*ſpr2*

(Rotation, n⁰ 30 ) < = ce. Therefore, finally, v = F/M × c + nz/ce + nz2. Had there been no addition of matter Mce + nz2

made, we ſhould have had *v =* F/M × —. It remains to M*ce* ſhow, that z may be ſo taken that c/ce may be leſs than c + nz / ce + nz2

—-——,. Now, if *c* be to z as *ce* to z2 that is, if z be taken equal to e, the two fractions will be equal. But if z be leſs than r, that is, if the additional matter is placed anywhere between S and G, the complex fraction will be greater than the fraction c/ce, and the velo­city of rotation will be increaſed. There is a particular diſtance which will make it the greateſt poſſible, name­ly, when z is made = — (√c2 + *nce - c),* as will easily be found by treating the fraction c + nz , with *ce* + nz2

z, conſidered as the variable quantity, for a maximum. In what we have been saying on this ſubject, we have conſidered the rotation only in as much as it is per­formed round the centre of gravity, although in every moment it is really performed round a ſpontaneous axis lying beyond that centre. This was done becauſe it af­forded an eaſy inveſtigation, and any angular motion round the centre of gravity is equal to the angular motion round any other point. Therefore the extent and the time of the evolution are accurately defined.— From obſerving that the energy of the force F is pro­portional to *q*G, an inattentive reader will be apt to conceive the centre of gravity as the centre of motion, and the rotation as taking place became the momenta of the ſails and rudder, on the oppoſite ſides of the centre of gravity, do not balance each other. But we must always keep in mind that this is not the cauſe of the ro­tation. The cauſe is the want of equilibrium round the point C (fig. 10.), where the actions of the water balance each other. During the evolution, which conſiſts of a rotation combined with a progressive motion, this point C is continually ſhifting, and the unbalanced momenta which continue the rotation always reſpect the momentary ſituation of the point C. It is nevertheleſs always true that the energy of a force F is proportional coe*teris paribus)* to *q*G, and the rotation is always made in the same direction as if the point G were real­ly the centre of converſion. Therefore the mainſail acts always (when oblique) by puſhing the stern away from the wind, although it ſhould ſometimes act on a point of the vertical lever through C, which is a head of C.

Theſe obſervations on the effects of the sails and rudder in producing a converſion, are ſufficient for ena­bling us to explain any case of their action which may occur. We have not conſidered the effects which they tend to produce by inclining the ſhip round a horizon­tal axis, viz. the motions of rolling and pitching. See **Rolling** and **Pitching.** To treat this ſubject pro­perly would lead us into the whole doctrine of the equi­librium of floating bodies, and it would rather lead to maxims of conſtruction than to maxims of manœuvre. M. Bouguer’s *Traité du Navire* and Euler’s *Scientia Navalis* are excellent performances on this ſubject,

and we are not here obliged to have recourſe to any erroneous theory.

It is eaſy to fee that the lateral preſſure both of the wind on the sails and of the water on the rudder tends to incline the ſhip to one side. The s\ails alſo tend to press the ſhip’s bows into the water, and, if ſhe were kept from advancing, would preſs them down conſiderably. But by the ſhip’s motion, and the prominent form of her bows, the resiſtance of the water to the fore part of the ſhip produces a force which is directed upwards. The sails alſo have a ſmall tendency to raise the ſhip, for they conſtitute a ſurface which in general ſeparates from the plumb-line below. This is remark­ably the case in the staysails, particularly the jib and fore-topmaſt ſtayſail. And this helps greatly to ſoften the plunges of the ſhip’s bows into the head leas. The upward preſſure alſo of the water on her bows, which we juſt now mentioned, has a great effect in oppoſing the immerſion of the bows which the sails produce by acting on the long levers furnished by the mails. M. Bouguer gives the name of *point velique* to the point V (fig. 12.) of the mail, where it is cut by the line CV, which marks the mean place and direction of the whole impulſe of the water on the bows. And he obſerves, that if the mean direction of all the actions of the wind on the ſails be made to paſs alſo through this point, there will be a perfect equilibrium, and the ſhip will have no tendency to plunge into the water or to rise out of it; for the whole action of the water on the bows, in the direction CV, is equivalent to, and may be reſolved into the action CE, by which the progreſſive motion is reſiſted, and the vertical action CD, by which the ſhip is raiſed above the water. The force CE must be oppoſed by an equal force. VD, exerted by the wind on the ſails, and the force CD is oppoſed by the weight of the ſhip. If the mean effort of the ſails

paſſes above the point V, the ſhip’s bows will be preſſed into the water; and if it paſs below V, her ſtern will be preſſed down. But, by the union of theſe forces, ſhe will rise and fall with the ſea, keeping always in a parallel poſition. We apprehend that it is of very little moment to attend to the ſituation of this point. Ex­cept when the ſhip is right afore the wind, it is a thouſand chances to one that the line CV of mean reliſtance does not paſs through any maſt; and the fact is, that the ſhip cannot be in a ſtate of uniform motion on any other condition but the perfect union of the line of mean action of the ſails, and the line of mean action of the reſiſtance. But its place ſhifts by every change of leeway or of trim; and it is impoſſible to keep theſe lines in one constant point of interſection for a moment, on account of the inceſſant changes of the ſurface of the water on which ſhe floats. M. Bouguer’s obſervations on this point are, however, very ingenious and original.

We conclude this diſſertation, by deſcribing ſome of the chief movements or evolutions. What we have ſaid hitherto is intended for the instruction of the artist, by making him ſenſible of the mechanical procedure, The deſcription is rather meant for the amuſement of the landsman, enabling him to understand operations that are familiar to the ſeaman. The latter will per­haps ſmile at the awkward account given of his business by one who cannot hand, reef, nor steer.

***To tack*** *Ship.*

The ſhip muſt firſt of all be kept full, that is, with