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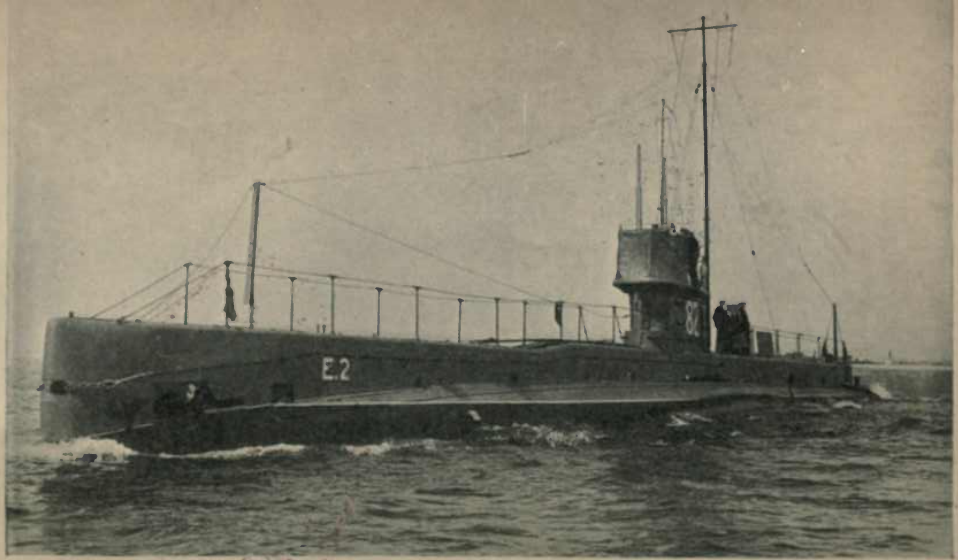
WAR BOOKS

SUBMARINES, MINES AND TORPEDOES IN THE WAR



Photo, Cribb, Southsea.]

THE BRITISH SUBMARINE "E.2."

Displacement, 800 tons; Speed, 16·10 knots; Armament, 4 torpedo tubes and 2 q.-f. guns
There are 17 vessels of this class, completed between 1912-14.

SUBMARINES, MINES AND TORPEDOES IN THE WAR

BY

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"SUBMARINE ENGINEERING OF TO-DAY," ETC.

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PREFACE

WARFARE has become so largely a matter of science that in order to arrive at an intelligent understanding of the *naval situation* or of the *military campaigns* in the Great European War, a knowledge of the scientific factors contributing to victory or defeat is essential. And in this volume it has been my aim not only to review the actual fighting underseas, but also to present a compendium of information relative to the submarine fleets and arms of the great Naval Powers engaged; which I venture to hope will prove of present interest on account of the prominent part played by the under-water fighting ships and appliances, and of permanent historic value as being the first work to describe the vast preparations and curious events leading to the new "Submarine Phase" in naval warfare.

C. W. D-F.

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INTRODUCTION

THE SUBMARINE PHASE OF THE NAVAL WAR

In the mist of war which envelops over half the entire world, no less than 264 underwater fighting ships are engaged. They form the submarine fleets of England, France, Russia, Japan, Germany and Austria; and the highly-trained crews of these modern additions to the fighting navies comprise nearly 20,000 men. But the conduct of submarine warfare on the grand scale requires far more than flotillas of submergible warships and their daring crews. This new branch of naval science is ever widening in its scope, its means of offence, and in its attendant ramifications. Every important naval base has its curious submarine

floating docks, ready for crippled members of its attached flotilla; every naval construction department has its corps of submarine experts; each of the 1,500 surface warships engaged in this titanic struggle for the dominion of Europe and the mastery of the seas carries the means for delivering submarine attacks in its torpedoes and surface and submerged discharging tubes. The oceans in the theatres of war have been strewn with German and Austrian mines; then they have been either counter-mined or swept clear and mined again. British seaplanes, with specially trained observers, are continually searching from high in the air for the *dark patches in the semi-transparent sea-green* which denote the presence of mines and submarines. Within signal-range or wireless call of the aërial scouts and their attendant ships are destroyer flotillas to give battle to the hostile submarines, while hundreds of trawlers and small steamers, fitted with special apparatus, are continually sweeping

up the hundreds of submarine mines laid by the enemy's vessels which are fitted to enable them to sow like seeds over the pathways of the sea these deadly perils to navigation. Submerged wire entanglements in conjunction with boom-defences and observation and contact submarine mines protect the seaward approaches to harbours in the same way as similar appliances are used to protect the approaches to land fortifications; and every harbour, waterway and channel of strategic importance is protected by elaborate submarine mine defences. All this is part of the new warfare underseas —that science which is daily rendering hazardous the life of the greatest battleship and the smallest merchantman afloat in the zone of war.

Before placing in review order the vast preparations made for submarine attack and defence in the years which preceded the outbreak of war and describing in detail the powerful submarine fleets engaged, it is necessary to make clear

to the reader the wonderful change which this new mode of attack has made in all branches of naval warfare and its influence on sea power. As indicative of this change we have only to survey *in their submarine aspect* the naval operations in the opening phase of this, the greatest war in history.

In the domain of naval strategy we find reflected the altered conditions caused by these invisible arms. Every battle on land and sea teaches its lesson of concealment and sudden stealthy attack; and even as the huge siege guns and devastating artillery fire of the land forces is causing the extension of the battle-front and the rapid burrowing under earth or entrenching of positions dearly won or with difficulty retained—"approximating to siege warfare"—so are the powerful 12 and 13.5-inch naval guns (weight of projectile 850 lbs. and 1,400 lbs. respectively), combined with the rapidity and accuracy of the modern warship's secondary armament, necessi-

tating the reduction in numbers of the big surface ships of the opposing fleets by frequent submarine and torpedo attacks prior to the decisive engagements between the battle fleets. Hence we find, in the opening phase of the naval war, the German and Austrian fleets, inferior in numbers and gun power, skulking behind fortifications and waiting for their submarine and surface torpedo-boats and light cruisers, in conjunction with the hundreds of submerged mines strewn over the North Sea, Baltic, Adriatic and elsewhere to reduce the number and power of the British, French, Russian and Japanese fleets before the decisive actions are fought; and in order that these tactics might be frustrated, and the big British ships, as well as those of her allies, costing several millions sterling each, should not be exposed to these grave risks when no good could result, they have been compelled to delay initiative, and meanwhile all their operations had to be screened by

smaller and faster vessels of the cruiser and destroyer types, while they waited within call should the German Battle Fleet—in the case of the North Sea—dare to come out to fight. The British submarines of the large sea-going type were in the meantime employed in watching the Frisian coast with the object of attacking any of the enemy's ships which ventured from behind the elaborate coast fortifications. Not content with this *rôle*, however, several British submarines made their way unseen through the dangerous waters of the Heligoland Bight and succeeded in getting within reconnoitering distance of the German submerged harbour defences, behind which lurk their big ships.

