local support to the bottom as well as general strength to the vessel. There are in a warship so many structural features, such as water- tight bulkheads and flats or platforms, required for the necessary subdivision, armour decks, plating and framing behind armour, &c., which are made to contribute to the strength of the structure as a whole, that the strength of the shell-plating and the transverse framing can be proportionately reduced.

In a merchant ship there are many considerations which require the structure to be stronger and heavier than would be necessary

to withstand the wind and waves which she may encounter. The continual change of cargo and of disposition of cargo necessitates special local strength throughout. The custom, often pursued, of grounding vessels to discharge cargo, and their liability to touch the ground in the ports they frequent, make the provision of great strength in the floors and the shell-plating essential. Other considerations affect the decks, and call for local strength in them with corresponding increase of weight.

Most warships, except gunboat, torpedo and other small craft, have double bottoms, chiefly for protection against damage in action, but also against accidental grounding. The space between the bottoms is divided into a large number of compartments by making some of the frames and longitudinals water-tight. The inner bottom extends on each bide to the turn of the bilge, and from that point is carried up vertically as a wing bulkhead, as shown in fig. 122, the wing spaces thus formed being occasionally utilized for coal-bunkers. The framing, consisting of frame bars, reverse frame bars and frame plates or brackets, is usually carried up in a fair curve to the armour shelf, supposing the vessel to be an armour-clad, as in fig. 122. From the edge of the armour, which is generally about 5 ft. below the load water­line, a change in structure is made, and the framing behind the armour is set back from the outside of the ship suffi­ciently to admit of an internal skin of steel plating (often worked in two thicknesses), teak backing, upon which the armour is embedded, and the armour itself, to be carried with the surface of the armour flush with the shell-plating. The vertical frames behind armour are spaced 2 ft. apart, and the longitudinals are made intercostal, the whole hav­ing exceptional strength, to support the armour. Above the armour another change is made, the frames being brought again to the outside of the ship, and the topside plating directly attached to them becoming flush with the outside of the armour. There is generally a strong deck, called the protective deck, extending from stem to stern in the form of a turtle back, the lower edges being at the armour shelf on each side of the ship, and the top of the arch forming the first deck above water, as indicated in fig. 120. With a view to maintaining its defensive power where it has to be perforated for funnels and air shafts, armour gratings, or armour bars as they are called, are fitted in the openings. As much water-tight subdivision as possible is introduced throughout the ship, but for communication between the various compartments openings are provided in the bulkheads, having water- tight doors which can be closed either from a position close to the

door or from a deck above water, or from both. Below the protective deck are the engine and boiler spaces, magazines, shell-rooms. submerged torpedo rooms, and steering-gear. A passage is provided on each side of the ship just below the protective deck, for the supply of ammunition to the secondary armament.

Fig. 118 shows the “ Idzumo ” partially in frame, looking forward from the after extremity: the frames below the armour deck over a considerable length of the ship are complete, and a number of the beams which carry the armour deck are in place. Fig. 119 shows the ram stem, which has just been placed in position. The collision bulkhead and the framing below the armour deck are for the most part in place. Fig. 120 gives the top of the armour deck, which is nearly completed, as seen from the fore end, with the forward citadel

bulkhead in course of construction. Fig. 121 shows the after part of the vessel, which is not so far advanced as the forward portion shown in fig. 120. In fig. 121 the framing has been carried to a bulk­head near the after extremity, the rudder post is in place, and the bearing for the rudder head can be seen in the foreground. The construction of the armour deck is proceeding, and the after citadel bulkhead is also well advanced, though no backing is yet upon it, as in the case of the forward bulkhead, but the base of the redoubt which carries the after turret is erected.

The fittings in a ship cannot be fully described in the present article, but we shall conclude with some account of the auxiliary machinery. Two ordinary arrangements of steering-gear fitted in merchant steamers are shown in fig. 123. In the first example a three-quarter circular grooved rim, keyed to the rudder head, carries the steering-chains, which are led forward one on each side of the hatches to the steam engine, placed in this case in the engine-room casing, and controlled by shafting from the bridge. The usual steering-wheel is fitted on the bridge, and actuates the controlling valve of the steam engine by means of the shafting. The second example is very similar to the first : a quadrant is keyed

on the rudder head, and worked by chains led over pulleys one on each side of the ship to the steam gear, which in this case is placed on the bridge, close to the wheel. In all such cases gear is also provided by which in an emergency the ship can be steered by hand, by steering-wheels placed close to the rudder head, as indicated in the figures.