his immediate assistants. Various types of vessels were devised, with arrangements of armour and dispositions of guns, to provide for the new conditions which had been introduced; and, in addition, great advance was made in the structural arrangements of ships, which up to this period had been considerably influenced by the old systems of construction in use in wooden ships. In investigating the qualities of ships, Sir Edward Reed had the good fortune to secure the co-operation and assistance of Mr William Froude, F.R.S., who had been the first to demonstrate accurately the theory upon which the behaviour of ships in a seaway depends. Mr Froude’s experimental investigations on the forms of ships and kindred matters, begun in 1870 on behalf of the Admiralty and continued till his death in May 1879, had a most important bearing on the improvement of ships and on the science of naval construction generally. It is not too much to say that nearly the whole of the accurate information as to the best forms of ships and their resistance at various speeds, in the possession of naval architects to-day, is the direct result of Mr Froude’s work; and that of his son, Mr R. E. Froude, F.R.S., who continued the work after his father’s death.

Among the considerations which Reed had in view in the reconstruction of the navy may be enumerated the following: (1) Steadiness of ship as a gun platform, with ample stability

in all conditions of lading to enable her to keep the

sea in all weathers, and sufficient stability in a partially riddled condition to enable her to reach port

in safety. (2) Protection by armour of the vitals of

the ship, and of the heavy-gun positions, especially

against shell fire. (3) The carrying of guns of power

sufficient to penetrate the armour of any possible

enemy. (4) Mounting the guns sufficiently high above

the water-line to enable them to be fought in bad

weather. (5) Simultaneous all-round fire, with con­centration of as many guns as possible on any given

point of the compass. (6) Speed to overtake or get

away from an enemy. (7) Manoeuvring power to

maintain, as far as possible, any desired position

with regard to an enemy. (8) Large radius of action. (9) Proper provision for the berthing of officers and crew. (10) Limitation of size and cost.

Objections were raised to the early armour-plated ships on the score of their unhandiness, heavy rig, exposed position of guns, &c. To meet these, Reed designed a number of vessels. The “ Bellerophon,” launched in 1865, was a vessel of 7550 tons displacement, 6500 I.H.P., 14 knots speed, and was 300 ft. long. Her armament consisted of ten 9-in. 14-ton and five 7-in. 6½-ton guns. Her water-line was wholly protected by 6-in. armour, and she was provided with a central battery 98 ft. long, protected with armour of the same thickness. She carried a considerable spread of canvas, and she was fitted with a balanced rudder. The “ Hercules,” completed in 1868, was a much more important ship, her dimensions being: length 325 ft., breadth 59 ft., draught 26½ ft., displacement 8680 tons. Her engines of 8500 I.H.P. gave her a speed of about 14½ knots. She had two 9-in. guns, mounted one forward and one aft on the main deck behind 6-in. armour, and eight 10-in. guns, mounted in a central battery on the main deck. Her water-line was protected by armour 9 in. thick amidships, reduced to 6 in. at her ends, and her battery was protected by 6-in. armour. The "Sultan,” completed in 1871, was in many respects a similar ship but larger, having a displacement of 9300 tons, *2* ft. more beam and I ft. more draught; she attained a speed of upwards of 14 knots. Her main-deck battery carried the same guns as the main-deck battery of the “ Hercules,” but the 9-in. guns at the extremities of the vessel on this deck were dispensed with, and she earned, in addition, an upper-deck battery, placed over the after-end of the main-deck battery, in which four 9-in. guns were carried. Both batteries were protected with 6-in. armour; elsewhere the armour followed that of the “ Hercules.”

*Turret Ships.—*The system of mounting heavy guns in revolving turrets was advocated in England by Captain Cowper Coles after

experience in the Crimean War; and in June 1860 he embodied his ideas in a paper read before the United Service Institution. When the American Civil War broke out, Congress ordered a number of armoured vessels to be built, and one of the first to be completed was the turret vessel “ Monitor ” designed by Ericsson. She was 170 ft. in length, 41½ ft. beam, 1200 tons displacement, of low speed and low freeboard, the sides being protected by 3- to 5-in. armour, built up of 1-in. plates on 27 in. of wood backing, and the single revolving turret which carried two 11-in. smooth-bore guns protected by 8-in. armour built up of 1-in. plates and placed amidships as shown in fig. 48. Her defeat of the “ Merrimac ” belongs to history. Several other similar low-freeboard turret vessels were built in America, and one of them, the “ Miantonomoh,” 250 ft. long, 55½ ft. beam, 14 ft. draught, 3850 tons displacement, 1800 I.H.P., 12 knots speed, with twin screws and two turrets carrying four 10-in. B.L. guns, of only 2 to 3 ft. freeboard, succeeded in cross­ing the Atlantic, returning again in safety; but the “ Monitor ” herself was caught in a gale and foundered off Cape Hatteras in 1862.

The first turret ships in the British navy were the “ Royal Sove­reign ” and “ Prince Albert.” The former, a wooden ship, launched in 1857 as a 121-gun three-decked line-of-battle ship, of a tonnage of 3760 tons, was in 1864 cut down to 7 ft. above water and fitted with 5½-in. side-armour bedded on a 36-in. wood side, and with four turrets on Captain Cowper Coles’ plan; and the latter, an iron vessel, 240 ft. long, 48 ft. beam, launched in 1864, with 4½-in. side-armour with 18-in. backing fitted on 1-in. skin plating, also carried four turrets, two fitted with pairs and two with single 12-ton guns; both were low-freeboard vessels and were reserved for coast defence. The

“ Monarch,” of 8300 tons displacement, was laid down in June 1866 as a sea-going turret ship. She was launched in May 1868, her dimen- sions being: length 330 ft., breadth 57 ft. 6 in. and draught 26 ft.; her I.H.P. was 8000, giving her a speed of about 15 knots, and she carried a large spread of canvas. She had a complete armour belt 9 ft. 9 in. wide and 7 in. thick, reduced to 6 in. at the extremities. Above this armour belt amidships, for a length of 84 ft., she was provided with a citadel, also of 7-in. armour, which protected the bases of two revolving turrets, each protected with 10-in. armour and carrying two 12-in. guns. She also carried two 9-in. guns forward on the upper deck and one 7-in. gun aft on the main deck, all protected by armour.

The design of the “ Monarch ” did not satisfy Captain Coles, and he induced the Admiralty to build a turret ship of much lower free- board, in accordance with his views. This vessel was the “ Captain,” built at Birkenhead and launched in March 1869. By an unfortunate error her freeboard was even less than Captain Coles had contemplated. She was fully rigged, with tripod masts and large sail- spread; this spread of canvas, with her low freeboard and deficient stability, resulted in her capsizing in the Bay of Biscay on 6th September 1870, amongst those drowned being her designer.

A number of low-freeboard turret vessels of the “ Monitor ” class, without masts and sails, were built for the British navy at this time, mostly for coast defence. Amongst these, the “ Cerberus ” for Australia and the “ Abyssinia ” and “ Magdala ” for India were completed in 1870. The “Abyssinia ” had a displacement of 2900 tons and a speed of about 9½ knots; her dimensions were: length 225 ft., beam 42 ft., draught 14½ ft., and her armament consisted of four 10-in. 18-ton guns. The other two vessels had the same armament, but were somewhat larger, being of 3340 tons displacement; and the thickness of their side-armour was 8 to 6 in., against 7 to 6 in. in the “ Abyssinia.” Several vessels of this type were also built for home service, including the single-turret vessels “ Glatton ” of 4910 tons and “ Hotspur ” of 4010 tons, each carrying two