With what degree of success this new opening or *submarine phase* in naval warfare has been attended is shown by the sinking, during the first few weeks of the war, of the British cruiser *Amphion*, a vessel of 3,440 tons displacement, completed in 1912, and

carrying ten 4-inch guns, with a loss of 131 men, by contact with a German mine; the destruction of the German submarine U.15 by the British cruiser *Birmingham*; the sinking of an Austrian torpedo-boat by a mine off Pola; the torpedoing of H.M.S. *Pathfinder*, a fleet scout of about 3,000 tons displacement, completed in 1905-6, by a German submarine; the destruction of the Wilson liner *Runo* by a mine; the sinking of the German cruiser *Hela*, a vessel of 2,000 tons displacement, built in 1896, by the British submarine E 9, and the torpedoing of the British armoured cruisers *Aboukir*, *Hogue* and *Cressy*—vessels of 12,000 tons displacement, carrying two 9.2-inch and twelve 6-inch guns besides twelve 12-pounder quick-firing guns and two torpedo tubes—by German submarines concealed behind a trawler engaged in laying mines, over which the Dutch flag had been hoisted as a blind.

This is in addition to the lamentable

destruction of much life and property belonging to neutral powers caused by the laying of German floating mines on the trade-routes.

To the Allies this *submarine phase* did not come unexpected. The British Naval yards in conjunction with the big shipbuilding and engineering firms, such as Messrs. Vickers Ltd., Barrow-in-Furness; Messrs. Armstrong, Whitworth and Co. Ltd., Newcastle-on-Tyne; the Whitehead Torpedo Company Ltd., Weymouth; Messrs. Siebe, Gorman and Co. Ltd., London; and Messrs. Scotts' Shipbuilding and Engineering Co. Ltd., as well as many other firms and individual submarine experts had been engaged for many years in solving one after another the problems continually arising in the practical application of all forms of submarine warfare. The first British naval submarines were launched in 1901-2 from Messrs. Vickers' works at Barrow, and the subsequent growth of our submarine flotillas has been rapid

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both in number of vessels and in size and armament. The British submarine fleet now numbers 82 vessels. The original boats from which the British type has since been evolved were built from the designs of Mr. John P. Holland, an American inventor.

To France belongs the honour of being the first naval power to adopt the submarine torpedo-boat as a vessel of war; and the first vessel, the *Gymnôte*, was launched in 1888, but it was not until 1893 that the Republic commenced the construction of her now powerful submarine flotilla, numbering 92 vessels.

The first Russian submarine was launched at Kronstadt in 1902, and since that date the Russian flotilla has steadily increased until it now numbers 37 vessels.

Japan commenced the construction of what is now a powerful and up-to-date flotilla of seventeen vessels by the acquisition of a British-Holland boat in 1904.

Turning to Germany we find at first

a great reluctance on the part of the Ministry of Marine to provide for the construction of submarines, but in 1905-6 this initial hesitation was overcome and the two vessels U.1 and U.2 were launched. Since then the belief in a powerful submarine flotilla steadily grew until at the moment when war was declared Germany possessed no less than 30 to 36 submarines of a very efficient type. The Austro-Hungarian Navy did not adopt submarines as units of the Fleet until 1909, and now possess only six small vessels.

From this brief *resumé* of the growth of the submarine fleets of the six great naval Powers at war, it will be seen that in point of numbers as well as in priority, bringing with it practical experience, Great Britain and France have a very appreciable superiority. It must, however, be left for succeeding chapters to describe in detail the steady growth and present size and capabilities of the submarine fleets at war.

The lessons taught by the Russo-Japanese war were not lost on the British Admiralty, and special methods had been prepared to deal with submarine attack in its various forms. Having in mind the destruction caused to both Russian and Japanese warships by submarine mines—especially those of the "offensive contact" type, which are moored to the bottom, float just under the surface and explode immediately on contact; and in the Russo-Japanese War were responsible for the sinking of the Japanese battleships *Hatsuse* and *Yashima* as well as the Russian battleship *Petropavlovsk* and the cruiser *Boyarin*—the British Admiralty foresaw the danger to which both warships and merchantmen would be exposed in time of war if the seas strewn with these mines could not be quickly cleared, and a new type of auxiliary came into being. This was the mine-sweeper, and eight vessels of the old torpedo-gunboat type were fitted out for

the work. In addition to these, however, the Admiralty purchased a considerable number of steam fishing trawlers, and fitted them with mine-sweeping appliances, and made arrangements for a large fleet of similar vessels to be placed at the disposal of the navy in the event of war. In order to man this new mine-sweeping fleet with experienced sailors on the outbreak of war, a new section of the Royal Naval Reserve was created in 1911. This is known as the "Trawler Section," and consists of 142 *skippers* and 1,136 men taken from the fishing fleet.

Realizing the value of the submarine mine in certain cases, the British Admiralty went further and created a small mine-laying fleet from seven old second-class cruisers, which had their aft-decks cleared and provided with rails for a large number of mines to be run down and slid over the stern into the water as the vessels steamed along, thus quickly laying a mine-field. But as the laying of mines, speaking generally, is a defensive

mode of warfare and the policy of the British Navy—owing to its supremacy—is attack and not defence, the mine-laying fleet is of second importance to the sweeping fleet, the work of which, although much augmented by additional small steamers pressed into service, was, during the first few weeks of the war, of a nature more arduous and dangerous than will ever be realised. Hundreds of German mines were swept up, and hundreds more were exploded by being dragged into contact with each other during the progress of sweeping operations.

