of the lever, as far from the ship’s side as it can be extend­ed consistently with the accommodation of the decks ; and by having the weight, that is, the security to keep down the beam-end, as close to the end of the beam, and conse­quently to the ship’s side, as it can be placed.

In the lever of the second order, that is, when we are considering the action on the weather arm, the effect of the power is diminished by increasing the distance between the fulcrum and the weight. The fulcrum, in this case, is the support of the lower side of the extreme end of the beam ; the weight is the strength of the knee, or whatever con­nexion is intended to tie it to the ship’s side, and maintain the angle invariable which is formed by them. The effect of this weight is increased by approaching it to the point at which the power is supposed to act. Therefore, in order to resist the action on the weather arm of the beam, the fulcrum, which, as we have said, is the support of the ex­treme end of the beam, that is, the edge of the clamp or shelf which fays to the timbers, should be most firmly con­nected to them ; and the weight, which is the downward tie, should be extended as far from the side as it may be consistently.

The difference of the action to which the two arms are subjected, points out therefore at once the principle which should guide us in all plans for connecting the beams to the side, and it may not be useless to recapitulate our con­clusions.

The action on the lee arm requires the extreme end of the beam to be closely tied down, either to the clamp or the shelf, as the case may be, and which is necessarily pre­sumed to be firmly connected to the ship’s side. This ac­tion also requires the centre of motion to be extended far from the side, in order to diminish the effect of the power. Therefore, the downward fastening close to the ship’s side, and the upward support far removed from it, is that which is necessary in this case.

The action on the weather arm requires an exactly different disposition of the securities. The extreme end of the beam is here the centre of motion, and is the part which ought to be supported ; and it is the downward tie which should be as far extended from the side as may be consistently.

It may be urged against these views, first, that if work­ing be presumed to take place in the lee-beam arm, round the midship or outer edge of the shelf, the distance between this fulcrum and the fastenings which keep the beam-end down will cause greater motion in that end, and greater strain on the fastening ; and, secondly, that if the weather­beam arm be presumed to work from the side or inner edge of the clamp or shelf, the distance between this point and the fastening intended to keep the beam down, will cause an increased strain on that fastening.

These objections are both true, but they do not embrace the correct view to be taken. The object is how to dis­pose the fastenings in the best possible manner, in order to prevent working. And this is attained in each case by ex­tending the distance between the weight and the fulcrum.

In the system of building the ships of the royal navy, introduced by Sir Robert Seppings, the shelf was brought upon the clamp (*m*, Plate CCCCLV.); it is now worked home to the timbers *(i, h, l),* and its front is therefore less extended from the side. One joint, that between the clamp and shelf, is avoided by this method, but security to the beam-end is lost by it. An arm of the iron knee, which has superseded Sir Robert Seppings’ forked knee, is ex­tended under the beam to compensate for this diminution in the width of the shelf ; but unless the rigidity of this arm be such that the fulcrum in the case of the lee-beam arm, and the weight in the case of the weather-beam arm, be removed from the ship’s side a distance at least equal to the diminution in the extension of the front of the shelf from the ship’s side, the object is not attained.

One of the most perfect securities for a beam-end, in point of principle, and combining at the same time simpli­city of workmanship, which is another important requisite, especially in all iron work, is the plate-bolt (*a*), frequently- adopted for round-house beams, and for the lower decks of frigates. The extreme end of the beam is tied downward by bolts, and supported by the shelf, and the extended downward fastening is by a dog-plate. These securities, and the upward support afforded by the chock to that plate, are, according to the foregoing reasoning, correctly applied, but are insufficient in amount of security for the beams of principal decks, as the downward tie depends wholly on the clench of the dog-plate. Probably a strap passing round ; the beam, as shown in fig. 44, Plate CCCCL VIII., might be an advantageous and simple modification of the above plan. For easiness of execution, and smallness of expense, it would be better if the strap was merely bent over, and scored into the top part of the beam, and the ends brought down and fastened on the sides of the chock, which would then re­quire to be only of the same siding as the beam. In this case there could be no in and out fastening through the strap ; the only in and out bolts would be those through the chock. The fastenings of the strap might be screws, as in the French knees (Plate CCCCLVIII. figs. 45, 46), which we shall describe. The disadvantage attending this sort of strap would be, that to obtain an equal degree of downward security for the weather-beam arm, the chock must be more extended from the ship’s side than if the ends of the strap were brought in front of the chock, and took their own in and out fastening.

The extension of the security from the side of the ship by means of a chock, is preferable to gaining the same breadth by bringing a shelf on to the clamp with a chock under it, in so far as extending the support to the beam is involved ; because the chock presents “ end-grain,” in which there is comparatively but little shrinkage, to receive the downward pressure of the weather-beam arm. A well se­cured and firmly supported clamp is sufficient to resist the downward pressure of the weather-beam arm ; and if this clamp be of a sufficient thickness to receive the up and down bolts through the water-ways and beam-end, that is all that is indispensable, and this would be little, if any, addition to the thickness of clamp already usually worked. We there­fore doubt much whether the shelf might not be advanta­geously discontinued, and substituted by a clamp with chocks under the beams, stepping on the projecting edge of the spirketing. We shall speak of the support to this clamp when we consider the short stuff between the ports. Of course this change presupposes a maximum of advan­tage to be derived from all the other combinations for strengthening the side.

An objection is urged against chocks, which is, that they occupy space against the ship’s side; but they afford a security to the beam-ends which cannot be well obtained without them ; and it is questionable whether the foundation of the objection is correct, because the continuous breadth of shelf should also be considered, and that effectually pre­vents a man’s standing erect close to the ship’s side, while the obstruction from the chocks is only partial, with inter­vals between.

Roberts’ plate-knee (*d*, Plate CCCCLV.) is a very strong method of fastening, as a preventive to any alter­ation of the angle formed by the beam and the side, pro­vided the in and out security of the chock to the side is sufficient to resist the strain that is brought on it. These knee-plates, together with up and down bolts in the beam­ends, fulfil all the requisites for a correct mode of fastening, unless it may be the objection against the chock which we have stated. The great objection which has been urged to their use arises from the fore and aft bolts through the beam, which, it is said, are liable to split the beam-end.