ant tie which a deck is to a ship, as he retained some of the midship-binding strakes, and introduced dowels to render their connexion with the beams and with the extremities of the vessel more perfect and more unyielding than could be effected by the old plan of scoring down, with its attend­ant evils from the shrinkage of the materials and neglect of workmanship.

The aftermost and the foremost beams of each deck might be advantageously made to afford support to the pro­jecting bows, and especially to the raking sterns of the mo­dem ships, by connecting the bow and stem timbers to them at each deck by long tie-bolts passing through se­veral beams, clenched on the aft side of the aftermost for­ward, and on the fore side of the foremost of them aft. These beams should have several ranges of carlings let down between them, to diffuse the strain. This would be far preferable to forelocking the bolt on the fore side of each beam ; first, because, generally speaking, the strain would only fall upon one beam, that which was most close­ly forelocked ; and, secondly, because by experiment we find that the size of the bolt being the same, the forelock would give way, or the bolt break at the forelock-holes, under about one half the strain which the clench would withstand.

Several Dutch ships have been built with a round-up to the decks in the direction of the length ; the keels of the same vessels were built to sag or curve downwards towards the midships of the length, and the fore and after extremi­ties were so constructed that the longitudinal vertical sec­tion should form an elongated ellipse. Only steam-boats have, we believe, ever been built on this plan.

The beams which support the deck have a curve upwards, in the direction of their length, to the middle of the ship, called the “ round-up.” This is for the purpose of strength, and for the convenience of the run of water to the scuppers. Beams are single piece, two, three, or four piece (Plate CCCCLIV., figs. 39, 40, 41, 42), according to the number of pieces of timber which are combined to form them. The several pieces are scarphed together, and coaked and bolted, the scarphs being always vertical. Hooked scarphs, with keys of hard wood or iron driven in, to bring the buts in close contact, have been lately introduced with much advan­tage in great additional neatness of appearance, great reduc­tion of weight, and consequently of materials and expense, by Mr Edye, the master-shipwright of Pembroke yard, fig. 38.

It is rather surprising, that in the very general applica­tion of iron for ship-building, the wooden beams which oc­cupy so much space between deck and deck, and so mate­rially contribute to the height of the vessel above the wa­ter, have not either been superseded by beams of iron, or at least by wood beams of much less moulding, to which the necessary rigidity might be given by iron plates at their sides. An objection to beams wholly of iron would arise from the great expansion and contraction of that metal un­der variations in its temperature.

The beams of ships are supported at each end, and the strain to which they are subjected is a downward pressure ; consequently the upper part of the beam must compress, and the lower fibre elongate, before there can be any alte­ration in the curvature. It is desirable therefore that the fibre of the wood towards the lower part of the beam should not be wounded, and that, whether for the purpose of se­curing the beam, or of security to the beam, no incision should be made, excepting in the upper, or compressed, ranges of the fibre, which may be cut through, according to Du Hamel’s experiments, one half, and according to Professor Barlow’s, five eighths, of their depth, without im­pairing the strength. Nay, if the carling or material to be inserted in the score be of harder texture than that which is removed, the strength is increased.

The connexion of the ends of the beams to the sides of the ship has afforded scope for the display of much ingenui­ty. We have in our plates (CCCCLV. and CCCCLVIII.) given sketches of those plans which have been adopted in the navy of England, and also of several taken from foreign works or observed in foreign yards. There are three things to be considered in the connexion of the beam with the side : that it shall act as a shore to prevent the sides from collapsing; as a tie to prevent their falling apart; and be perfectly rigid, that there may be no working.

That the beam may be an effective shore, nothing more is necessary than that the abutment of the end against the ship’s side may be perfect. In order to constitute it a tie between the two sides, it is generally dowelled to the upper surface of the shelf, and the under surface of the water-way is dowelled to it. These dowels connect it therefore with the fastenings of the shelf and water-way, which pass through the side. There is also in the ships of the royal navy a plank called a side-binding strake, scored down over and into the beam-ends, at some distance from the side, and bolted through the side between the beams. The scoring into the beams connects the in and out fastening of this strake with the longitudinal tie of the beam. There are also the various bolts forming that part of the fastening of the beam-ends, whether in the knees or in the chocks, which passes in and out through the ship’s side.

It will be very easily conceived, from the short outline which we gave of the disturbing forces acting on a ship, that the strain on the ends of the beams to destroy the ri­gidity of their connexion with the side must be very great when the ship is under sail either on a wind or before it, that is, either inclined or rolling.

The principal action of these forces is to alter the verti­cal angles made by the beam and the ship’s side ; and it will be seen that the action is alternately to decrease and to in­crease the angles made by the beam and the part of the side below it, or, what is the same thing, alternately to in­crease and decrease the angles made by the beam and the ship’s side above it. Now the first of these actions takes place on the lee side ; the gravitation of the weather side, and all connected with it, of the deck and every thing upon it, as well as the upward pressure of the water, all tend to diminish the angle made by the beam and the ship's side below it, and increase the angle made between them above it. The contrary effect is produced on the weather side, the angle above the beam being closed, and that below opened.

In investigating the nature of the action of these forces, we shall find that in each case the beam may be considered as a lever. The power being supposed to be applied at the opposite end of the beam to that at which the forces under investigation act, the weight being the fastening applied to prevent alteration in the angle formed by the beam and the ship’s side, and its action being supposed to take place at the point in which it should be applied to produce the most advantageous effect.

The lever is of the first order, that is, with the power and weight on opposite sides of the centre of motion or fulcrum, when its effect on the lee arm is considered ; and it is of the second order, that is, with the power and weight on the same side of the fulcrum, when its effect on the weather arm is considered.

The object in securing the beam-ends in each case should be to diminish the effect of the power and increase that of the weight. We lessen the effect of the power by dimi­nishing the distance between the point at which it acts and the fulcrum, and we increase the effect of the weight by increasing the distance between the point at which it acts and the fulcrum. In the lever of the first order, that is, when we are considering the action on the lee arm, this is accomplished by bringing the support of the under side of the beam, the midship side of which support is the fulcrum