What the clearance of these vast fields of floating and anchored mines in the North Sea meant to the British Navy, engaged in blockading the German Fleet, and to the Mercantile Marine not only of England, France, Russia and Belgium, but also to that of the neutral countries, it is perhaps a little difficult to realize until one remembers that several hundred British and French warships were patrolling the North Sea and

Channel, and, at the opening of hostilities, there were hundreds of merchantmen homeward bound whose course lay across this mine-infested sea. Many of these vessels had on board not only valuable cargoes of food, raw material for manufacture and gold and silver bullion, but also officers and men returning from various parts of the world to rejoin their regiments. Again, the Expeditionary Force had to be transported across the Channel to France. This could not be attempted until a guarantee had been given by the Navy that the seas were clear of hostile warships, submarines and mines. The fleet blockading the Frisian coast had to be supplied with coal and fresh food; and last but by no means least it was of vital importance to the Allied Armies in the Field that the whole coast-line from Bordeaux to Antwerp, forming the rear and left-flank, should be accessible to friendly shipping. It is not difficult to realize what would have been the effect had thousands of

these deadly German contact mines been allowed to float unhindered in these narrow seas, for, notwithstanding the magnificent effort made by thousands of seamen in hundreds of mine-sweepers assisted by seaplanes, many vessels—some belonging to neutral powers and others to the enemy themselves—were destroyed before the seas could be effectively swept clear, the hostile mine-layers destroyed or chased into port and there blockaded with their cowardly fleet.

The torpedo has long been recognised as one of the most effective of naval arms. It is carried by every modern warship afloat, but it is essentially the arm of the submarine and of the small and fast surface vessel. For a torpedo attack to be successful it is absolutely necessary for the vessel carrying the weapon to get within about 1,000 yards of the object of attack. The difficulty of accomplishing this manœuvre with an enemy on the alert is easily apparent, but if the attacking vessel can creep up

to within torpedo range unobserved her chances of sinking the enemy are decidedly good, and it is the quality possessed by the submarine of making herself invisible by sinking beneath the surface and approaching her enemy "seeing but unseen" that makes this type of vessel the ideal torpedo-boat. But, like everything else, there are limits to its use, for a submarine, although it can navigate on the surface like an ordinary torpedo-boat, cannot deliver a submerged attack at night owing to the periscopes, which are the "eyes" of these underwater fighting ships, being useless in the dark. When night covers the sea, however, the chances of the fast grey-painted surface torpedo-boat or destroyer being able to approach the enemy unseen are more than doubled, and in this way fleets become exposed to submarine torpedo attack by day and surface torpedo attack by night. Further, a submarine will often attack while a seaplane hovers over the enemy in order to draw attention. It

is this constant exposure to sudden and unseen submarine attack which is primarily responsible for the terrible nerve strain imposed on the crews of modern surface warships in time of war.

Owing to the ability of submarines to deliver stealthy attacks by day, naval tacticians have designated this type of craft "Daylight torpedo-boats," but they are rapidly passing beyond the purely torpedo and coastal defensive stage and are taking on to themselves the *rôle* of the ocean cruiser. The size of these vessels has increased from 50 to 1,000 tons displacement in ten years. They now carry not only a considerable number of the largest size torpedo but also quick-firing guns for repelling attacks by small surface vessels, and are capable of accompanying fleets to sea. The Australian naval submarines A.E.1 and A.E.2 both made the voyage from Barrow to Sydney under their own power and without convoy. The radius of action of the latest vessels both of the

British and French Navies amounts to several thousand miles. In the case of the British "F" class the displacement has risen to 1,500 tons, the speed to 20 knots and the armament to six torpedo tubes and four 12-pounder quick-firing guns, thus making them in every sense ocean cruisers capable of keeping the sea in almost any weather and possessing wide range of action and considerable offensive power. Hitherto British submarines, like the ordinary surface torpedo-boats, have been known by numbers only, but the latest vessels are to receive names which indicates the increase in size and importance of these craft. They may be termed the advance guards of the submarine battleships of the future.

The torpedo, which is the principal arm of the submarine boat, is itself a submarine projectile. After being discharged from the firing tube it sinks a short distance below the surface and is propelled by its own engines at a high

rate of speed in a straight line towards its object of attack. Great improvements have been made during the past ten years in the construction of these delicate weapons. The extreme effective range and speed has risen from 4,000 yards at 18 knots to 7,000 yards at 45 knots or 11,000 yards at 30 knots. The "war-head" or front section of the torpedo contains a charge of about 200 pounds of damp gun-cotton which is fired by a detonator on the torpedo striking an object. This very powerful explosive charge is capable of tearing open an enormous hole in the unprotected under-water skin of the surface warship. The type of weapon used in the British, French, Russian and Japanese Navies is the *Whitehead* torpedo (18-inch and 21-inch). The German Navy uses the *Schwartzkopf* torpedo (18-inch and 21-inch), which is very similar to the Whitehead and is a very powerful weapon.

In the first phase of the naval war no

less than eight warships have been sunk by submarine torpedoes.

The activity of the British submarines *in the theatre of war*, from the beginning of hostilities, is admirably set forth in the following dispatch from Commodore Roger B. Keyes, C.B., which is the first dispatch in the history of naval warfare to describe in detail submarine attack and reconnaissance :—

H.M.S. *Maidstone*,
17th October, 1914.

" Sir,—In compliance with Their Lordships' directions, I have the honour to report as follows upon the services performed by the Submarines since the commencement of hostilities :—

" Three hours after the outbreak of war, Submarines E.6 (Lieutenant-Commander Cecil P. Talbot), and E.8 (Lieutenant-Commander Francis H. H. Goodhart), proceeded unaccompanied to carry out a reconnaissance in the Heligoland Bight. These two vessels returned with useful

information, and had the privilege of being the pioneers on a service which is attended by some risk.

