in certain circumstances it forms a galvanic couple with the steel plate. For warships the British Admiralty requires the removal of this scale from these parts by immersing the plates in a weak solution of hydrochloric acid. Red and white lead, oxide of iron and oxide of zinc form the bases of most of the paints used on steel ships.

*Structural Arrangements.*

The following are particulars of ships recently built at New London (Conn., U.S.A.) on the *longitudinal* system: "The great centre girder, which in all vessels prior to these has been in the form of an I girder, is formed of a double II or box; that is, these vessels

have two vertical keels instead of one. The girder is of the same depth as the double bottom (6 ft.). On each side of this girder there are several other vertical longitudinal members, having the plating on the top, forming the tank top, and the shell-plating below, forming the bottom of the tank. This tank or double bottom is 6 ft. deep for the greater part of its length, and is increased at the extremities, where it merges into the fore-and-aft peaks at the collision bulk- heads. The whole of this space can be filled with water when desired, to sink the ship to a suitable draught when making a voyage without a cargo or with a very light one, at the same time allowing the ship to keep afloat whenever the outer shell or skin has been pierced by rocks or by colliding with other vessels. This bottom girder or double bottom forms the ‘ backbone' of the ship, from which the great frames spring or extend up to the weather deck, about 6oft. above the keel. The frames are made of channel steel spaced 30 in. apart, but as they near the extreme ends they are spaced closer, and are

composed of angle bars riveted together. At certain parts of the structure, where the heave of the sea will tend to strain the ship, the frames are double and made very strong. The outer surface of these frames is covered with a shell of steel plates averaging about I in. in thickness. These enormous plates are arranged to give a maximum of strength, and the riveting of them to the frames and to each other is receiving the utmost care.

“ These ships have a continuous longitudinal bulkhead on the centre, extending from the inner bottom to the main deck. The side plating of the shell, with this longitudinal bulkhead, form three vertical members of the entire structure. The upper flanges of the girder are formed by the upper and main decks, which are laid with heavy steel plates. This great girder is designed to support a full cargo when suspended by long sea waves at either end. The side girders are kept in place by three inter- mediate decks between the tank and the main deck, making in all five complete decks, each covered with heavy steel plate. The beams supporting all these decks are of channel steel, and fitted to every frame by large bracket plates. One of the many notable features in the con- struction of these vessels is the distribution of the water ballast. Various conditions of trim and safety can be obtained. The double bottom is divided longitudinally into three water-tight divisions and transversely into about twelve, making in all thirty-six separate tanks. In addition to these there are the fore-and-after peak tanks, and side tanks between the main and ’tween decks, about one quarter of the vessel’s length from either end. The latter tanks are really fitted for the purpose of controlling the ship’s stability and seaworthiness.

“ The vessels are divided transversely into thirteen water-tight compartments, while the longitudinal bulk- head is water-tight in the machinery space, which makes in all fifteen water-tight compartments. The engine- rooms are completely independent of each other; so are the boiler-rooms; but access is had from one to the other by water-tight doors. The coal can gravitate direct to the stokehold floor. The method of pillaring is somewhat novel. . . . Strong girders run under the transverse beams and are supported at wide intervals by built stanchions. By this means the least possible trouble is experienced in stowing the cargo.”

Fig. 110 shows the construction of a typical American Lake steamer, a diagram of which is given in the article Ship, fig. 16. She is 450 ft. over all, 50 ft. beam and 28 ft. 6 in. moulded depth; and when loaded to a draught of 18 ft. 3 in. can carry about 6000 tons weight of cargo on a total displacement of about 9000 tons. For half the length or more the ship is of the same transverse section, the frames being made identical in form. The outside plating is about ⅝ in. thick generally, but it is thicker at the garboards, flat keel and sheer strake, and becomes thinner generally towards the ends of the vessel. The frames are 24 in. apart, and consist of four separate pieces—two across the bottom and one up each side. These across the bottom consist of a 15-in. channel bar, with deep flanged brackets of 17½ lb plating connecting their inner ends to the centre keelson and their outer ends to the bilge and tank top. Extending up each side the frames consist of 6-in. channel bars of 17 lb per foot, worked 24 in. apart in the case of ordinary frames; and 15-in. channel bars of 33 lb per foot, worked 8 ft. apart, and called belt or special frames. The frames are all connected to the tank top and to the upper deck-plating by flanged bracket plates 17½ lb per square foot; and the belt frames are stiffened by hold beams of I section, 12 in. deep and 35 lb per foot, attached to each by deep flanged brackets of 17i lb plating as indicated, and supported in the middle by stanchions or pillars of similar section. The stanchions are attached to the tank top by double clips of 6-in. angle bar, and to the upper deck beams by direct riveting and by flanged brackets of 15 lb plating. Each belt frame is thus complete in itself, and very readily erected after the tank top is completed. The tank top is of 20 lb plating amidships and under the loading hatches and 17½ lb elsewhere. The margin plate is a continuation of the tank top, is made of 17½ lb plating, and flanged against the shell. The centre keelson is of about 22½ lb plating and about 5½ ft. deep; the side keelsons are of 17½ lb and slightly less depth, so that with a small rise of floor on the outside, say 3 in. in the half-breadth of the ship, there is a small fall of the tank top towards the bilges, say 6 in. in the half-breadth, so as to drain the hold to the water-courses over the margin plates. The centre keelson extends from the inner to the outer bottom, being attached to the tank top and the flat keel by heavy double angle bars, and well stiffened by the flanged floor brackets, which are connected to it by heavy double angle bars. The side keelsons are connected to the tank top and the floors by fore-and-aft angle bars 3 in. by 3 in. of 7½ lb per foot, and stiffened by vertical 6-in. angle bars at every frame. At the lower edge the keelson plates are connected to fore-and-aft intercostal channel bars