

during a war. What with the cold, the heat, the stifling air when submerged, the whole cramped unnatural life—not to speak of the nerve-racking terrors when the submarine becomes the hunted instead of the hunter—existence on board an undersea vessel cannot exactly be described as ideal.

Weapons of the Submarine

Guns and torpedoes are the submarine's weapons, with guns for choice if the enemy is unable to offer resistance. In order to use its guns, however, a submarine must present itself as target, with excellent chances of being sent below if the adversary is armed. Torpedoes, on the other hand, are very costly, and it would be foolish to waste one on a vessel known to be unarmed or on one so far away that there is no certainty of hitting it. So the German U-boats had orders not to fire a torpedo at a greater distance than 300 yards, unless the conditions were particularly favourable.

A submarine's torpedo, when it explodes in the vitals of a battle-ship, is usually fatal, and the Germans expected to weaken the British fleet thus "by attrition" until their own fleet could engage it successfully. The U-boats accounted for more battle-ships than did any other German

to smash the submarine in a stand-up fight, which that elusive craft risks as seldom as possible.

In April 1917 the Allied and neutral merchant shipping sunk by the German submarines approached 900,000 tons. An extraordinary number and range of measures of relief and protection were adopted before it became possible to bring the U-boat menace under control.

Merchant vessels sailed in convoys and close formation, under naval escort. Listening devices or hydrophones of a variety of kinds, making use of the fact that water is an excellent medium for the transmission of sound, were perfected to such a degree that it was often possible to ascertain the approximate position of a submerged submarine by the sound of its machinery. Destroyers and submarine chasers patrolled infested regions. Aeroplanes and "blimps," hovering above, were often able to sight a submerged U-boat, invisible from the surface. "Mystery" or "Q ships"—war vessels disguised as tramps and worked by naval officers and men—lured many U-boats to destruction.

Pitting Submarine against Submarine

A submarine could escape molestation from

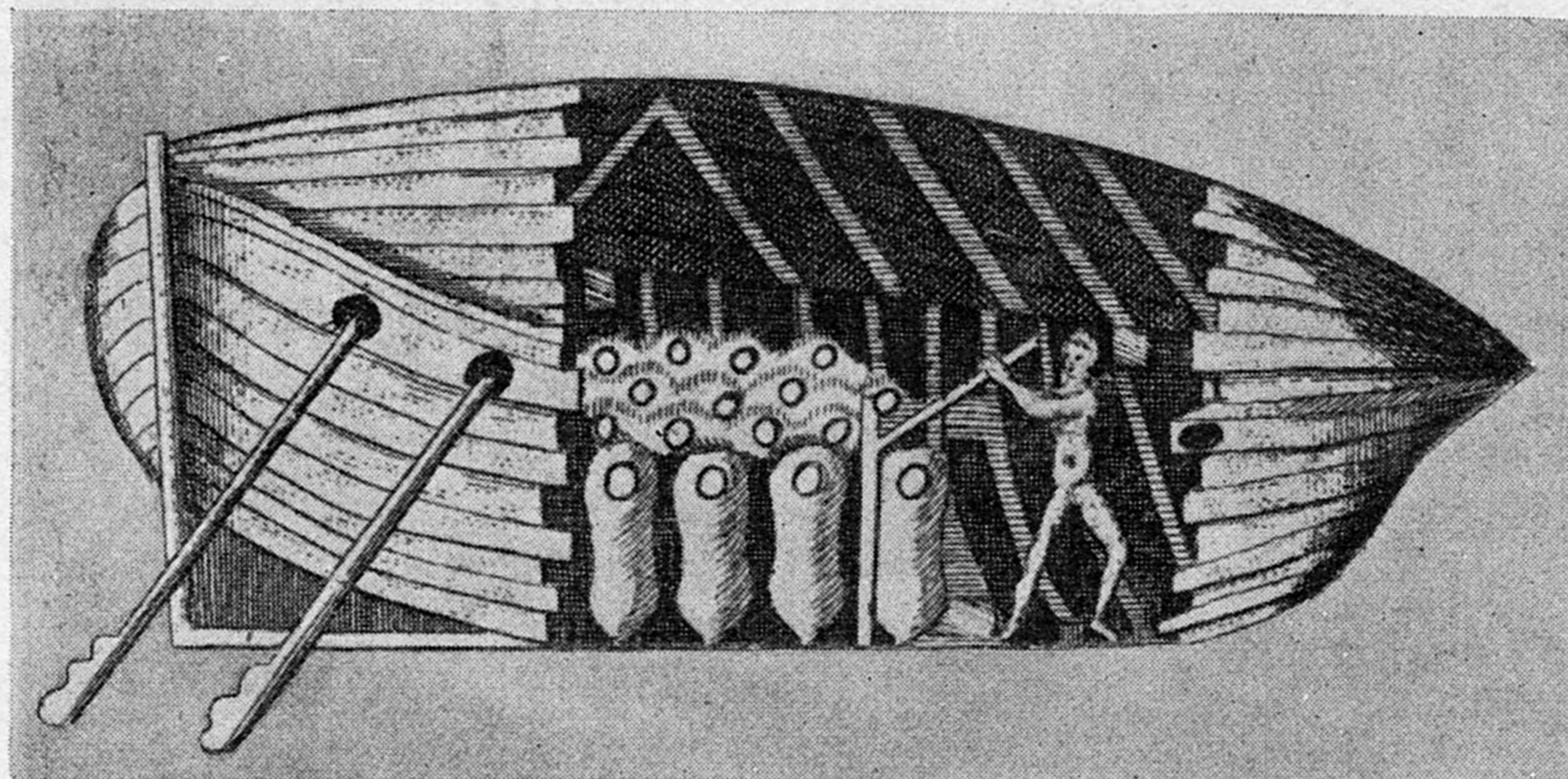
surface craft by diving, but the invention of the depth bomb cancelled that immunity. The deadliest enemy of the submarine, however, proved to be the submarine itself. The 500 Allied torpedo-boat destroyers sank a greater number of U-boats than did any other type of craft, but the 100 Allied submarines sank nearly as many.

The idea of an under-water boat had haunted the minds of inventors since early in the 17th century, and had proved fatal to several. The *Turtle*, invented in 1776 by an

American, David Bushnell, embodied the fundamental principles of modern submarine construction. Another American, Robert Fulton, offered his idea of a submarine first to Napoleon and then to Pitt, but obtained no recognition.

John P. Holland, an Irish-born American, devised the type of submarine which has been largely adopted as the model for the world's navies. His ninth model, launched in 1898, was the first practically successful submarine. Simon Lake contributed to the development of the undersea boat, as did also numerous other inventors, working for the navies of Germany, Great Britain, France, and other countries.

AN ENGLISH SUBMARINE OF AN OLDER DAY



An early type of Submarine. It was suggested that she would be best propelled by a paddle in the stern, "by whose vibrations she will the more easily cut the water."

craft, yet they never materially weakened the Allied fleet, because it was constantly escorted and screened by a type of fighting vessel which is, because of its greater speed, lighter draught, and heavier armament, practically immune against the submarine, namely the torpedo-boat destroyer.

The Torpedo-boat Destroyer

To maintain a straight course, the submarine's torpedo must run about 15 feet below the surface, otherwise it will be diverted by the waves. As a destroyer has a draught of only 9 or 10 feet, a torpedo would pass under without touching it. On the other hand, its larger guns and heavier torpedoes enable the destroyer