"During the transportation of the Expeditionary Force the *Lurcher* and *Firedrake* and all the Submarines of the Eighth Submarine Flotilla occupied positions from which they could have attacked the High Sea Fleet, had it emerged to dispute the passage of our transports. This patrol was maintained day and night without relief, until the *personnel* of our Army had been transported and all chance of effective interference had disappeared.

"These Submarines have since been incessantly employed on the Enemy's Coast in the Heligoland Bight and elsewhere, and have obtained much valuable information regarding the composition and movement of his patrols. They have occupied his waters and reconnoitred his anchorages, and, while so engaged, have been subjected to skilful and well executed anti-submarine

tactics; hunted for hours at a time by Torpedo Craft and attacked by gunfire and torpedoes.

"At midnight on August 26th, I embarked in the *Lurcher*, and, in company with *Firedrake* and Submarines D.2, D.8, E.4, E.5, E.6, E.7, E.8, and E.9 of the Eighth Submarine Flotilla, proceeded to take part in the operations in the Heligoland Bight arranged for August 28th. The Destroyers scouted for the Submarines until nightfall on the 27th, when the latter proceeded independently to take up various positions from which they could co-operate with the Destroyer Flotillas on the following morning.

"At daylight on August 28th the *Lurcher* and *Firedrake* searched the area, through which the Battle Cruisers were to advance, for hostile Submarines, and then proceeded towards Heligoland in the wake of Submarines E.6, E.7, and E.8, which were exposing themselves with the object of inducing the enemy to chase them to the westward.

"On approaching Heligoland, the visibility, which had been very good to seaward, reduced to 5,000 to 6,000 yards, and this added considerably to the anxieties and responsibilities of the Commanding Officers of Submarines, who handled their vessels with coolness and judgment in an area which was necessarily occupied by friends as well as foes.

"Low visibility and calm sea are the most unfavourable conditions under which Submarines can operate, and no opportunity occurred of closing with the Enemy's Cruisers to within torpedo range.

"Lieutenant-Commander Ernest W. Leir, Commanding Submarine E.4, witnessed the sinking of the German Torpedo-Boat Destroyer V.187 through his periscope, and, observing a Cruiser of the *Stettin* class close, and open fire on the British Destroyers which had lowered their boats to pick up the survivors, he proceeded to attack the

Cruiser, but she altered course before he could get within range. After covering the retirement of our Destroyers, which had had to abandon their boats, he returned to the latter, and embarked a Lieutenant and nine men of *Defender*, who had been left behind. The boats also contained two Officers and eight men of V.187, who were unwounded, and eighteen men who were badly wounded. As he could not embark the latter, Lieutenant-Commander Leir left one of the Officers and six unwounded men to navigate the British boats to Heligoland. Before leaving he saw that they were provided with water, biscuit, and a compass. One German Officer and two men were made prisoners of war.

"Lieutenant-Commander Leir's action in remaining on the surface in the vicinity of the enemy and in a visibility which would have placed his vessel within easy gun range of an enemy appearing out of the mist, was altogether admirable.

"This enterprising and gallant Officer took part in the reconnaissance which supplied the information on which these operations were based, and I beg to submit his name, and that of Lieutenant-Commander Talbot, the Commanding Officer of E.6, who exercised patience, judgment, and skill in a dangerous position, for the favourable consideration of Their Lordships.

"On September 13th, E.9 (Lieutenant-Commander Max K. Horton) torpedoed and sank the German Light Cruiser *Hela* six miles South of Heligoland.

"A number of Destroyers were evidently called to the scene after E.9 had delivered her attack, and these hunted her for several hours.

"On September 14th, in accordance with his orders, Lieutenant-Commander Horton examined the outer anchorage of Heligoland, a service attended by considerable risk.

"On September 25th, Submarine E.6

(Lieutenant-Commander C. P. Talbot), while diving, fouled the moorings of a mine laid by the enemy. On rising to the surface she weighed the mine and sinker; the former was securely fixed between the hydroplane and its guard; fortunately, however, the horns of the mine were pointed outboard. The weight of the sinker made it a difficult and dangerous matter to lift the mine clear without exploding it. After half an hour's patient work this was effected by Lieutenant Frederick A. P. Williams-Freeman and Able Seaman Ernest Randall Cremer, Official Number 214235, and the released mine descended to its original depths.

"On October 6th, E.9 (Lieutenant-Commander Max K. Horton), when patrolling off the Ems, torpedoed and sank the enemy's Destroyer S.126.

"The enemy's Torpedo Craft pursue tactics which, in connection with their shallow draft, make them exceedingly difficult to attack with torpedo, and

Lieutenant-Commander Horton's success was the result of much patient and skilful zeal. He is a most enterprising submarine officer, and I beg to submit his name for favourable consideration.

"Lieutenant Charles M. S. Chapman, the Second in Command of E.9, is also deserving of credit.

"Against an enemy whose capital vessels have never, and Light Cruisers have seldom, emerged from their fortified harbours, opportunities of delivering Submarine attacks have necessarily been few, and on one occasion only, prior to the 13th September, has one of our Submarines been within torpedo range of a Cruiser during daylight hours.

"During the exceptionally heavy westerly gales which prevailed between the 14th and 21st September the position of the Submarines on a lee shore, within a few miles of the Enemy's coast, was an unpleasant one.

"The short steep seas which accompany westerly gales in the Heligoland Bight

make it difficult to keep the conning tower hatches open. There was no rest to be obtained, and even when cruising at a depth of 60 feet, the Submarines were rolling considerably, and pumping —*i.e.* vertically moving about twenty feet.

"I submit that it was creditable to the Commanding Officers that they should have maintained their stations under such conditions.

"Service in the Heligoland Bight is keenly sought after by the Commanding Officers of the Eighth Submarine Flotilla, and they have all shown daring and enterprise in the execution of their duties. These Officers have unanimously expressed to me their admiration of the cool and gallant behaviour of the Officers and men under their command. They are however, of the opinion that it is impossible to single out individuals when all have performed their duties so admirably, and in this I concur.

"The following Submarines have been

in contact with the enemy during these operations:—

D.1 (Lieutenant-Commander Archibald D. Cochrane).

D.2 (Lieutenant-Commander Arthur G. Jameson).

