its original dimenſions on the ceſſation of the changing force, the extensions or compreſſions are ſensibly proportional to the extending or compreſſing forces ; and therefore *the connecting forces are proportional to the distances of the particles from their quieſcent, neutral, or inactive positions.* This ſeems to have been firſt viewed as a law of nature by the penetra­ting eye of Dr Robert Hooke, one of the moſt eminent philoſophers of the laſt century. He publiſhed a cipher, which he ſaid contained the theory of ſpringineis and of the mo­tions of bodies by the action of springs. It was this, *cc i i i n o s s s t t u u.—*When explained in his diſſertation, publiſh­ed ſome years after, it was ut *tensio sic vis.* This is preciſely the propoſition juſt now aſſerted as a general fact, a law of nature. This diſſertation is full of curious obſervations of facts in ſupport of his aſſertion. In his application to the motion of bodies he gives his noble diſcovery of the balance-ſpring of a watch, which is founded on this law. The ſpring, as it is more and more coiled up, or unwound, by the motion of the balance, acts on it with a force proportional to the diſtance of the balance from its quieſcent poſition. The balance therefore is acted on by an accelerating force, which varies in the ſame manner as the force of gravity act­ing on a pendulum ſwinging in a cycloid. Its vibrations therefore muſt be performed in equal time, whether they are wide or narrow. In the ſame diſſertation Hooke mentions all the facts which John Bernoulli afterwards adduced in ſup­port of Leibnitz’s whimſical doctrine of the force of bodies in motion, or the doctrine of the *vires vives;* a doctrine which Hooke might juſtly have claimed as his own, had he not ſeen its futulity.

Experiments made ſince the time of Hooke ſhow that this law is ſtrictly true in the extent to which we have li­mited it, viz. in all the changes of form which will be com­pletely undone by the elaſticity of the body. It is nearly true to a much greater extent. James Bernoulli, in his diſ­ſertation on the elaſtic curve, relates ſome experiments of his own, which ſeem to deviate conſiderably from it ; but on cloſe examination they do not. The fineſt experiments are thoſe of Coulomb, publiſhed in ſome late volumes of the me­moirs of the Academy of Paris. He ſuſpended balls by wires, and obſerved their motions of oſcillation, which he found accurately correſponding with this law.

This we ſhall find to be a very important fact in the doc­trine of the ſtrength of bodies, and we deſire the reader to make it familiar to his mind. If we apply to this our man­ner of expreſſing theſe forces by perpendicular ordinates *C c, D d* (fig. 1.), we muſt take other ſituations E, F, of the particle B, and draw E *e,* Ff*;* and we muſt have D *d* : F f = BD : EF, or C *c* : E *e =* EC : BE. In ſuch a ſuppoſition F-*d* B *c e* muſt be a ſtraight line. But we ſhall havg abundant evidence by and by that this cannot be ſtrictly true, and that the line B c *e* which limits the ordinates ex­preſſing the attractive forces becomes concave towards the line ABE, and that the part B *d f* is convex towards it. All that can be ſafely concluded from the experiments hi­therto made is, that *to a certain extent* the forces, both at­tractive and repulſive, are sensi*bly* proportional to the dilata­tions and compreſſions. For,

*5thly,* It is univerſally observed, that when the dilatations have proceeded a certain length, a leſs addition of force is sufficient to increaſe the dilatation in the ſame degree. This is always obſerved when the body has been ſo far ſtretched that it takes a ſet, and does not completely recover its form. The like may be generally obſerved in compreſſions. Moſt perſons will recollect, that in violently ſtretching an elaſtic cord, it becomes ſuddenly weaker, or more eaſily ſtretched. But theſe phenomena do not poſitively prove a diminution of the corpuſcular force acting on one particle ; It more probably ariſes from the diſunion of ſome particles, whoſe action contributed to the whole or ſenſible effect. And in compreſſions we may ſuppoſe ſomething of the ſame kind ; for when we compreſs a body in one direction, it common­ly bulges out in another; and in cases of very violent action ſome particles may be diſunited, whoſe tranſverſe action had formerly balanced *part* of the compreſſing force. For the reader will ſee on reflection, that ſince the compreſſion in one direction causes the body to bulge out in the tranſverſe direction ; and ſince this bulging out is in oppoſition to the tranſverſe forces of attraction, it muſt employ ſome part of the compreſſing force. And the common appearances are in perfect uniformity with this conception of things. When we preſs a bit of dryiſh clay, it ſwells out and cracks tranſverſely. When a pillar of wood is overloaded, it ſwells out, and ſmall crevices appear in the direction of the fibres. After this it will not bear half of the load. This the carpenters call crippling ; and a knowledge of the circumſtances which modify it is of great importance, and enables us to underſtand ſome very paradoxical appearances, as will be ſhown byand by.

This partial diſuniting of particles formerly cohering is, we imagine, the chief reaſon why the totality of the forces, which really oppoſe an external ſtrain does not increaſe in the proportion of the extenſions and compreſſions. But ſufficient evidence will also be given that the forces which would connect one particle with one other particle do not augment in the accurate proportion of the change of diſtance ; that in extenſions they increaſe more ſlowly, and in compreſſions more rapidly.

But there is another cauſe of this deviation perhaps equal­ly effectual with the former. Moſt bodies manifeſt ſome de­gree of ductility. Now what is this ? The fact is, that the parts have taken a new arrangement, in which they again cohere. Therefore, in the passage to this new arrangement, the ſenſible forces, which are the joint reſult of many corpuſcular forces, begin to reſpect this new arrangement inſtead of the former. This muſt change the ſimple law of corpuſcular force, characteriſtic of the particular ſpecies of matter under examination. It does not require much reflec­tion to convince us that the poſſible arrangements which the particles of a body may acquire, without appearing to change their nature, muſt be more numerous according as the par­ticles are of a more complex conſtitution ; and it is reaſonable to suppoſe that the conſtitution even of the moſt ſimple kind of matter that we are acquainted with is exceedingly complex. Our microſcopes ſhow us animals ſo minute, that a heap of them muſt appear to the naked eye an uniform maſs with a grain finer than that of the fineſt marble or ra­zor hone ; and yet each of theſe has not only limbs, but bones, muſcular fibres, blood-vessels, fibres, and a blood consiſting, in all probability, of globules organiſed and complex like, our own. The imagination is here loſt in wonder; and no­thing is left us but to adore inconceivable art and wisdom, and to exult in the thought that we are the only ſpectators of this beautiful ſcene who can derive pleaſure from the view. What is trodden under foot with indifference, even by the half-reaſoning elephant, may be made by us the ſource of the pureſt and moſt unmixed pleaſure. But let us proceed, to obſerve,

*6thly,* That the forces which connect the particles of tan­gible bodies change by a change of diſtance, not only in de­gree, but alſo in kind. The particle B (fig. 1.) is attracted by A when in the situation C or E. It is repelled by it when. at D or F. It is not affected by it when in the ſituation B. The reader is requeſted carefully to remark, that this is not an infe­rence founded on the authority of our mathematical figure. The figure is an expreſſion (to aſſiſt the imagination) of facts in na­ture. It requires no force to keep the particles of a body in