general proposition, that as the proportion which the re­sultant of the direct and vertical resistances on the bows of a vessel, bears to the resultant of those resistances on the stern, is greater than the proportion which the sine of the angle made by the resultant of the after-resistances with a horizontal line, bears to the sine of the angle made by the resultant of the fore-resistances with a horizontal line, the height of sail will be diminished, and as this proportion is diminished, the height of sail will be increased. Now when DF is infinite in comparison with EC, that is, when the negative resistances vanish, BQ will coincide with BP, and the height of sail will be at W, the point in which the ver­tical line drawn from the centre of gravity of the ship in­tersects the direction of the resultant of the positive re­sistances. But if DF vanishes in comparison with EC, BQ will coincide with BI, and the height of sail will be at R, the point in which the vertical line drawn from the centre of gravity intersects the line be ; consequently the points R and W will be the limits between which the position of the height of sail must be situated. The directions of the resultants of the resistances on the bow and stern being known, the position of this point within these limits will depend upon the velocity of the ship, in as far as that ve­locity affects the ratio which these resultants bear to each other. And since the negative resistance depends on the degree of vacuum which the vessel creates by the velocity of its passage through the water, it will evidently be very inconsiderable as long as the velocity continues small. In fact, this is found to be the case experimentally, as is also that, after certain limits, this negative resistance increases in a greater ratio than the velocity. We may therefore draw the general conclusion, that the less the velocity of the ship is, the nearer will the height of sail approximate to that of its lowest limit ; and, on the contrary, the greater the velocity of the ship, the nearer will this point approach its highest limit. But as we are not yet sufficiently ac­quainted with the laws of the motion of fluids to determine the ratio of the increase or decrease of the positive and ne­gative resistances experienced by bodies in their passage through the water, we cannot ascertain how near the ulti­mate position of the height of sail with the greatest velocity which the vessel can acquire will approximate to the limit which has been assigned to it.

One circumstance which may affect the height of sail re­mains to be noticed ; this is, the deviation of the apparent water-line of the ship when she is in motion, from her hori­zontal water-line, which is occasioned by the accumulation of fluid at the fore-part of the ship, and the depression of it at the after-part, that is incidental to the motion of a body on a fluid. This will vary in degree in proportion to the velo­city of the ship. Now if this addition to the one and diminu­tion from the other of the resisting surfaces alter the propor­tions between their respective vertical and direct resistances, the directions of the resultants of the resistances on these surfaces, which depend on these proportions, will also be al­tered. If the extremities of the vessel were formed by plane surfaces, neither the accumulation nor the depression would alter the directions of the resultants of the resistances, since the angles of incidence would be the same for every part of the surfaces ; but as the extremities of the vessel are curved surfaces, the effect produced on the direction of the re­sultants of their respective resistances will depend on the relative inclination to the horizon of the curve of that part of the body beneath the horizontal water-line, and of the parts above or below the water-line, which will be affected by the accumulation and depression of the water. Since the lower parts of the vessel’s body, both forward and abaft, are those which are generally most inclined to the horizon, it is probable that the direction of the resultant of the re­sistances on the bow is lowered by the accumulation of the water against them, and that the direction of the resultant

of the resistances to the stem is rather raised by the depres­sion of the water at that part. At the same time it must also be observed, that, by the effect of the accumulation, the centre of effort at which the resultant of the resistances against the bows acts will be raised, while, by the effect of the depression, that at the stern will be lowered.

The position of this point will determine the height above the centre of gravity of the ship, at which the common centre of effort of the sails should be placed, not only when the directions of the wind and of the ship’s course coincide with each other, but also whatever may be the direction of the ship’s course with regard to that of the wind ; for, under all circumstances, that portion of the force of the wind which acts in propelling the ship in the direction of her course, will be subject to the same laws which govern the action of the whole force of the wind when it acts in that direction.

It is also evident, that it is not only necessary that the centre of effort of the surface of those sails which are usually set, and for which the position of the height of sail is gene­rally recommended to be estimated, should coincide with this point ; but also, that when additions are made to the quantity of sail set, care should be taken to preserve the common centre of effort of the whole surface as nearly at this same height above the centre of gravity of the ship as is possible.

It is frequently observed that a ship’s velocity does not increase or decrease in proportion to the additional quantity of sail set or taken in. It is evident, from the principles which have been explained, that these apparent anomalies must arise from the mal-position of the centre of effort of the sail ; and, in fact, it is even possible that the velocity of a ship may be decreased by the addition and increased by the diminution of sail, if the centre of effort is improperly placed. That this may be the more evident, suppose AB (fig. 8) to be the water-line of a ship, when the centre of effort of the sails is situated at the correct height of sail GF ; then suppose the disposition of the sails to be so alter­ed that their centre of effort coincides with E, a point si­tuated above the point F ; and let *a —* the force of the wind on the sails both before and after the alteration ; its moment to turn the ship round its centre of gravity G, when its action takes place at the point E, will be equal to *a .* EG, and this force will be opposed by the horizontal resistance of the water, also = *a,* acting at the distance FG from the centre of gravity G ; therefore *a ∙* EG — *a·*FG = *a* ∙ EF will be the force exerted by the wind to make the ship revolve round G, its centre of gravity, and immerse the bows ; and the inclination will continue from the effect of this action until the moment of hydrostatical stability, which it will generate, becomes sufficient to counteract it. It should