here be observed, that by the difference which the inclina­tion of the ship will make in the angles of incidence of the water on the bows and stern, the correct height of sail, after the inclination, will most probably not coincide with F, but the alteration arising from this circumstance in the position of this point will depend on the form of the vessel's body.

When the force *a ∙* EF is destroyed, suppose the water- line to coincide with CD, then from G draw GH, making with GE the angle EGH cqual to the angle of inclination DGB ; take GH = GE, then H will be the position of the centre of effort E of the sail after the inclination, and the angle BGH will represent the inclination of the plane of the sails to the horizon, they having been supposed to be vertical before the inclination of the ship. Now from H draw HM horizontal, and take MH to represent the whole force of the wind acting in that direction, at the points H and F ; then from M draw ML perpendicular to GH ; and from L draw LK perpendicular to MH ; MK will re­present the horizontal force of the wind acting to propel the ship in the direction of its course, when the centre of effort of the sails is at E. Since MH represents the quantity of this force when the centre of effort of the sails is at the true height of sail F, KH will represent that part of the horizon­tal force which is lost by the mal-position of the centre of effort ; and if MH, the whole force of the wind, be assumed equal to radius, then from similar triangles MHL, LHK, we get the value of KH equal to the square of the sine of the angle of inclination divided by the radius, when radius is cqual to the whole force of the wind. Therefore, if the removal of the centre of effort from its correct position at the height F had been accomplished by an addition to the quantity of sail set, instead of by an alteration in its dispo­sition, unless the increase of MH, the force of the wind arising from the increase in the area of sail set, was greater than this value of KH, which represents the force lost, the velocity must be diminished instead of being increased, by the addition to the force of the wind ; since its effective force to propel the ship would be diminished by a quantity equal to the difference between this value of KH and the increase of the whole force of the wind. Now suppose that by the mal-position of the centre of effort at E, the ship is inclined so that GH is the plane of the sails, it is evident that the quantity of sail may be reduced until the force of the wind is diminished by a quantity equal to s^n',

rad. MH without diminishing the velocity, if, by this reduction in the <∣uantity of sail, the centre of effort is removed to its correct position at F. This reasoning shows that when the centre of effort of sail is placed too high above the centre of gra­vity of the ship, the disadvantages of such an adjustment may be lessened by raking the masts, since by that means the loss in the force of the wind may be avoided.

When the centre of effort is above the height of sail, the velocity of the ship will be subject to further decrease from the increase of resistance which will result from the immer­sion of the full parts of the body forward, and the conse­quently greater area of midship section. Also, in the case which has been supposed of the plane of the sails being vertical before the commencement of the action of the wind, when the longitudinal inclination EGH takes place, a part of the action of the force KL will act to increase the displacement, and consequently the resistance. This dis­advantage may also be diminished by raking the masts.

There arc other circumstances arising out of the longi­tudinal inclination of the ship, caused by the excess of the moment of the wind on the sails over the moment of hy­drodynamical stability, which are disadvantageous to the good properties of the ship. The equilibrium which en­sues between the excess of the moment of the wind and the moment of hydrostatical stability, which has been de­scribed as being generated by the inclination, will not be constant, as every increase or decrease in the force of the wind will cause an increase or decrease in the moment of stability, which must be obtained by a corresponding change in the inclination ; therefore a ship in which the centre of effort is placed above the true height of sail, will be subject to an alteration in her water-line at every change in the force of the wind ; and it will, owing to this circumstance, not only be impossible to adjust the longitudinal position of the centre of effort to any fixed trim of the ship which may have been found to be advantageous, but it will be equally impossible to determine the best longitudinal position for this point, after the ship is in a state of motion, since her trim will be subject to constant change.

If the centre of effort, instead of being supposed to be situated above the true height of sail, be considered to be below that point, the immersion will take place at the after-extremity of the ship, from the action of the excess of the moment of the resistance of the water. It must also be observed, that there will be this difference in the two cases. When the centre of effort is above the height of sail, at every increase in the force of the wind the ship will, from the increased immersion of the bows, fly up to the wind, while the effect of the immersion of the after-part will be to make her fall off from it. The ill effects which have been described as attendant on the mal-position of the centre of effort of the sails with respect to the height of sail, though they cannot be removed while the cause exists, and which may consist in the improper proportions of the masts and yards, can in some cases be diminished by an alteration in the disposition of the weights on board the ship. If, instead of supposing the ship to incline, from the action of the force of the wind at the point E, we suppose the effort of this force to produce the inclination to be counter­acted by the removal of a weight (*b*) from a point N at the fore-part of the ship, to another point O at the after-part, then the ship will be maintained in a state of equilibrium by the action of the two equal forces *a*∙EF and *b∙* NO ; and she will therefore move without longitudinal inclination, as long as the force of the w ind remains constant ; but any alteration in that force must be counteracted by a corre­sponding alteration in the position of the weight : also, when, from the action of the water on the hull, the ship acquires an angular velocity, the angular momentum will be increased by that of these two forces, which may both be considered as weights acting at their respective distances from the centre of gravity of the ship. It is therefore evident, that an error in the position of the centre of effort of the sails cannot be advantageously remedied by any alteration in the disposition of the weights in the ship, except in peculiar cases of smooth water ; and further, if the error be that the centre of effort is above the height of sail, the ship will la­bour under the disadvantage of a diminished area of sail, since the moment of sail must be in constant proportion to the moment of stability ; and if the centre of effort is too low', the ship may not be able to obtain all the advantage of motive power that her stability would admit of her applying.

It appears, therefore, that unless the centre of effort of the sail be placed at the height of sail, a ship, however good her form, and the properties connected with it, may be, and whatever may be the care bestowed to render those pro­perties most efficient, will labour under very serious disad­vantages ; while, on the contrary’, a correct adjustment of this element, and a knowledge of the principles on which that adjustment depends, will place it in the power of a commander to obtain a maximum of advantage from the powers and properties of his vessel, since it will enable him to acquire the greatest possible efficient action from the motive power at his disposal.

As was before said, the determination of the height of sail must be classed among those problems of naval archi-