THE ROYAL NAVY'S FIRST SUBMARINES

BY

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The idea of the submarine as the perfect vehicle for surprise attacks upon an enemy fleet or defended harbour attracted many enterprising engineers in the eighteenth and early nineteenth centuries but despite considerable ingenuity, lack of a suitable source of power for underwater propulsion prevented any really practical development. Another problem was the lack of a weapon capable of being used under water, although attempts were made by Dr. David Bushnell with a submersible called the *American Turtle* in 1776 to attach explosive mines to the undersides of British warships at anchor off New York. Apparently the copper sheathing of the British warships defeated the screw which was supposed to secure the infernal machine to the unsuspecting victim's hull.

Three nineteenth century inventions radically changed the situation and opened the way for the development of a practical submersible. The first requirement for a satisfactory non-air supported source of power was met by the conjoint development of the direct current motor and the lead-acid storage battery. The latter, although heavy, took up comparatively little space, was of low internal resistance electrically and was capable of being readily recharged.

The practical electric motor resulted from the work of Thomas Davenport in 1837 but another thirty nine years passed before such machines, manufactured in the first instance to the designs of Z. T. Gramme, became readily available from commercial suppliers. Likewise, the lead-acid battery underwent a long period of gestation for although a battery of this type had been constructed by Gaston Planté in 1859, it wasn't until Faurè improved its design by the introduction of the pasted plate in 1880 that it acquired any merit as a compact, reasonably robust and easily handled power source. This combination of electric motor and storage battery presented the submarine designer with an eminently satisfactory power package which required only the addition of some form of prime mover, thus enabling the electric motor to be driven as a direct current generator for recharging the battery, to complete the propulsion installation. In the eighteen nineties, designs developed by Laubeuf in France employed a steam prime mover which was used also for surface propulsion, but in the United States, J. P. Holland's Torpedo Boat Company (later to become part of the Electric Boat Company) adopted the recently perfected Otto gasoline engine for the 64/74 ton private venture submarine *Holland* (originally *Holland VIII*) which, after exhaustive trials, was purchased by the U.S. Navy Department in April 1900.

The other requirement for the submarine as a practical warship was an effective weapon capable of being discharged under water at a safe distance from a target. By the eighteen nineties, however, a solution to this problem was already to hand in the form of the Whitehead automobile torpedo, developed by Robert Whitehead at Fiume (then in Austria) and adopted by several of the world's navies for surface craft. Both above water and submerged topedo tubes were employed in surface ships although, in fact, Whitehead's own torpedoes were designed for submerged discharge using compressed air for ejection. Adaptation for firing from a dived submarine was thus a comparatively simple matter. Although at that time the U.S. Navy favoured the flywheel 'stored energy' Howell torpedo, the Whitehead type was adopted for the *Holland* submarine which was armed with a single 18-in. torpedo tube forward. Three torpedoes were carried.