D.3 (Lieutenant-Commander Edward C. Boyle).

D.5 (Lieutenant-Commander Godfrey Herbert).

E.4 (Lieutenant-Commander Ernest W. Leir).

E.5 (Lieutenant-Commander Charles S. Benning).

E.6 (Lieutenant-Commander Cecil P. Talbot).

E.7 (Lieutenant-Commander Ferdinand E. B. Feilmann),

E.9 (Lieutenant-Commander Max K. Horton).

I have the honour to be, Sir,

Your obedient servant,

(Signed) ROGER KEYES,

Commodore (S)."

In conclusion, it must therefore be set on record that the opening phase in the greatest naval war in history has been one of submarine attack and counter-attack, mine-laying and destroying, war-ships and merchantmen sunk in a few minutes by submarine torpedoes and mines, with sharp engagements between the cruisers and destroyers acting in conjunction with the under-water craft. The much-vaunted German Fleet, like that of its ally Austria-Hungary, has not dared to show itself from behind the forts and carefully-screened anchor-ages of the naval bases, suffering rather the everlasting disgrace of having stood in cowardly idleness while the 5,000 merchant ships it was built to protect hauled down the flag of the "Father-land" and German maritime commerce was swept from the seas while the Allied fleets hold undisputed command of every ocean.

The First Lord of the British Admiralty has said that if the German

Fleet will not come out to fight it must be "dug out like rats in a hole." This, then, may be the second phase in the naval war, and out in the grey mist of the North Sea, ready and eager for the work, lies the great battle fleets of England.

CHAPTER I

THE MODERN SUBMARINE TORPEDO-BOAT

THE submarine torpedo-boat is to most people a complete mystery, and before describing the composition and strength of the submarine fleets at war it may therefore be of interest to say something of the principal features common to all types of submarine craft.

Method of Submergence

It may sound ridiculous, in face of the many accidents which have occurred, to say that one of the greatest difficulties is to make a submarine sink sufficiently quickly, and one of the easiest of operations to make her rise, and yet such is undeniably the case.*

* "Submarine Engineering of To-day." By Charles W. Domville-Fife. (London: Seeley, Service & Co. Ltd. 1914.)

It will be readily understood that any delay in disappearing beneath the surface when attacking would be a great danger to a submarine in action. For example, a number of hostile torpedo-boat destroyers are scouring the sea in advance of a fleet, and are discovered at daybreak by the submarines, which are waiting to attack the fleet behind, approaching at a speed of 30 knots an hour. A hurried dive beneath the surface is necessary if the waiting submarines would avoid detection, which would, in all probability, mean destruction by the quick-firing guns of the destroyers.

When a submarine is travelling on the surface she is in what is technically called the *light condition*, that is to say, with her water ballast tanks empty, but when it is required to sink her so that only the tiny platform, or deck, and conning-tower are above the surface, water is let into these ballast tanks, and the additional weight causes her to sink into the sea until her

back is almost flush with the surface—this is known as the *awash condition*.

It is not difficult to perceive that when travelling awash, a wave might at any moment roll along the tiny unprotected deck of the submarine, break over the mouth of the conning-tower, and descend like a waterspout into the interior. Were this to happen a terrible disaster might result, for it must be remembered that when travelling awash, a very little additional weight would cause the submarine to plunge beneath the surface. In order to obviate this risk it has become a rule that when proceeding with this small margin of buoyancy, the hatch covering the mouth of the conning-tower should be screwed down and the submarine hermetically closed, ready to sink.

To many it may appear strange that total submergence is not accomplished by letting still more water into the ballast tanks, but entirely with the aid of the propellers and rudders. A sub-

marine has two, and sometimes three, pairs of rudders; one pair of ordinary vertical ones to guide her to port or starboard, and a horizontal pair to cause her to dive and rise. Two additional *fins* are frequently placed on each side of the forepart of the vessel to assist the diving and rising.

In order to make the submarine dive beneath the surface, the horizontal rudders are deflected when the boat is proceeding at full speed. The action of the water against the rudders is such that the bows are forced down and the whole vessel slides under the surface. The principle is much the same as that of steering an ordinary surface vessel, where the force of the water against the rudder causes the vessel to swing to right or left.

From this it will be seen that a submarine is only held below the surface by the action of her rudders on the passing water; should the propellers driving her along cease to revolve and

the vessel slow down, she automatically rises to the surface because the rudders have no longer any effect.

Although the steering both on the vertical and horizontal plane is controlled by hand, it would be quite beyond the strength of a man to move the various rudders as required, so electric motors are installed to perform the actual work. In fact, almost everything in a submarine is operated by electricity.

In the earlier types of submarine boats, a considerable time was required to open the valves and allow sufficient water to enter the ballast tanks to make them sink to the awash condition. Some of the now obsolete French naval boats took as long as fifteen to twenty minutes to carry out this simple operation. The main reason for this was, that they were designed with too much surface buoyancy, that is to say, they rode too high in the water when floating in the light condition compared with the inadequate means then employed for the

inlet of water into the ballast tanks, and were thus forced to let in an enormous quantity of water at a very slow rate before they settled down sufficiently to enable total submergence to be accomplished by the use of the horizontal fins and rudders. This great drawback has now been completely overcome, and the modern submarine can sink below the surface in about three minutes.

When water is pumped into the ballast tanks in order to make the submarine settle down, the air which normally fills these tanks is compressed into a fraction of its proper space, and is therefore always exerting a downward pressure which increases as more water is pumped in. Therefore, when it is desired to bring the submarine to the surface again, all that is necessary is to open the valves and allow the compressed air to force the water out. It should, however, be remembered that there is really no need to "blow out" the ballast tanks in order to bring the submarine to the

surface, for this can be much quicker accomplished by simply elevating the horizontal rudders; but in this case the submarine only rises just above the surface—to the awash condition—whereas if the tanks are emptied of water she rises to the light or cruising condition. This substantiates the assertion made at the beginning of this chapter—that it is far more difficult to make a submarine sink than it is to make her rise.

