already outstrip the war vessel in the important advantages of size and fleetness and carrying power. It is apparently in pro­tective advantages that the essential difference will lie.

The merchant ship is badly provided against fatal damage by collision, or by a blow delivered in any manner by which water is admitted into the ship. The propelling machinery of these ships and their steering apparatus are also dangerously exposed to artillery fire. Excepting torpedo boats, the ship of war of any size has its propelling machinery either under water or under cover of armour, and in a great number of cases there is either protection for the steering apparatus or there arc two propellers. The approximation towards war-ship arrangements which is needed in the merchant ship is the adoption of more than one screw and of greater breadth of ship, so that defences round machinery may be created in time of war. Both these changes in merchant-ship practice are demanded also by mercantile interests. The increase in breadth amidships would greatly reduce the risk of foundering in collisions and give more spacious accommodation amidships. Such increase when accompanied by fine ends is also favourable to speed.

The use of two screws is economical of power, and is a much- needed security against the evil results of an accident to an engine, a shaft, or a propeller. The time will doubtless come when a single propeller in a large passenger ship will be regarded as an unpardonable fault, and when the division into compartments now common will be held to be no better than a delusion and a snare.

The protection given to the regular ships-of-war by side armour, or by a protecting deck, at or near the water-line, will probably become a definite and indispensable feature in them, and may, perhaps, be their only distinguishing characteristic, apart from their outfit and equipment.

If this should prove to be the issue of events, their course will have been very indirect. In the ships-of-war of the last century no attempt was made to employ armour on the sides or to prevent the passage of projectiles and water into the holds by means of a protecting deck. There was a deck just below the water-line, but it had no protective qualities. It served, among other things, to furnish passage ways in action for the carpenter and his crew to get at the inner side of the wooden walls of the ship at and near the water-line, so that when shot entered there the holes might be immediately plugged. When screw propulsion was introduced into these ships, and it was found practicable to keep the engines and boilers under water, it would have been possible to place a deck over the machinery and beneath 'the water, which would have greatly added to the security of the engines, boilers, and magazines. The space above this deck might also have been so subdivided into compartments as to have protected the buoyancy and stability of the ship against the immediately fatal results of the invasion of water. The protection of the buoyancy and stability by these means would not have been absolute, in the sense of making the ship safe, but it would have been of the utmost value as compared with ships, otherwise similar, but having no such protection.

Thirty years passed between the date when screw-propeller engines were placed beneath the water-level in ships of war and that at which a committee on designs, under the presidency of Lord Dufferin, pro­posed to place such a covering deck over them, or to construct a water-line raft-body. The proposal of the main body of the com­mittee was to associate such a raft-deck for the protection of the buoyancy and stability of the ship against artillery with a central armoured citadel. That of the minority was to suppress the armour in the region of the water-line entirely, and to protect buoyancy, stability, machinery, and magazines by a raft-deck alone. In 1873 the plan as indicated by the main body of the committee was put into practice nearly simultaneously in the “ Duilio” and “ Dandolo” in Italy and in the “ Inflexible ” in England. In 1878 the system as conceived in principle by the minority of the committee of 1871, although not in the manner they recommended, was adopted in much smaller vessels in the British navy. A raft-deck was intro­duced into the “Comus” class of corvettes of 2,380 tons displace­ment, a class which was regarded as unarmoured. Since that date the raft-deck has been adopted in a more or less complete form in nearly all classes of unarmoured ships in the English navy. So it has come about that, out of some 850 unarmoured ships of war built and building in Europe, 47 have such protecting raft-decks. Of these 32 are English. There can be no doubt that all unarmoured ships of war will eventually be protected in this manner. The num­ber of so-called ironclads built and building in Europe is 270. Of these, 34 are based on the recommendation of the committee on designs ; 18 of them are English. There are six other English ships with central citadels and under-water protecting decks, built more than twenty years ago, but the raft-body principle is absent in them.

