provided it has a ſufficient degree of ſtiffneſs : but as ſoon as it begins to give way, it is evident it muſt bend in a convex manner, ſince its middle would obey the forces C *c* and D d*,* while its extremities would be ac­tually drawn downwards by the forces A *a* and B *b.*

The vessel is generally found in ſuch a ſituation ; and ſince similar efforts continually act whilſt the veſſel is immerſed in the water, it happens but too often that the keel experiences the bad effect of a ſtrain. It is therefore very important to inquire into the true cauſe of this accident.

For this purpoſe, let us conceive the vessel to be di­vided into two parts by a tranſverſe ſection through the vertical axis of the veſſel, in which both the centre of gravity G (fig. 51.) of the whole veſſel and that of the immerſed part are ſituated : ſo that one of them wall repreſent the head part, and the other that of the ſtern, each of which will be considered ſeparately. Let *g* be the centre of gravity of the entire weight of the firſt, and *o* that of the immerſed part correſponding. In like manner, let *y* be the centre of gravity of tire whole after part, and w that of its immediate por­tion.

Now it is plain, that the head will be acted upon by the two forces g *m* and o n*,* of which the firſt will preſs it down, and the latter puſh it up. In the ſame man­ner, the ſtern will be preſſed down by the force γμ, and puſhed up by the force ων. But theſe four forces will maintain themſelves in equilibrium, as well as the total forces reunited in the points G and O, which are equi­valent to them ; but whilſt neither the forces before nor thoſe behind fall in the ſame direction, the veſſel will evidently ſuſtain efforts tending to bend the keel upwards, if the two points ο *ω* are nearer the middle than the two other forces *g m* and γμ contrary effect would happen if the points ο and ω were more diſtant from the middle than the points *g* and *γ.*

But the firſt of theſe two cauſes uſually takes place almoſt in all veſſels, ſince they have a greater breadth towards the middle, and become more and more narrow towards the extremities ; whilſt the weight of the veſſel is in proportion much more conſiderable towards the extremities than at the middle. From whence we see, that the greater this difference becomes, the more alſo will the veſſel be ſubject to the forces which tend to bend its keel upwards. It is therefore from thence that we muſt judge how much ſtrength it is neceſſary to give to this part of the veſſel, in order to avoid ſuch a conſequence.

If other circumſtances would permit either to load the veſſel more in the middle, or to give to the part immerſed a greater capacity towards the head and ſtern, ſuch an effect would no longer be apprehended. But the deſtination of moſt veſſels is entirely oppoſite to ſuch an arrangement : by which means we are obliged, to ſtrengthen the keel as much as may be neceſſary, in order to avoid ſuch a diſaſter.

We ſhall conclude this chapter with the following practical obſervations on the hogging and fagging of ſhips by Mr Hutchinſon of Liverpool :.

“ When ſhips with long floors happen to be laid a- dry upon mud or fand, which makes a ſolid reſiſtance againſt the long ſtraight floors amidſhips, in compan­ion with the two ſharp ends, the entrance and run meet with little ſupport, but are preſſed down, lower than the flat of the floor, and in proportion hogs the ſhip amid­ſhips ; which is too well known from experience to occaſion many total loſſes, or do ſo much damage by hogging them, as to require a vaſt deal of trouble and expence to save and repair them, ſo as to get the hog taken out and brought to their proper ſheer again : and to do this the more effectually, the owners have often been induced to go to the expence of lengthening them; and by the common method, in proportion as they add to the burden of theſe ſhips, by lengthening their too long ſtraight floors in their main bodies amidſhips, ſo much do they add to their general weakneſs to bear hardſhips either on the ground or afloat ; for the ſcantling of their old timber and plank is not proportionable to bear the additional burden that is added to them.

“ But defects of this kind are beſt proved from real and inconteſtable tacts in common practice. At the very time I was writing upon this ſubject, I was called upon for my advice by the commander of one of those ſtrong, long, ſtraight floored ſhips, who was in much trouble and distraction of mind for the damage his ſhip had taken by the pilot laying her on a hard, gentle ſloping sand, at the outſide of our docks at Li­verpool, where it is common for ſhips that will take the ground to lie for a tide, when it proves too late to get into our wet docks. After recommending a pro­per ſhip carpenter, I went to the ſhip, which lay with only a ſmall keel, yet was greatly hogged, and the butts of her upper works ſtrained greatly on the lee- side ; and the learns of her bottom, at the lower fut­tock heads, vaſtly opened on the weather side : all which ſtrained parts were agreed upon not to be caulk­ed, but filled with tallow, putty, or clay, &c. with raw bullocks hides, or canvas nailed with battons on her bottom, which prevented her sinking with the flow of the tide, without hindering the preſſure of water from righting and doling the ſeams again as ſhe floated, ſo as­to enable them to keep her free with pumping. This veſſel, like many other inſtances of ſhips of this conduc­tion that I have known, was ſaved and repaired at a very great expence in our dry repairing docks. And that them bottoms not only hog upwards, but ſag (or curve) downwards, to dangerous and fatal degrees, ac­cording to the ſtrain or preſſure that prevails upon them, will be proved from the following tacts :

“ It has been long known from experience, that when ſhips load deep with very heavy cargoes or ma­terials that are flowed too low, it makes them ſo very labourſome at ſea, when the waves run high, as to roll away their masts ; and after that misfortune cauſes them to labour and roll the more, ſo as to endanger their working and ſtraining themſelves to pieces : to prevent which, it has been long a common practice to leave a great part of their fore and after holds empty, and to ſtow them as high as poſſible in the main body at mid- ſhips, which cauſes the bottoms of theſe long ſtraight floored ſhips to ſag downwards; in proportion as the weight of the cargo flowed there exceeds the preſſure of the water upwards, ſo much ſo as to make them, dangerouſly and fatally leaky.

“ I have known many inſtances of thoſe ſtrong ſhips of 500 or 600 tons burdens built with long ſtraight floors, on the eaſt coast of England, for the coal and timber trade, come loaded with timber from the Baltic