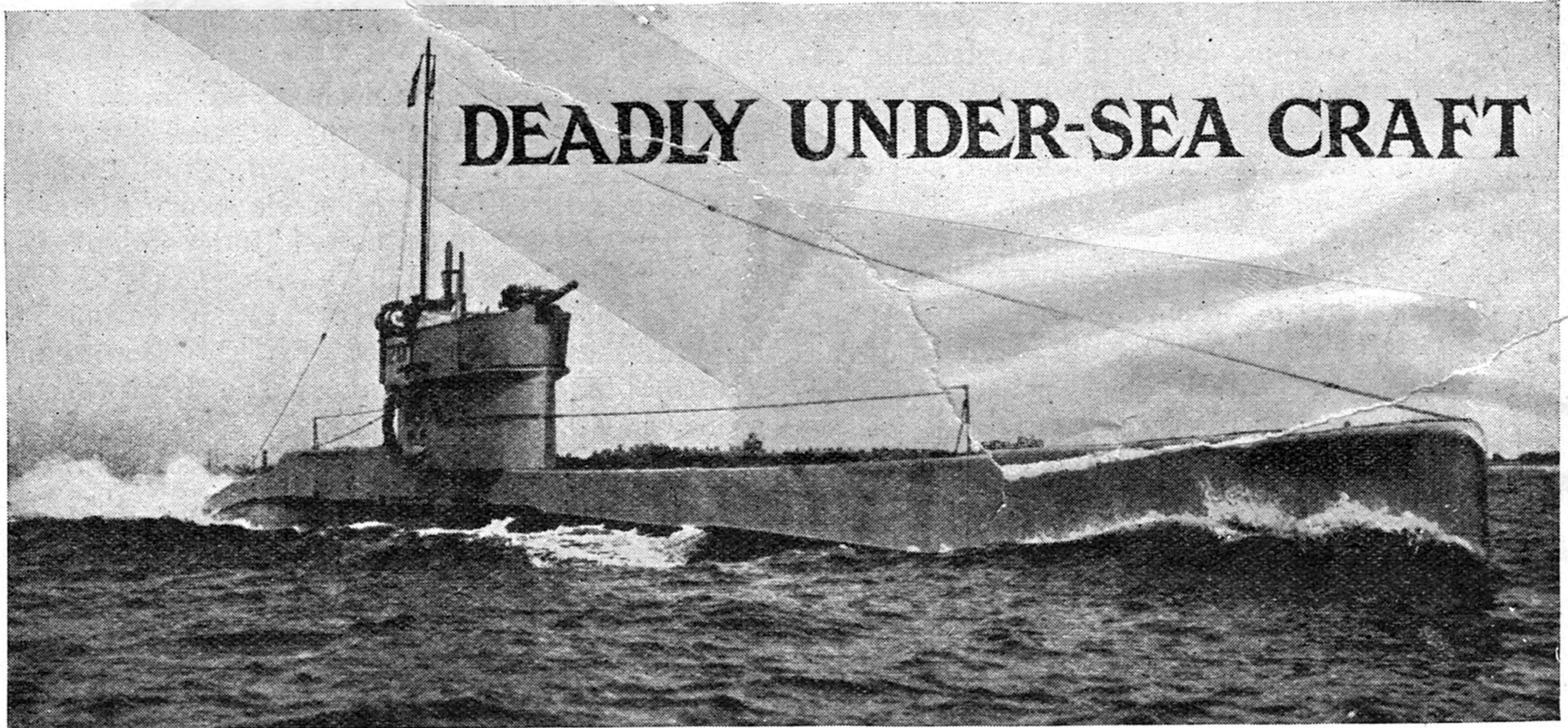




SUBMARINE. With the sinking of the British cruisers, the *Hogue*, *Cressy*, and *Aboukir*, in September 1914, the general public realized, what naval authorities already knew, that the submarine was an enemy to reckon with. With the sinking of the *Lusitania* and the *Falaba*, the horrified world awoke to the fact that this same submarine, in unscrupulous hands, was, perhaps, the deadliest sea weapon yet devised.

The submarine is merely a "submersible"; it can swim under water, but for a limited time only—usually about 48 hours—and at a limited depth. With its periscope submerged it is almost entirely blind, and, so long as the boat is so much submerged that it has to depend on the periscope, its vision is by no means equal to that of a surface craft. The size of its guns and the number of torpedoes it can carry are limited by the small size of the vessel. Its speed on the surface at the beginning of the World War was about 15 miles, and 8 or 10 submerged, as against 21 to 25 miles for a battle-ship, 25 to 30 for cruisers, and 35 to 40 for destroyers. Its one overwhelming advantage is its ability to become invisible at will—to fight when conditions are in its favour, and to escape unseen when they are not.

What a Submarine Looks Like

A spindle or cigar-shaped craft, about 230 feet long, 21 feet beam, and about 12 feet draft, with a little hump of a conning-tower and bridge on top, and a signal mast and one or two periscopes standing up above that—such is, roughly, the outer aspect of an 800-ton submarine. The hull may be single or double. In the latter case, the space between the hulls is used for fuel and ballast tanks, which help to protect the inner hull from shells, torpedoes, or other source of harm.

On the surface most submarines are driven by internal-combustion (Diesel) engines burning heavy oil, for petrol fumes are too dangerous in the confined spaces of the hull. But this admirable engine cannot be used when the vessel is submerged, because of the vast amount of air required for its consumption. Below the surface an electric engine, which needs no air, is used. The batteries in recent types are charged by the Diesel engine while at the surface. One reason that the submarine cannot run under water for an indefinite time is that it must come to the surface to recharge the batteries. It is said the German U-boats (from *Untersee*, meaning "submarine") did not average three hours a day below the surface.

The Important Ballast Tanks

The submarine dives by letting sea water into the ballast tanks; it rises by blowing the water out of the tanks with compressed air, stored in seamless steel flasks at pressures of 1,000 and 2,500 lb. a square inch. The distribution of these water-ballast tanks, so that the boat will run on an even keel whether submerged, awash (that is, with only the conning-tower exposed), or on the surface, is exceedingly important. In the German U-boat, in addition to the ballast tanks distributed between the inner and outer hulls, there are two inner ballast tanks amidships. The fuel-oil tanks have holes in the bottom to admit water as the oil is used up. The heavy lead keel can be dropped off in case of accident beneath the water, to bring the boat to the surface.

In order to remain at any given depth, the submarine must keep moving; it cannot hang suspended and motionless between the waves and the sand. To run below the surface, it usually takes on just enough ballast to leave

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