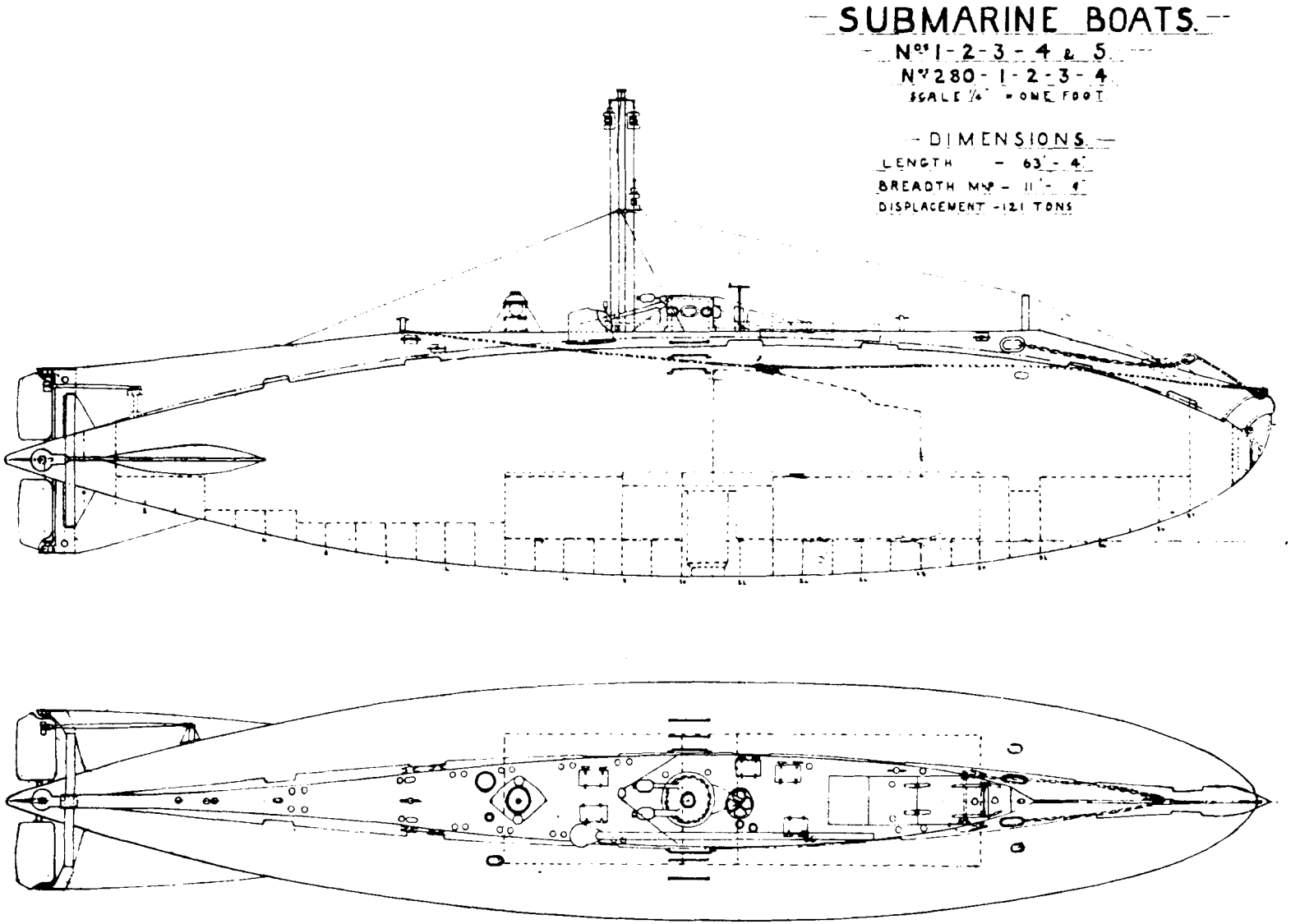

FIG. 1—THE R.N. HOLLAND SUBMARINE

FIG. 2—HOLLAND SUBMARINE NO. 3 'STEAMING' OUT OF HARBOUR FOR TRIALS CIRCA 1904. H.M.S. 'VICTORY' IS IN THE BACKGROND

One final problem remained, that of vision. The magnetic compass, necessarily mounted outside the pressure hull, could not be seen when dived and in the absence of any optical aid the submarine had to be brought awash from time to time in order to take bearings and make any necessary course correction. The *Holland* was provided with ports in the diminutive conning tower for this purpose. Likewise, the boat could be aimed at a potential target only when awash.

A small positive buoyancy of a few hundred pounds was maintained in submerged trim and the boat was dived by tilting through the action of hydroplanes mounted aft. The lack of forward hydroplanes proved an unsatisfactory feature, however, and a level trim at the desired depth could be maintained only with difficulty. In fact the normal 'dived' attitude of the *Holland* involved a porpoise-like motion, diving and then rising awash to take bearings every two to three hundred yards.

In January 1900, Holland made proposals for an improved version of his submarine and a few months later, after consideration by the Navy Department of this *Holland IX* design, orders were placed for the construction of seven further boats. Larger than the *Holland*, the vessels of the *Adder* class were 63 feet long with a single circular-sectioned pressure hull, a little under 12 feet in diameter, and internal ballast tanks. A petrol engine of 160 h.p. gave a surface speed of 8.5 knots and when submerged the battery/70 h.p. electric motor enabled 7 knots to be maintained for about three hours. A single 18-in. torpedo tube with five torpedoes constituted the offensive weapon fit. As in the *Holland*, hydroplanes were provided aft only.

In the meantime, experiments had been carried out with a rudimentary periscope which made it possible to sight the horizon and to take bearings when submerged, although in the event real progress in submarine periscope design didn't come until around 1905 when its development was taken up by the German optical industry.

Throughout this period the British Admiralty maintained a detached view bearing in mind the limited coastal defence capability of the contemporary submarine. This policy was questioned in Parliament, however, and eventually

it was put to the Controller that Vickers, Sons & Maxim would undertake the constuction of *Holland* type submarines at Barrow under licence from the Electric Boat Co. which had acquired the rights to Holland's designs. A demand that the Electric Boat Co. should receive a royalty in respect of the first twenty submarines built for the Royal Navy, irrespective of design or builder, was quietly dropped, however, and in the event the 1901 Navy Estimates made provision for the construction by Vickers of five *Holland* submarines to the same basic design as USS *Adder*. A number of improvements were inspired by James McKechnie, the project leader at Barrow, and Captain R. H. Bacon, R.N., a torpedo officer appointed as Inspecting Captain of submarines, and the first boat was laid down as Yard No. 280 later in 1901. As construction progressed considerable assistance was afforded by Captain F. T. Cable of the Electric Boat Co. who had come across from the United States with a trained crew to conduct the early trials and to train the British team.