It has been said that a man walking from one end of a submarine to the other would, in all probability, cause her to plunge dangerously, so delicate is the state of equipoise when totally submerged. Whatever may have been the case in the early types it is certainly not so now. So steady are modern submarines when running below the surface, especially those of the British, Russian, French, and Japanese and German Navies, that the long up and down hill glides, which, with some boats, used to amount to yaws of from 20 to 30 feet, have now

been reduced to a few feet in so many hundreds of yards. In fact, this switch-back motion is almost unnoticeable except when the submarine is being swung round at a sharp angle. In no case, however, is it sufficient materially to affect the firing of the torpedoes.

The reserve buoyancy of a submarine in the awash condition—or *diving-trim*, as it is called in the British flotillas—is necessarily very small, amounting to little more than two or three pounds in a thousand, which in a 300-ton vessel means a difference of only about 100 gallons of sea-water between the ability to float and the inevitability of sinking. Any material increase in the small margin of what is known as *positive-buoyancy* must be accompanied by a corresponding increase in the power of propulsion, otherwise it would be quite impossible to drive her under, or, in other words, to overcome the vessel's natural tendency to float on the surface.

For these and other reasons, a sub-

marine when running submerged is in such a delicate state of equipoise that any sudden increase or loss of weight would upset the balance and so cause the vessel to either dive or rise with dangerous rapidity.

This would be the effect produced when a torpedo was discharged were provision not made to counter-balance this sudden loss of weight by means of *compensating-tanks*, into which sufficient water is pumped to compensate for the loss of weight incurred by the discharge of *each* torpedo.

Many submarines are also fitted with bow and stern *trimming-tanks*, into which water can be pumped in such a manner as to correct any tendency of the vessel to float too high or low at either extremity.

Propulsion.

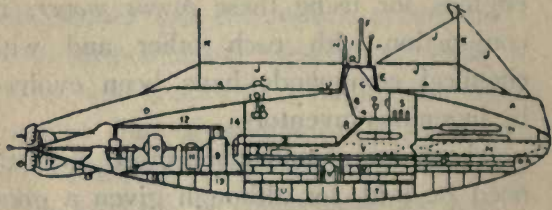
Of the many complicated problems surrounding submarine boat construction the motive power and propelling engines

have been in the past, and are still, the most profound puzzles. Steam, compressed air, electricity, petrol, and heavy oil have all been used with varying results since first this type of vessel came into being; and many curious engines for using these *prime movers* in conjunction with each other and with chemical compounds have been evolved by ingenious inventors.

About steam and compressed air little need be said, for although given a good trial, especially by the French naval authorities, they were abandoned some years ago in favour of a combination of petrol and electric engines, which in turn have given place to more powerful machines using heavy oil and electricity. Steam is, however, again being used in conjunction with turbine engines for surface propulsion.

The carrying of large quantities of petrol, or heavy oil, is under all circumstances attended with a certain amount of risk, and when many tons

have to be carried in a confined space, as in a submarine, this risk is more than doubled, as the slightest leakage when the vessel is submerged would mean that a powerful explosive mixture of petrol and air would be made.



A modern submarine torpedo-boat (British type). *A*. Deck superstructure. *B*. Scuppers for filling superstructure. *D*. External connections. *E*. Conning-tower (4-inch armour). *F*. Periscope. *G*. Periscope motor (for turning, &c.). *H*. Air cowls. *I*. Conning-tower cap (opening sideways). *J*. Mast stays. *K*. Mast (not part of service equipment). *L*. Torpedo-tube cap. *M*. Torpedo-tubes (twin), torpedoes in. *N*. Air-flask (for expelling torpedoes). *O*. Hydroplane engines. *X*. Double casing, with special vent for accumulators. *Y*. Spare torpedoes. *Z*. Petrol storage tanks (2). 1. Air flasks. 2. Centrifugal pumps. 3. Air-lock, with submarine escape dresses. 4. Commander's platform. 5. Ladders. 6. Depth and deflection indicator, registering submarine's deflection from horizontal. 7. Speed dials. 9. Petrol engines. 10. Electric engines. 11. Dynamo, for recharging batteries. 12. Petrol engines—exhaust.

It being also quite impossible, for obvious reasons, to use a petrol engine

when running submerged, a second motive power, an engine, with its additional space and weight, has to be carried to drive the submarine when under water. For this purpose electricity is used in almost all types. But electricity, again, has many drawbacks. It costs in weight nearly thirty times more than other motive powers, and is extremely dangerous, for should salt water in any way gain access to the storage batteries, chlorine gas would be given off in large quantities, although in the more recent vessels of the British, American, and French Navies this danger has been minimised by enclosing the batteries in air-tight cases. On account of the weight and the space required, it is impossible to install a very powerful electric engine in a submarine (compared with the size of the boat), and thus both the speed and radius of action are curtailed.

If this division of power between the surface and submerged engines could

be overcome, and the whole space made available for one powerful set of engines suitable for driving the vessel both on the surface and when submerged, not only would the mechanism of submarines be simplified, but a very considerable increase in both speed and range of action would naturally result.

In the "D," "E" and "F" classes of British submarines, and in the more modern vessels of the French, Russian and German Navies, heavy oil is being used in place of petrol on account of the increase in power obtained with greater safety.

Arrangements are made in almost all modern submarines so that when the vessel is using the oil engines for running on the surface the electricity for use when submerged is being made by a dynamo and stored in batteries. From this it will be seen that there are really three separate engines in a submarine:—(1) the oil or petrol motor, which drives the vessel when on the surface, and, at

the same time, by a suitable arrangement of gearing, operates a dynamo, (2) which makes the electric current for storage, and (3) an electric engine which drives the vessel when submerged, obtaining the necessary power from the batteries.

It is, however, technically incorrect to say that there are two sources of power in a submarine, for electricity is not, in itself, a source of power, but merely a handy method of storing and transmitting it. The only actual source being the oil or petrol.

There are also numerous small engines to add to the complexity of machinery in a submarine, such as the air compressors used for charging the torpedo tubes with compressed air for expelling the torpedoes and for other purposes, and electric motors for operating the pumps, steering mechanism, and periscopes. In addition to all this, hand-mechanism is provided for use in case of a breakdown to operate most of these

important appliances. Then again there is, of course, the armament mechanism for working the torpedo tubes and semi-automatic quick-firing guns.

