as long as the inequality of the surface of the water con­tinues ; but when the direction of the wind on the vessel be∞mes such that she no longer meets and passes over the seas, so that it may be said to act in conjunction with gravity, in offering a constant opposition to the vessel’s oscillations, the motion will cease. For these causes, the pitching motion can only exist to any great extent when a vessel is on a wind : then, its force will depend on the de­gree of inequality of the surface of the water, on the quick­ness or slowness of the succession of the waves, on the di­rection in which they strike the bow of the vessel, and on the shape of the bow, as this greatly influences the degree of violence with which it meets the water, and the resistance it opposes to submersion.

The least injurious action of pitching occurs when the state of the sea is such that the motion of the ship may be supposed to take place round a line passing through its centre of gravity as a fixed axis of rotation ; for then the motion may be compared to the oscillations of a pendulum, and its extent may, in a great degree, be regulated by either increas­ing or diminishing the length of the isochronal pendulum, according as the state of the sea appears to require the oscil­lations to be made in longer or shorter periods. These effects may be severally produced, by removing weights further from, or by approaching them nearer to, the axis of rotation ; that is, by increasing or diminishing the moments of inertia of the fore and after parts of the body round its axis of rotation.

But it is, as has before been said, only in some states of the sea that the pitching motion in a vessel can be compared to the oscillations of a body round a fixed axis of rotation passing through its centre of gravity, and where the mo­ments of inertia of both the fore and after bodies oppose the motion ; for, under many of the circumstances of heavy seas, though, at the commencement of the motion, the axis of rotation may pass through the centre of gravity of the ship, it will pass abaft it as the wave passes aft. In this case, then, the moment of inertia of the body before the axis of rotation, which, when this axis passed through the centre of gravity, was equal to the sum of the particles in that body multiplied by the squares of their distances from the axis of rotation, will become, at any instant afterwards, when the axis of rotation shall have passed abaft the centre of gravity, increased, by the difference between this quantity and the sum of the products of the particles in the then fore­body, multiplied by the squares of their distances from the new axis of rotation ; consequently the moment of inertia of the fore-body will be constantly increasing until the end of the motion, while the moment of inertia of the part abaft the axis of rotation will be constantly diminishing, under the same limits ; that is, tire force which has an injurious effect on the violence of the pitching increases, while that which diminishes its violence decreases. As the direction of the motion of the waves is opposed to that of the vessel, the momentum with which the bow of the ship will meet the sea at the expiration of the motion, is equal to the sum of the momenta of the bow and the sea ; and this impulse is often so great in practice, as to be sufficient completely to check, for several seconds, the motion of the vessel in her course. Frequent recurrences of these shocks must, therefore, not only be extremely injurious to the strength of the fabric of the ship, but must materially affect her pro­gress through the water, and may even, in some situations, in­volve her safety, from the increased liability of shipping seas, especially in deep-waisted vessels ; and also, unless a ship can contend with advantage against a head sea, her chance of escaping the danger of a lee shore must be considerably diminished, as in such a situation her safety would in a great measure depend on the possession of that property.@@1

From these considerations, it is evident that every alter­ation which can be made to diminish the extreme violence of this motion, when it takes place under the circumstances which have been described, either by lessening the mo­ment of inertia of the fore-part of the ship, or by giving that part the form which will the most conduce to render its impact with the water more gradual, must be advanta­geous with respect to the velocity, to the preservation of the strength of the ship, and even to the increasing the safety of the crew. But since the bow of a ship is subject­ed to shocks of such a violent nature, it must necessarily consist of a vast combination of materials to insure an ade­quate degree of strength to resist them : great care, how­ever, should be taken that there be not more weight than this renders absolutely necessary. These considerations point out at once one limit to the poβition of the masts; for it is evidently desirable that the weight of the fore-mast and the pressure of the head-sails should act with as little inju­rious effect in increasing the violence of the pitching, as is consistent with the necessity for head-sail ; this will be better understood as we proceed with our investigation of the various forces which act on a ship when in motion.

When the ship is under sail, there are two forces acting on it ; the one, the force of the wind on the sails, to propel the ship ; and the other, the resistance the water opposes to her motion. These forces, immediately the ship has acquired the velocity due to the strength of the wind, are equal, and, as is the case with all forces, may each be reasoned on as if acting on only one point of the surface over which its effect is diffused. This point is that in which, if the whole force were to be concentrated, its effect would be the same as when dispersed over the whole area : it is usual to call these, “ resultants of forces,” and the points on which they are supposed to act, “ centres of effort.”

From what has been before said, the resultant of the force of the wind on the sails, and the resultant of the force of the water on the hull, are equal ; the one acting on the weather side of the ship, in the direction into which the force of the wind resolves itself, and the other opposed to it, acting on the lee side, in the direction into which the

It is simply the constructing of one end of a ship upon the basis of the other end, so as to insure the attainment of the object in view,— the least possible degree of pitching and 'scending.

@@@ Mr Henwood, a member of the late School of Naval Architecture, has advanced some new views on the subject of the pitching and 'scending motions in ships, which we think of sufficient importance to endeavour to explain. They are as follow.—that these longi­tudinal motions of a ship depend both on the form of the immersed part of the body, and on the positions of the various weights which compose the lading or equipment ; and the form of a ship, and the positions of the weights, determine the situation of the centre of gravity through which the axis of the pitching and 'scending motions passes. It is the position of this point or axis which, Mr Henwood has stated and endeavoured to show, might and ought to be so determined in all ships, that the pitching and 'scending motions would be diminished to the lowest possible degree.

In order to construct a ship on this principle, the fore-part of the ship, viz. that before the centre of gravity, would be formed in the usual manner ; but the after-part would be constructed so as to have precisely the same cubic content as the fore-body, and its centre of gravity at the same distance from the centre of gravity of the ship as that of the fore-body.

In the stowage of a ship thus constructed, the weights must be so disposed that one half of the total weight of the ship and her equipment may be on each side of the vertical and transverse plane, through the centre of gravity.

The object intended to be gained by the fulfilment of the above conditions is, that a ship should perform her longitudinal or pitching motions exactly as she does her lateral or rolling motions ; and that as there is the same tendency to roll either side equally deep, so there should be a like tendency of the fore and after ends to pitch and ’scend. The pitching and 'scending motions would, Mr Henwood considers, thus be reduced to a minimum, and the velocity of sailing retarded in the least possible degree.

This proposed desideratum in the construction of ships is irrespective of the form of the midship section, or of the water-lines, Ac.