Holland 1 was launched at Barrow in November 1902 and it is interesting to note the close relationship between her hull lines and those of the present day SSN. As in the American prototype the single screw was driven in surface trim by a 160 h.p. four-cylinder petrol engine of U.S. manufacture, since although the basic heavy oil engine had been developed as a commercially practical machine, it was at that stage too large and heavy for use in the restricted space available in a submarine. Thus there was always the attendant risk of explosion in addition to the toxic effects of petrol vapour to which the ship's company were continuously exposed. It should be added that detection of any dangerous concentration of vapour was the duty of the ship's company white mice!

The electrical installation too was primitive with little by way of any enclosure so that sparks added to the hazards associated with the use of petrol. The battery, comprising 60 Chloride Storage Co. cells (120 volts, 1840 ampere-hours) and sited in a tank under the control position deck, was relatively inaccessible and lacked adequate ventilation so that the risk of a battery explosion was yet another hazard to be faced by the early (volunteer) submariner. As if these dangers were not enough, there would have been an inevitable accumulation of water in the bilges resulting from minor leaks and condensation making it difficult to keep the electrical equipment dry and free from earth faults.

The *Hollands* were of 121 tons submerged displacement and, like the American prototype, had a dived duration of about three hours at 6–7 knots (i.e. at 75 h.p.). There were no internal bulkheads apart from the collision bulkhead forward and the ship's company of seven officers and men camped out where best they could. In the matter of auxiliary machinery, the most important were the electrically-driven ballast pump, which served to pump out the ballast tanks when restoring surface trim, and the air compressor, likewise electrically driven and a continual source of trouble, which charged air bottles for the torpedo discharge system and for ventilating the boat when submerged. Trim was adjusted by pumping water from forward to aft or vice versa and an automatic arrangement provided compensation for the weight of fuel burnt off. The hull and framing were built to withstand the pressure at a depth of 100 feet although in practice the boat was limited to about a fifty foot diving depth.

A light, free-draining superstructure was provided for use when running on the surface and there was an armoured conning tower amidships, 32-in. diameter and 4-in. thick for the use and protection of the navigator. One improvement compared with earlier submarines was the provision of a simple periscope, ten feet long, so that bearings could be taken when the boat was just submerged. In this latter condition, glazed openings in the pressure hull gave limited illumination but, these apart, the crew had to rely upon electric battery lamps since there was no fixed electric lighting installation. Likewise, creature comforts were con-

spicuously lacking, there being no facilities for cooking, washing or heating!

J. P. Holland's development work had been carried out in relatively sheltered waters and it soon became apparent once the British *Hollands* entered service that this type of boat with its small surface buoyancy, low freeboard and lack of any bridge was not suited to anything but the calmest sea, a condition met but infrequently around the British Isles. Early breakdowns and defects were gradually overcome, however, and by the early months of 1904 all five boats were operating with reasonable efficiency. They were employed in their intended coastal defence role during fleet manoeuvres and it should be remembered that the then current war strategy involved still the nineteenth century (and earlier) concept of a close blockade of an enemy's harbours! Time and again the *Hollands* proved able to creep undetected to within close torpedo range, proceeding at night either awash or on the surface with the aid of the silent drive of the electric motor. Lengthy coastal passages were usually undertaken in tow, with the openings closed in anything but calm sea conditions.

Despite their apparent lack of seaworthiness and the inherent dangers associated with the joint presence of petrol vapour, non-flameproof electrics, battery gases and salt water, the five boats maintained a good safety record notwithstanding occasional battery explosions and frequent breakdowns. Unfortunately, later classes, designed to operate further afield than the little *Holland* boats, were not so lucky and a number of disastrous accidents marred progress during the next decade.

The limitations of Holland's design had been realized in fact long before the boats were ready for sea but their construction did enable both Vickers and the Admiralty to gain experience in submarine work and to build up a store of expertise. In the meantime, Captain Bacon together with Vickers developed an improved design of nearly twice the size possessing considerably improved sea keeping qualities. The first of this new 'A' class was laid down at Barrow early in 1902 nearly a year before *Holland 1* was completed for trials. Of the thirteen vessels of the 'A' class, the final boat, A.13, was the first British submarine with a heavy oil engine—the ubiquitous Vickers diesel which was to be fitted widely in its fully developed form in British submarines over the next twenty years—but 'slinging the piston' is another story.