If the passage from the steam line-of-battle ship of 1840-1860 to the “Admiral’’class of 1884 had been made under the guidance of the principles of the committee of 1871, European nations would not find themselves possessed of large fighting ships covered from end to end, or over large areas of their sides, with thin armour, penetrable to a very large proportion of the guns brought against them. But the sailors of 1854-1860 did not take the view that

buoyancy and stability, and machinery and magazines, were the vital parts, needing defence by armour or by a raft-deck. They dreaded the effects of shell exploding between decks, setting fire to the ships, and converting the decks, crowded with men, into slaughter-houses. Their demand was, “Keep out the shells.” So it came about that iron armour-plates, thick enough to keep out the most powerful shell of the time, were worked upon the sides of the ships, and the guns were fought through ports cut in this armour. This feeling was so strong that the English Admiralty built the “Hector” and “ Valiant” with armoured batteries overlapping by many feet at each end the armour beneath them, which protected the buoyancy, stability, machinery, and magazines. Guns in­creased in power, and the armour was gradually thickened to resist them, until from 4 1/2 inches of armour, through which broadside ports were cut, 9 inches and 10 inches were reached. But this thickening of the armour had so reduced the possible number of the guns in a ship of moderate size, and the guns required for breaching such armour had so increased in weight, that the broadside ship had to give way to the turret or barbette ship, in which about four such guns were all that could be carried, and these had to be worked on turn-tables in or near the central line of the ship.

The point now reaςhed in all navies is that the broadside iron­clad with ports cut through an armoured side, as invented in France by M. Dupuy de Lôme, and copied by every power, is obsolete. Guns must be worked singly or in pairs on revolving turn-tables, each turn-table being surrounded by an armoured tower, forming the loading chamber or protecting the mechanism. The side armour protecting the buoyancy, stability, machinery, and magazines, although not introduced for that purpose originally, is retained in France for very large ships, is given up in Italy in favour of a raft-body, and is retained partially in England and Germany in conjunction with a raft-body.

The use of armour has arrested the development of the shell. But it is not inconceivable that its abandonment in front of the long batteries of guns in the French and Italian ships will invite shell attack, and make existence in such batteries, if they are at all crowded, once more intolerable. It remains to be seen whether in that case exposure will be accepted, or a new demand made for armour, at least against the magazine gun and the quick-firing gun. If exposure is accepted, it will be on the ground that the number of men at the guns is now very few, that the gun positions are numerous and the fire rapid, and that, if the guns had once more to be fought through ports in armour, the number of gun positions would be reduced, and the fragments of their own walls, when struck by heavy projectiles, would be more damaging than the projectiles of the enemy.

Internal armour for the protection of the heavy armour-breach­ing guns must be retained so long as such guns are used, and if they were abandoned an enemy could cover himself with armour invulnerable to light artillery. This the French attempted to do in inaugurating the system. They have been driven from it by the growth of the gun. Abandon the heavy gun, and complete armour-plating might again be adopted.

We must conclude that the buoyancy, stability, machinery, and magazines must be protected as far as possible against fatal damage from a single blow of these armour-breaching guns. The tendency will be to come to the lightest form of such protection. That lightest form appears to be a protecting deck a little above the water-level throughout the greatest part of its surface, but sloping down at the sides and at the ends, so as to meet the side walls of the ship under the water-line. However the armour is arranged (apart from a complete covering with invulnerable plat­ing), —whether as a belt with its upper edge 3 feet out of the water, as in the French ships; as a central armoured citadel and a raft- body at the ends, like the English and German ships ; or as a raft- body throughout, like the Italian ships,—shot holes in action will admit water and gradually reduce the necessary stability of the ship. In the French ships the assistance of the unarmoured upper parts is as necessary to prevent them from upsetting in anything but smooth water as is the assistance of the unarmoured raft ends in the English and German ships. In the intact condition the English ships have far greater stability than those of France. In the English ships a reserve of stability is provided, against the con­tingency of loss by injuries in action. In the French ships no more is provided than is required for the intact condition. The French have not accepted the position taken up in England that much greater initial stability may be given to heavily-armoured broad ships than is usually given, without causing heavy rolling. Nor have they accepted the further incontrovertible truth that the free passage of water in the raft-body from side to side of the ship in rolling is rapidly effective in quelling the motion and bringing the ship to rest in the upright position.

*Propulsion.*

The propulsion of ships by sails differs from the drifting of bodies in the air before the wind in a roost important respect. Ships may drift or sail in the direct course of the wind, and they