following order: (1) rafts—floating logs, or bundles of brush- wood or reeds or rushes tied together; (2) dug-outs—hollowed trees; (3) canoes of bark, or of skin stretched on framework or inflated skins (balsas) ; (4) canoes or boats of pieces of wood stitched or fastened together with sinews or thongs or fibres of vegetable growth; (5) vessels of planks, stitched or bolted together with inserted ribs and decks or half decks; (6) vessels of which the framework is first set up, and the planking of the hull nailed on to them subsequently. All these in their primitive forms have survived, in various parts of the world, with different modifications marking progress in civilization. Climatic in­fluences and racial peculiarities have imparted to them their specific characteristics, and, combined with the available choice of materials, have determined the particular type in use in each locality. Thus on the north-west coast of Australia is found the single log of buoyant wood, not hollowed out but pointed at the ends. Rafts of reeds are also found on the Australian coast. In New Guinea catamarans of three or more logs lashed together with rattan are the commonest vessel, and similar forms appear on the Madras coast and throughout the Asiatic islands. On the coast of Peru rafts made of a very buoyant wood arc in use, some of them as much as 70 ft. long and 20 ft. broad; these are navigated with a sail, and, by an ingenious system of centre boards, let down either fore or aft between the lines of the timbers, can be made to tack. The sea-going raft is often fitted with a platform so as to protect the goods and persons carried from the wash of the sea. Upright timbers fixed upon the logs forming the raft support a kind of deck, which in turn is itself fenced in and covered over.@@1 Thus the idea of a deck, and that of side planking to raise the freight above the level of the water and to save it from getting wet, are among the earliest typical expedients which have found their development in the progress of the art of shipbuilding.

I. History to the Invention of Steamships

Whether the observation of shells floating on the water, or of split reeds, or, as some have fancied, the nautilus, first sug- gested the idea of hollowing out the trunk of a tree, the practice ascends to a very remote antiquity in the history of man. Dug- out canoes of a single tree have been found associated with objects of the Stone Age among the ancient Swiss lake dwellings; nor are specimens of the same class wanting from the bogs of Ireland and the estuaries of England and Scotland, some obtained from the depth of 25 ft. below the surface of the soil. The hollowed trunk itself may have suggested the use of the bark as a means of flotation. But, whatever may have been the origin of the bark canoe, its construction is a step onwards in the art of ship­building. For the lightness and pliability of the material necessitated the invention of some internal framework, so as to keep the sides apart, and to give the stiffness required both for purposes of propulsion and the carrying of its freight. Similarly, in countries where suitable timber was not to be found, the use of skins or other water-tight material, such as felt or canvas, covered with pitch, giving flotation, demanded also a framework to keep them distended and to bear the weight they had to carry. In the framework we have the rudimentary ship, with longitudinal bottom timbers, and ribs, and cross-pieces, imparting the requisite stiffness to the covering material. Bark canoes are found in Australia, but the American continent is their true home. In northern regions skin or woven material made water­tight supplies the place of bark.

The next step in the construction of vessels was the building up of canoes or boats by fastening pieces of wood together in a suitable form. Some of these canoes, and probably the earliest in type, are tied or stitched together with thongs or cords. The Madras surf boats are perhaps the most familiar example of this type, which, however, is found in the Straits of Magellan and in Central Africa (on the Victoria Nyanza), in the Malay Archipelago and in many islands of the Pacific. Some of these canoes show a great advance in the art of construction, being

built up of pieces fitted together with ridges on their inner sides, through which the fastenings are passed.@@2 These canoes have the advantage of elasticity, which gives them ease in a seaway, and a comparative immunity where ordinary boats would not hold together. In these cases the body of the canoe is constructed first and built to the shape intended, the ribs being inserted afterwards, and attached to the sides, and having for their main function the uniting of the deck and cross-pieces with the body of the canoe. Vessels thus stitched together, and with an inserted framework, have from a very early time been constructed in the Eastern seas far exceeding in size anything that would be called a canoe, and in some cases attaining to 200 tons burthen.

From the stitched form the next step onwards is to fasten the materials out of which the hull is built up by pegs or treenails; and of this system early types appear among the Polynesian islands and in the Nile boats described by Herodotus (ii. 96), the prototype of the modern “ nuggur.” The raft of Ulysses described by Homer presents the same detail of construction. It is remarkable that some of the early types of boats belonging to the North Sea present an intermediate method, in which the planks are fastened together with pins or treenails, but are attached to the ribs by cords passing through holes in the ribs and corresponding holes bored through ledges cut on the inner side of each plank.

We thus arrive, in tracing primitive efforts in the art of ship construction, at a stage from which the transition to the practice of setting up the framework of ribs fastened to a timber keel laid lengthwise, and subsequently attaching the planking of the hull, was comparatively simple. The keel of the modern vessel may be said to have its prototype in the single log which was the parent of the dug-out. The side planking of the vessel, which has an earlier parentage than the ribs, may be traced to the attempt to fence in the platforms upon the sea-going rafts, and to the planks fastened on to the sides of dug-out canoes so as to give them a raised gunwale.@@3 The ribs of the modern vessel are the development of the framework originally inserted after the completion of the hull of the canoe or built-up boat, but with the difference that they are now prior in the order of fabrication. In a word, the skeleton of the hull is now first built up, and the skin, &c., adjusted to it; whereas in the earlier types of wooden vessels the outside hull was first constructed, and the ribs, &c., added afterwards.@@4 It is noticeable that the invention of the outrigger and weather platform, the use of which is at the present time distributed from the Andaman Islands eastward throughout the whole of the South Pacific, has never made its way into the Western seas. It is strange that Egyptian enterprise, which seems at a very early period to have penetrated eastward down the Red Sea and round the coasts of Arabia towards India, should not have brought it to the Nile, and that the Phoenicians, who, if the legend of their migration from the shores of the Persian Gulf to the coast of Canaan be accepted, would in all probability, in their maritime expeditions, have had opportunities of seeing it, did not introduce it to the Mediterranean. That they did not do so, if they saw it at all, would tend to prove that even in that remote antiquity both nations possessed the art of constructing vessels of a type superior to the outrigger canoes, both in speed and in carrying power.

The earliest representations that we have as yet of Egyptian vessels carry us back, according to the best authorities, to a period little short of 3000 years before Christ. Some of these are of considerable size, as is shown by the number of rowers, and by the cargo consisting in many cases of cattle. The earliest of all presents us with the peculiar mast of two pieces, stepped apart but joined at the top. In some the masts are shown lowered

@@@1 The raft of Ulysses described in Homer (*Od.v.*) must have been of this class.

. @@@2 See Captain Cook's account of the Friendly Islands, La Pérouse on Easter Island, and Williams on the Fiji Islands.

@@@3 Compare the planks upon the Egyptian war galleys, added so as to protect the rowers from the missiles of the enemy.

@@@4 It is curious that these two methods should still survive, and be in use, in the construction of light racing 8-oared boats. Some of these are built ribs first, and skin laid on afterwards; others, skin laid on moulds and framework first, and ribs inserted in the shell when turned over.