done even in line-of-battle ships, as they carry their orlop­beams right aft.

Since compression is the action to which the lower part of the body is subjected, we see the evident inutility of sa­crificing economy in order to obtain length of shift, for the plank of the bottom, or, indeed, of making any great sacri­fice of plank for this purpose below the surface of the water, excepting for the foremost and aftermost shifts, at the bluff of the bow, and under the buttock.

The deck below the water, that is, the orlop, in ships of the line, and the lower deck in frigates, though near the neutral line, are below it ; and therefore the action to which they are subjected is compression, to resist which the ranges of carlings should be maintained from one extremity of the vessel to the other, and all their abutments should fit as closely as they can be got in place.

We have mentioned the keel scarphs as an exception to our general remarks. They are usually in England verti­cal scarphs, with coaks raised in the lip-ends of the scarphs, to fit into mortices sunk for their reception in their but- ends. These coaks serve as a stop to the caulking, and, in connexion with the scarph-bolts, are well devised, in the event of the curvature of the keel, to enable the scarph to partake of it, and to prevent leakage. In France, and gene­rally in the foreign yards, the scarphs of the keel are hori­zontal. Very lately the horizontal scarphs have been adopt­ed in the English service. We consider the vertical scarph much to be preferred, for the reasons above stated.

In those parts of the ship situated above the line of in­action, every means should be taken to multiply longitudi­nal ties. Since, in order to resist compression in the lower parts of the body, the openings are filled in, and form a solid mass ; to produce the opposite effect, that is, to enable the frame to resist extension, it should be chain-bolted together towards the upper parts of the body, wherever the continuous range of bolts can be placed not to interfere with the in and out fastenings ; as opposite the openings between the shelf and water-way of the several decks just above the scuppers. This plan has been pursued in several of the modern ships. The shifts of the different wales, spirketings, and clamps, should be long, the regular shift of the buts most carefully maintained, and the buts of the inside assemblages made to give shift to the buts of those outside. Sir Robert Sep- pings’ plan of supporting the fastenings, and compensating for the weakness of the buts in some of the principal as­semblages of plank, by dowels into the timbers in the strakes immediately above and below the buts, is of great utility. Also the plan of connecting several strakes together by tie­bolts placed opposite the openings between the timbers in the frame, where they could not interfere with any fasten­ing, was admirably adapted to diffuse strength, and to pre­vent longitudinal working of the planks, or the sliding of one edge past another, from any partial weakness. These might advantageously be much more extensively applied than was contemplated in the instructions issued by Sir Robert ; indeed, to all the internal assemblages of plank in which they can be driven.

Plank is either worked in parallel strakes, when it is called “ straight-edged,” or in combinations of two strakes, so that every alternate seam is parallel. There are two methods of working these combinations, one of which is called “ an­chor-stock,” and the other “ top and but.” The difference in their appearance will be best seen by a reference to Plate CCCCLVIII., fig. 43. The difference in the intention is, that in the method of working two strakes anchor-stock, the but of one strake always occurs opposite to the widest part of the other strake, and there is consequently the least possible sudden interruption of longitudinal fibre arising from the abutment ; therefore this disposition of plank is used where strength is especially desirable. In top and but strakes the intention is, by having a wide end and a nar­

row end in each plank, to approximate to the growth of the tree, and to diminish the difficulty of procuring the plank.

The shift of plank is the manner of arranging the buts of the several strakes. In the ships of the royal navy the buts recur with intervals of three whole strakes between. In merchant-ships there are often not more than two whole strakes between the recurrence of the buts. The regula­rity of the shift of plank is far more carefidly maintained in English building-yards than in those abroad.

The fastening of the plank is either “ single,” by which is meant one fastening in each strake through each timber of the frame which it crosses ; “ double,” or two fastenings in each timber ; and “ double and single,” meaning alter­nations of the double fastening in one timber with the single fastening in the next.

This fastening consists generally either of nails or tree­nails, excepting at the buts, which are secured by bolts. Several other bolts are driven in each shift of plank as addi­tional security. These additional fastenings are far more plentifully diffused in the royal yards than in those of pri­vate builders. Whatever system of securing the plank may be determined upon, great care should be taken to guard against a repetition of fastening, which will otherwise occur from the various bolts that will come through the bottom as securities to the riders, shelves, water-ways, knees, and bolts connected with the service of the guns. These bolts should evidently, for economy, and also for the sake of avoiding unnecessarily wounding the timbers, supply the place of the regular fastenings of the plank.

Before copper sheathing was introduced, iron was used for fastening. Since then, either bolt-nails cast of a mixture of zinc, copper, and grain tin, technically called “ metal,” or pure copper bolts, are used in addition to the treenails. Experiments are now being made in Holland to protect iron bolts, used for fastening the plank on ships’ bottoms, from the galvanic action induced by the copper. The bolts arc punched within the wood, and covered with a cement made of equal parts of lignum vitæ saw-dust, smiths’ ashes, and “ minium.” In France also several ships’ bottoms have lately been iron-fastened, with Roman cement over the bolts ; they were then felted and sheathed, the sheathing being secured with copper nails, and the bottom afterwards coppered. This inquiry as to the possibility of applying iron for the fastening of ships in connexion with the copper sheathing, is of great importance, as, independently of the difference in the expense of the two metals, the difference in their tenacity is as 995 to 546, or copper is only about 11/20ths of the strength of iron, or little more than one half.

The plank in the royal yards is not usually permanently fastened for some time after it is trimmed and brought on to the bottom of a ship, but is temporarily secured by Blake's screws, and allowed to season and shrink. About one strake in eight or ten is left out for the purpose of making good the shrinkage and relaying the strakes. With­out this precaution there would be such an alteration of edge as would throw the holes made for the temporary se­curities out of the ranges of the strakes ; but this precau­tion being taken, it is very seldom that the alteration of edge is such as to require new holes, especially as the iron screw eye-bolts used for this temporary fastening are of much smaller diameter than the permanent treenail fasten­ing, and therefore the holes for the screws will make good holes through the plank for the treenails.

This method of securing the planks in a temporary man­ner is of immense advantage in enabling them to be brought into close contact with the timbers, in the saving of bolt­fastenings, and in causing a g∞d and regular seam to be given for the caulking.

The circumference of the bottom being much larger at the midship part than towards the extremities, that is, at the bow and buttock, the lines for the strakes of plank must