From the foregoing it may appear that the interior of a submarine presents a picture of mechanical complexity utterly incomprehensible. Yet such is not the case. The fanciful belief that the crew stand, boxed up in these vessels, sweating with the heat, struggling for breath, and with crank-shafts whirling uncomfortably close to the small of their backs, electric motors buzzing within a few inches of their ears, and nervous hands grasping one or other of the levers ranged in rows in front of them, is, doubtless, most romantic, but quite unreal. Much of the undoubtedly complicated machinery in a submarine is tucked away in the conical extremities, under the interior decking, and fixed to the arched steel sides. The centre is left almost entirely clear, so that trestle-tables may be erected for meals,

hammocks swung for sleeping, and sufficient space allowed to make these small vessels as habitable as possible. Not the least difficulty of the submarine designer is to create order and leave space among the chaos of machinery which has to be installed in these peculiar and deadly little torpedo craft.

Vision When Submerged.

Perhaps the greatest difficulty which has beset both submarine construction and navigation is the puzzle how to see when submerged. This is now accomplished by means of periscopes, or tubes extending up from the roof of the submarine to a height of several feet above the surface—not unlike hollow masts. By a series of lenses and reflectors a picture of the surface is thrown down these tubes on to reflectors inside the submarine. A man with his eyes at the bottom of a periscope can see the surface clearly. Although it projects above the surface when the whole submarine is submerged,

it is far too small an object to be easily seen moving through the water, and extremely difficult to hit by gun-fire.

The latest panoramic periscope—two of which are fitted in modern submarines—has a field of vision of about 60 degrees. The range of vision is, however, very short, owing to the periscopic tube projecting only a few feet above the surface. On a moderately smooth and fairly clear day steering by periscope is not altogether difficult, but at night or in fog this instrument is useless, and for this reason it would be almost impossible for a submarine to effect a submerged attack on an enemy at night. Hence the name given to this type of craft—daylight torpedo-boats—for in the brilliant light of day, when any attempt by ordinary torpedo craft to get sufficiently close to hostile warships to discharge a torpedo with reasonable hope of success would be foredoomed to failure, there is every possibility that submarines would effect a surprise attack.

Armament.

The chief armament of all naval submarines is the torpedo, which is expelled by a blast of compressed air from one of the tubes fitted in the bow and stern. Several torpedoes are usually carried by each boat, so that if one failed to strike the object of attack further attempts can be made.

About the efficiency of torpedoes nothing need be said here, for they now form an important weapon in every navy, and to this subject a future chapter is devoted.

The latest submarines built are also fitted with quick-firing guns for use when these vessels are cruising on the surface. The guns are arranged so that when it is desired to sink they can be made to disappear beneath the narrow deck of the submarine. The provision of guns has been made with the object of giving these vessels a means of defence should they be discovered by prowling hostile torpedo-boat destroyers, or by air-craft.

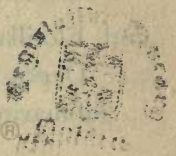
Habitability.

Many people imagine the interior of a submarine to resemble a stokehold, hot, stifling, and semi-dark, whereas the exact contrary is the truth. The temperature is but little above the normal for a ship's engine-room, the air-supply is amply sufficient, and the whole interior is well illuminated by electric lamps.

The necessary supply of pure air is derived either from large steel cylinders containing the air in a highly compressed state or from flasks of oxylithe. The carbonic acid gas of the respired air being at the same time chemically absorbed.

Food is cooked for the crew by electricity, and drinking water obtained from special tanks. Notwithstanding these arrangements, however, it is almost impossible for the crew to live on board for many weeks at a time, owing to the small free space in the interior and to the cramped deck; but as the size and radius

of action of these boats increase, so also does the space available for exercise, and thus the habitability.



CHAPTER II

BRITISH SUBMARINES

The British Fleet at the moment when war was declared possessed 82 submarine torpedo-boats built and 22 building. Some of these were, however, stationed at the oversea naval bases. The composition and distribution of the submarine flotillas at the outbreak of hostilities were as follows :—

Submarines in Home Waters.

Patrol Flotillas.

1st Flotilla. Devonport.
Depôt ship : *Onyx.*
Submarines : A.8 and A.9.

2nd Flotilla. Portsmouth.
Depôt ship : *Dolphin.*
Submarines : A.5, A.6, A.13 and B.1.

3rd Flotilla. Devonport.
Depôt ship: *Forth.*
Submarines B.3, B.4, B.5, C.14, C.15 and C.16.

4th Flotilla. Portsmouth.
Depôt ships: *Arrogant* and *Hazard.*
Submarines: C.17, C.18, C.31, C.32, C.33, C.34, C.35.

5th Flotilla. Chatham.
Depôt ship: *Thames.*
Submarines: C.1, C.2, C.3, C.4, C.5, C.6.

6th Flotilla. Chatham.
Depôt ships: *Bonaventure* and *Hebe.*
Submarines: C.7, C.8, C.9, C.10, C.12, C.13.

7th Flotilla. Chatham.
Depôt ships: *Vulcan* and *Alecto.*
Submarines: C.19, C.20, C.21, C.22, C.23, C.24, C.25, C.26, C.27, C.28, C.29, C.30.

8th Flotilla. Portsmouth.
Depôt ships: *Maidstone* and *Adamant.*

Submarines: D.1, D.2, D.3, D.4, D.5, D.6, D.7, D.8, E.1, E.2, E.3, E.4, E.5, E.6, E.7, E.8, E.9.

9th Flotilla. Devonport.

Depôt ship: *Pactolus*.

Submarines: A.10, A.11, A.12.

SUBMARINES ON FOREIGN STATIONS.

Attached to Mediterranean Fleet.—Submarines B.9, B.10, and B.11.

At Gibraltar.—Submarines B.6, B.7, and B.8.

Attached to China Squadron.—Submarines C.36, C.37, and C.38.

With Australian Fleet.—Submarines A.E.1* and A.E.2.

