that one half of the beam may be cut on the under side without diminution of its strength (taking care to drive in a slice of harder wood), we may conclude that the point A is at the middle, or somewhat above it.

Much lies before the curious mechanician, and we are as yet very far from a scientific knowledge of the strength of timber.

In the mean time, we may derive from these experiments of Buffon a very useful practical rule, without relying on any value of the absolute cohesion of oak. We see that the strength is nearly as the breadth, as the square of the depth, and as the inverse of the length, it is most conve­nient to measure the breadth and depth of the beam in inches, and its length in feet. Since, then, a beam four inches square and seven feet between the supports is broken by 5312 pounds, we must conclude that a batten one inch square and one foot between the supports will be broken by 581 pounds. Then the strength of any other beam of oak, or the weight which will just break it when hung on *bd2*

its middle, is 581 -y.

But we have seen that there is a very considerable devi­ation from the inverse proportion of the lengths, and we must endeavour to accommodate our ride to this deviation. We found, that by adding 1245 to each of the ordinates or numbers in the column of the five-inch bars, we had a set of numbers very nearly reciprocal of the lengths ; and if we make a similar addition to the other columns in the propor­tion of the cubes of the sixes, we have nearly the same re­sult. The greatest error (except in the case of experi­ments which are very irregular) does not exceed 1/15th of the whole. Therefore, for a radical number, add to the 5312 the number 640, which is to 1245 very nearly as 43 to 53. This gives 5952. The 64th of this is 93, which corre­sponds to a bar of one inch square and seven feet long. Therefore 93 × 7 will be the reciprocal corresponding to a bar of one foot. This is 651. Take from this the present empirical correction, which is b40/b4, or 10, and there re­mains 641 for the strength of the bar. This gives us for a general rule *p —* 651 — 10 *bd?.*

*Example.* Required the weight necessary to break an oak beam eight inches square and twenty feet between the props, *p* = 651 × —~~×θ~~ ■ 10 × 8 × 8t. This is 11,545, whereas the experiment gives 11,487. The error is very small indeed. The rule is most deficient in comparison with the five-inch bars, which, we have already said, appear stronger than the rest.

The following process is easily remembered by such as are not algebraists.

Multiply the breadth in inches twice by the depth, and