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

Multiply the breadth in inches twice by the depth, and call this product f*.* Multiply by 651, and divide by the length in feet. From the quotient take 10 times f*.* The remainder is the number of pounds which will break the beam.

We are not ſufficiently ſenſible of our principles to be confident that the correction 10 f ſhould be in the propor­tion of the ſection, although we think it moſt probable. It is quite empirical, founded on Buffon’s experiments. There­fore the ſafe way of using this rule is to ſuppoſe the beam ſquare, by increaſing or diminiſhing its breadth till equal to the depth. Then find the ſtrength by this rule, and diminiſh or increaſe it for the change which has been made in its breadth. Thus, there can be no doubt that the ſtrength of the beam given as an example is double of that of a beam of the same depth and half the breadth.

The reader cannot but obſerve that all this calcula­tion relates to the very greateſt weight which a beam will bear for a very few minutes. Mr Buffon uniformly found that two-thirds of this weight ſenſibly impaired its ſtrength, and frequently broke it at the end of two or three months. One-half of this weight brought the beam to a certain bend, which did not increaſe after the firſt minute or two, and may be borne by the beam for any length of time. But the beam contracted a bend, of which it did not recover any conſiderable portion. One-third ſeemed to have no permanent ef­fect on the beam ; but it recovered its rectilineal ſhape com­pletely, even after having been loaded ſeveral months, pro­vided that the timber was ſeaſoned when firſt loaded ; that is to ſay, one-third of the weight which would quickly break a ſeaſoned beam, or one-fourth of what would break one just felled, may lie on it for ever without giving the beam a sett.

We have no detail of experiments on the ſtrength of other kinds of timber : only Mr Buffon says, that fir has about 6/10ths of the ſtrength of oak ; Mr Parent makes it 10/12ths ; Emerſon, 2/3ds, &c.

We have been thus minute in our examination of the mechanism of this transverſe ſtrain, becauſe it is the greateſt to which the parts of our machines are exposed. We wiſh to impreſs on the minds of artiſts the neceſſity of avoiding this as much as poſſible. They are improving in this reſpect, as may be ſeen by comparing the centres on which ſtone arches of great ſpan are now turned with thoſe of former times. They were formerly a load of mere joiſts reſting on a multitude of poſts, which obſtructed the navigation, and were frequent­ly losing their ſhape by ſome of the poſts sinking into the ground. Now they are more generally trusses, where the beams abutt on each other, and are relieved from tranſverſe strains. But many performances of eminent artiſts are ſtill very injudiciouſly expoſed to croſs ſtrains. We may inſtance one which is considered as a fine work, viz. the bridge at Walton on Thames. Here every beam of the great arch is a joiſt, and it hangs together by framing. The fineſt piece of carpentry that we have ſeen is the centre em­ployed in turning the arches of the bridge at Orleans, deſcribed by Perronet. In the whole there is not one croſs ſtrain. The beam, too, of Hornblower’s ſteam-engine, deſcribed in that article, is very ſcientifically conſtructed.

IV. The laſt ſpecies of ſtrain which we are to examine is that produced by twilling. This takes place in all axles which connect the working parts of machines.

Although we cannot pretend to have a very diſtinct con­ception of that modification of the coheſion of a body by which it reſiſts this kind of ſtrain, we can have no doubt that, when all the particles act alike, the reſiſtance must be proportional to the number. Therefore if we ſuppoſe the two parts ABCD, ABFE (fig. 24.), of the body EFCD to be of inſuperable ſtrength, but cohering more weakly in the common ſurface AB, and that one part ABCD is pushed laterally in the direction AB, there can be no doubt that it will yield only there, and that the reſiſtance will be pro­portional to the ſurface.

In like manner, we can conceive a thin cylindrical tube, of which KAH (fig. 25.) is the ſection, as cohering more weakly in that ſection than anywhere else. Suppoſe it to be graſped in both hands, and the two parts twiſted round the axis in oppoſite directions, as we would twiſt the two joints of a flute, it is plain that it will firſt fail in this ſection, which is the circumference of a circle, and the particles of the two parts which are contiguous to this circumference will be drawn from each other laterally. The total reſiſt­ance will be as the number of equally reſiſting particles, that is, as the circumference (for the tube being ſuppoſed very thin, there can be no ſenſible difference between the dilatation of the external and internal particles). We can now ſuppoſe another tube within this, and a third within the ſecond, and ſo on till we reach the centre. If the par­ticles of each ring exerted the ſame force (by ſuffering the same dilatation in the direction of the circumference), the reſiſtance of each ring of the ſection would be as its circum­ference and its breadth (ſuppoſed indefinitely ſmall), and the whole reſiſtance would be as the ſurface ; and this would repreſent the reſiſtance of a ſolid cylinder. But when a cy­linder is twiſted in this manner by an external force appli­ed to its circumference, the external parts will ſuffer a greater circular extenſion than the internal ; and it appears that this extenſion (like the extenſion of a beam ſtrained tranſverſely) will be proportional to the diſtance of the par­ticles from the axis. We cannot ſay that this is demonſtrable, but we can aſſign no proportion that is more pro­bable. This being the case, the forces simultaneouſly ex­erted by each particle will be as its diſtance from the axis. Therefore the whole force exerted by each ring will be as the ſquare of its radius, and the accumulated force actually exerted will be as the cube of the radius ; that is, the accu­mulated force exerted by the whole cylinder, whoſe radius is CA, is to the accumulated force exerted *at the ſame time* by the part whoſe radius is CE, as CA3 to CE3.

The whole coheſion now exerted is juſt two-thirds of what it would be if all the particles were exerting the ſame attractive forces which are juſt now exerted by the particles in the external circumference. This is plain to any perſon in the leaſt familiar with the fluxionary calculus. But ſuch as are not may eaſily ſee it in this way.

Let the rectangle AC *c a* be ſet upright on the ſurface of the circle along the line CA, and revolve round the axis C*c.* It will generate a cylinder whoſe height is Cc or A*a,* and having the circle KAH for its baſe. If the diagonal C*a* be ſuppoſed also to revolve, it is plain that the triangle *c*C*a* will generate a cone of the ſame height, and having for its baſe the circle deſeribed by the revolution of *ca,* and the point C for its apex. The cylindrical ſurface generated by Aa will expreſs the whole coheſion exerted by the circumference AHK, and the cylindrical ſurface ge­nerated by E*e* will repreſent the coheſion exerted by the circumference ELM, and the ſolid generated by the triangle CA*a* will repreſent the coheſion exerted by the whole circle AHK, and the cylinder generated by the rectangle AC*ca* will repreſent the coheſion exerted by the ſame ſur­face if each particle had ſuffered the extenſion A*a.*

Now it is plain, in the first place, that the ſolid genera­ted by the triangle *e*EC is to that generated by *a*AC as EC3 to AC3. In the next place, the ſolid generated by