All fore and aft bolts through the beam-end, as they do not pass through the fulcrum round which the beam would work, are nearly equally liable to this objection, whether they occur in the same range of fibre or not, because when motion ensues they must all act to split the beam-end. But we have already said we do not consider this line of argu­ment should be urged. The occurrence of working should not be presupposed in determining securities to prevent it, because such a course would frequently militate against the application of the most advantageously disposed preventives to motion ; not however that we are arguing in favour of fore and aft bolts through beam-ends ranking among these ; on the contrary, we think they should be avoided.

The foregoing observations embrace the main outline of the principles which should be kept in view in connecting the two sides of the ship by means of the beams.

The bows, as we have already said, are connected by timbers called hooks. It is important to remember that the hooks above and those below the surface of the water are subjected to an opposite strain. The tendency of the pres­sure of the water on the bow is to make the sides collapse, and therefore the hooks below the water’s surface should not only act as ties to the bow while the ship is grounded, as, for instance, when in dock, but should be formed more especially to resist the pressure of the water when she is afloat. Those hooks which are above the surface of the water act principally as ties, the rake of the bow and the gravitation of its parts tending to separate the two sides of the ship. These observations are of little importance when the hooks are of wood ; but when they are formed partly of wood and partly of iron, they materially affect the applica­tion of the iron plate. Below water it should evidently be brought as close to the inner surface of the bows as possible, and therefore on the fore side of the hook. It should also be secured to the wooden ekeings, independently of the bolts which secure the hook to the bows. Very slight consideration will suffice to prove, that by these means the utmost advantage is obtained from the materials employed, to resist the pressure, while at the same time they form a sufficient tie to support the sides of the bows when the ship is in dock, before launching, or aground. In made hooks above the water, the iron plate should be on the aft side, as far from the bow, and as straight as may be, that it may be a more effective tie.

We shall now pass to the several systems of strengthen­ing the sides, and of preventing the hogging, which have been successively introduced.

In the system of building which was superseded by that termed the diagonal system, the whole of the interior sur­face of the frame was planked, and a series of internal frames worked upon this planking, agreeing in direction with the timbers of the ship (Plate CCCCLVI. fig. 47). They ap­pear principally to have been intended to support the frame in the event of the ship’s grounding, as they could add no longitudinal strength to the fabric. There were about eight “ bends” of the “ riders” in three-decked ships, and six bends in two-deckers. There were other timbers running up to the top-sides, called breadth, middle, and top riders. These were more closely spaced than the bends in the lower parts of the body, and were placed in a diagonal direction evidently only to avoid the ports. The beams were sc- cured to the side by hanging and lodging knees of wood : they rested on the clamp, there being no shelf. The wa­ter-way was merely a thicker strake of deck gouged out, or “ chined down,” as it is technically called, from the front of the spirketing, to the same thickness as the flat of the deck. This chining down is for the protection of the water-way seam, by keeping it above the run of the water. There were different methods of shifting the bends of riders in the hold, several of which we have introduced in the plate.

An enormous quantity of timber was thus massed to­gether, having the appearance of great strength ; but in fact, from its weight, injudicious combination, disposition, and fastening, much of it was, if not injurious, at least use­less. The riders in the hold were no doubt originally ne­cessarily introduced when ships were “ grounded” for re­pairs ; but that necessity has now ceased to exist. In the earliest drawings representing them there are “ pointers,” or shores, extending from them at the bilge of one side, to the gun-deck at the opposite side of the middle line, which we shall presently refer to.

The system we have described was partially superseded by single riders in the hold, scarphing to chocks under the orlop-beams, and running down to give shift to the floor­heads. The top-sides were supported by standard knees brought on the deck over the beams ; and the beams were secured by Roberts’ plate-knees brought on the sides of chocks under the beams.

The idea of diagonal trussing was not novel at the time the system of Sir Robert Seppings was first proposed : It may even be observed in Plate CCCCXLVI. in the vessel of the fifteenth century, under repair. In the plates of a Dutch work of the date of 1697, there are diagonal pointers in an athwartship direction from the floor-heads on one side, to the quarters of the upper-deck beam of a two-decker on the other. Sir Walter Raleigh also mentions this mode of strengthening ships ; and the Dutch author, Van Yk, gives the drawing as a representation of the English system of building at the date of the publication of his work. Somewhat similar also were those afterwards proposed by Mr Snodgrass, the surveyor of shipping to the East India Company, though his were to step upon the keelson and ex­tend to the clamps of the lowest gun-deck, and were there­fore less judiciously placed to resist the strain in grounding than those represented in the Dutch work. Diagonal truss­ing between the keelson and the gun-deck beams along the vertical longitudinal section of the ship, had also been pro­posed, and partial experiments of various diagonal supports or shores made, both abroad and in England ; but until the introduction of the diagonal riders and trusses by Sir Ro­bert Seppings, there had been no permanent results from these experiments.

We quote the following description of the system from a paper communicated by the inventor to the Royal Society, and which is printed in the Philosophical Transactions for 1814.

“ An accurate conception of the state of a ship’s hold may be formed by referring to the longitudinal section (fig. 48), which is termed the Jesuit’s perspective, or bird’s-eye view of the internal part of one side of a seventy-four-gun ship in a complete state, with fillings in the openings between the timbers of the frames, instead of the planking over them.

“ In this state the diagonal timbers are introduced, inter­secting the timbers of the frame at about the angle of forty- five degrees, and so disposed as that the direction in the fore is contrary to that in the after part of the ship (as may be seen in the engraving), and their distance asunder from six to seven feet or more ; their upper ends abutting against the horizontal hoop or shelf-piece of the gun-deck beams, and the lower ends against the limber strakes, except in the midships, where they come against two pieces of timber placed on each side of the keelson (called additional keel­sons), for the purpose of taking off the partial pressure of the main-mast, which always causes a sagging down of the keel, and sometimes to an alarming degree. These pieces of timber are nearly as square as the keelson, and fixed at such a distance from it, that the main step may rest upon them. They may be of oak or pitch-pine, and as long as can be conveniently procured. Pieces of timber are next placed in a fore and aft direction, over the joints of the frame-timbers, at the floor and first futtock-heads ; their