three sails cut it in the points i, k, and m. This line i m maybe considered as a lever, moveable round C, and acted on at the points *i, k,* and *m,* by three forces. The rotatory momentum of the ſails on the mizenmaſt is D*i* × iC; that of the ſails on the mainmaſt is E*e × k*C; and the momentum of the ſails on the fore- maſt is Ff *×* *m*C. The two firſt tend to preſs forward the arm Ci, and then to turn the ſhip’s head towards the wind. The action of the ſails on the foremaſt tends to pull the arm Cm forward, and produce a contrary rotation. If the ſhip under theſe three ſails keeps ſteadily in her courſe, without the aid of the rudder, we muſt have Di *×* iC + Ee *× k*C = F*ſ × m*C. This is very poſſible, and is often ſeen in a ſhip under her mizen-topſail, main-topsail, and fore-top sail, all parallel to one another, and their ſurfaces duly proportioned by reefing. If more ſails are ſet, we muſt always have a ſimilar equilibrium. A certain number of them will have their efforts directed from the larboard arm of the lever *im* lying to lee-ward ol CI, and a certain number will have their efforts directed from the ſtarboard arm lying to windward of CI. The ſum of the products of each of the firſt ſet, by their diſtances from C, muſt be equal to the ſum of the ſimilar products of the other ſet. As this equilibrium is all that is neceſſary for preſerving the ſhip’s poſition, and the ceſſation of it is im­mediately followed by a converſion; and as theſe ſtates of the ſhip may be had by means of the three ſquare ſails only, when their ſurfaces are properly proportion­ed—it is plain that every movement may be executed and explained by their means. This will greatly simplify our future diſcuſſions. We ſhall therefore ſuppoſe in future that there are only the three topſails ſet, and that their ſurfaces are ſo adjuſted by reefing, that their actions exactly balance each other round that point C of the middle line AB, where the actions of the water on the different parts of her botttom in like manner balance each other. This point C may be differently ſituated in the ſhip according to the leeway ſhe makes, depend­ing on the trim of the ſails; and therefore although a certain proportion of the three ſurfaces may balance each other in one ſtate of leeway, they may happen not to do ſo in another ſtate. But the equilibrium is evidently attainable in every cafe, and we therefore ſhall al­ways ſuppoſe it.

It muſt now be obſerved, that when this equilibrium is dcſtroyed, as, for example, by turning the edge of the mizen topſail to the wind, which the ſeamen call shiver*ing* the mizen-topſail, and which may be conſidered as equivalent to the removing the mizen-topſail entirely, it does not follow that the ſhip will round the point C, this point remaining fixed. The ſhip muſt be conſi­dered as a free body, ſtill acted on by a number of forces, which no longer balance each other; and ſhe muſt thereſore *begin* to turn round a ſpontaneous axis of converſion, which muſt be determined in the way ſet forth in the article Rotation. It is of importance to point out in general where this axis is ſituated, There­fore let G (fig. 10.) be the centre of gravity of the ſhip. Draw the line *q* G *v* parallel to the yards, cut­ting D*d* in *q,* E*e* in r, CT in t, and Ff in *v.* While the three sails are ſet, the line q *v* may be conſidered as a lever acted on by four forces, *viz.* D*d,* impelling the lever forward perpendicularly in the point *q;* E *e,* im­pelling it forward in the point *r;* Ff, impelling it for­

ward in the point *ν;* and CI, impelling it backward in the point *t.* Theſe forces balance each other both in respect of progreſſive motion and of rotatory energy; for CI was taken equal to the ſum of Dd*,* E*e,* and Ff; ſo that no acceleration or retardation of the ſhip’s progreſs in her courſe is ſuppoſed.

But by taking away the mizen-topſail, both the equi­libriums are destroyed. A part D*d* of the accelerating force is taken away; and yet the ſhip, by her inertia or inherent force, tends, for a moment, to proceed in the direction C*p* with her former velocity; and by this ten­dency exerts for a moment the ſame preſſure CI on the water, and ſuſtains the ſame reſiſtance IC. She muſt therefore be retarded in her motion by the exceſs of the reſiſtance IC over the remaining impelling forces E*e* and F*f,* that is, by a force equal and oppoſite to Dd*.* She will therefore be retarded in the ſame manner as if the mizeu-topſail were ſtill ſet, and a force equal and oppoſite to its action were applied to G the centre of gravity, and ſhe would ſoon acquire a ſmaller velocity, which would again bring all things into equilibrium; and ſhe would stand on in the ſame courſe, without changing either her leeway or the poſition of her head.

But the equilibrium of the lever is alſo deſtroyed. It is now acted on by three forces only, viz. E*e* and Ff*,* impelling it forward in the points r and *v,* and IC impelling it backward in the point *t.* Make r*v : ro =* Ee + Ff : Ff, and make *op* parallel to CI and equal to Ee + Ff. Then we know, from the common prin­ciples of mechanics, that the force *op* acting at o will have the ſame momentum or energy to turn the lever round *any* point whatever as the two forces Ee and Ff applied at r and *v;* and now the lever is acted on by two forces, *viz.* IC, urging it backwards in the point *t,* and *op* urging it forwards in the point *o.* It muſt therefore turn round like a floating log, which gets two blows in oppoſite directions, If we now make IC — *op : op = to : tx,* or IC — *op:* IC = *to : ox,* and apply to the point *x* a force equal to IC — *op* in the direction IC; we know, by the common principles of mechanics, that this force IC — op will produce the ſame rotation round any point as the two forces IC and *op* applied in their proper directions at *t* and *o.* Let us examine the ſituation of the point *x.*

The force IC — *op* is evidently = Dd, and *op* is = Ee + Ff. Therefore *ot : tx = Dd : op.* But because, when all the ſails were filled, there was an equi­librium round C, and thereſore round *t,* and becauſe the force *op* acting at *o* is equivalent to E*e* and Ffacting at *r* and *v,* we muſt ſtill have the equilibrium; and therefore we have the momentum D*d × qt = op × ot.* Therefore *ot : tq = Dd : op,* and *tq = tx.* Therefore the point *x* is the ſame with the point *q.*

Therefore, when we ſhiver the mizen-topſail, the ro­tation of the ſhip is the ſame as if the ſhip were at reſt, and a force equal and oppoſite to the action of the mi­zen-topſail were applied at *q* or at D, or at any point in the line Dq.

This might have been ſhown in another and ſhorter way. Suppoſe all ſails filled, the ſhip is in equilibrio. This will be diſturbed by applying to D a force oppo­ſite to D*d;* and if the force be alſo equal to D*d,* it is evident that theſe two forces deſtroy each other, and that this application of the force *d*D is equivalent to