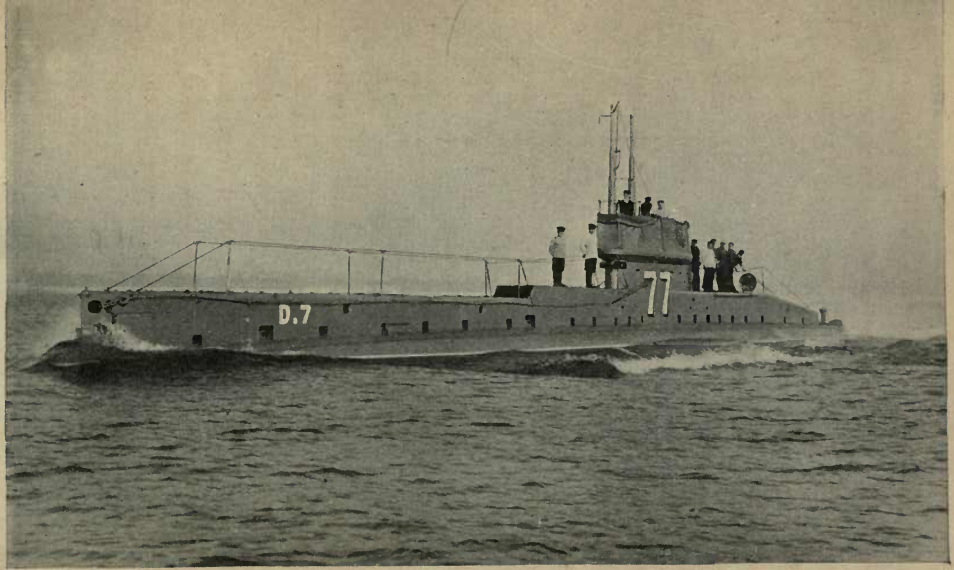
The statement that the headquarters of the various submarine flotillas in home waters are at Chatham, Portsmouth, and Devonport, must not be taken as indicating that these are the only points along the coast protected by submarines. These places are merely the chief bases

* Sunk October, 1914.

of the *Patrol Flotillas*. The wide range of action of modern submarines enables them to operate several hundred miles from any base or depôt, and consequently Chatham becomes merely the *general store*, or head-depôt, of what should be termed the North Sea Flotillas, which not only patrol the whole East, North-East and South-East Coasts of England and Scotland, but also have their floating secondary bases in the form of *Depôt Ships*, which, with their attached submarines, are often at Harwich, Newcastle, Rosyth, etc. In the same way Portsmouth is merely the headquarters of the submarines patrolling the Channel; and Dover, Portland, etc., are seldom without strong flotillas of submarines with their Depôt ships. The Devonport Flotillas have the longest coast-line to patrol, for their area covers not only the West Coast of England, Wales and Scotland, but also the Irish Coast. They are, however, furthest removed from the zone of war.

Considerable alterations have taken place in the composition and distribution of the British submarine flotillas since the outbreak of war, with the object of materially strengthening the Fleet in the main theatre of operations, but the addition to the flotillas of new vessels of the latest "E" type—nearly completed when war broke out—has made this rearrangement possible without materially weakening the flotillas guarding the more distant coasts of Great Britain or recalling vessels from overseas.

The first submarine torpedo-boat built for the British Navy was launched from the yard of Messrs. Vickers Ltd., Barrow-in-Furness in 1901, and was designated the No. 1. It was constructed from the designs of the famous American inventor, Mr. John P. Holland, and was one of the most successful boats afloat at that time. A series of exhaustive trials with this and the succeeding five vessels, all of the same type and launched during 1901–2,



Photo, Cribb, Southsea.]

THE BRITISH SUBMARINE "D.7."

Displacement, 620 tons; Speed, 16·10 knots; Armament, 2 bow and 1 stern torpedo tube.
There are 8 vessels of this class, completed between 1908-12.

proved conclusively the fighting value of this type of craft, and a further order was given by the British Admiralty for four new vessels embodying the improvements suggested by the trials of the first five. These vessels were the first of the "A" class, and were designated the "A's 1, 2, 3, and 4." They had a submerged displacement of 180 tons, a length of 100 feet and a beam of 10 feet. They were propelled by petrol motors of 190 H.-P. on the surface and by electric motors of about 80 H.-P. when submerged. Their speed ranged from 8 knots an hour on the surface to 5 knots when travelling submerged, and their maximum surface endurance (or fuel capacity) was only 400 knots at 8 knots. Their armament consisted of three 18-inch Whitehead torpedoes and one bow tube.

All these vessels were, however, obsolete and therefore scrapped before the opening of hostilities, hence information concerning them is only of interest as showing the rapid growth

in size, power and armament of British submarines. The next batch of vessels were the A's 5 to 13, launched at Barrow in 1904, but these, as will have been seen from the table showing the composition and distribution of the submarine flotillas at the outbreak of war, are still on the effective list. All the following British submarines are now in the fighting line.

"A" Class.

(Completed 1904.)

A's 5, 6, 8, 9, 10, 11, 12, 13.

These vessels are the oldest British submarines in commission. They were built at Messrs. Vickers' works at Barrow, and have a submerged displacement of 204 tons. Their length is 150 feet. They are propelled on the surface by petrol motors of 600 H.-P. and by electric engines of 100 H.-P. when submerged. Their surface and submerged speed is 11 knots and 7 knots respectively. The cruising

range, or maximum surface endurance on the fuel carried, is 400 knots at 10 knots an hour, and the endurance submerged three hours at full speed. Their armament consists of two bow tubes with four 18-inch Whitehead torpedoes. Complement: Eleven officers and men.

These vessels, which are now used almost entirely for harbour defence, can be distinguished from later types by their high conning-towers and single short periscopes. The A.7 was lost off Plymouth early in 1914, and was never raised.

"B" Class.

(Completed 1904-6.)

B's 1, 3, 4, 5, 6, 7, 8, 9, 10, 11.

These are submarines of the improved Holland type, and are in every way superior to their predecessors. They may be considered the first of the sea-going type. Their submerged displacement is 316 tons; length 135 feet, and beam 13½ feet. The motive power is the

same as in the "A's"—petrol for surface propulsion and electricity for use when submerged. The horse-power of the petrol engines is 600, and that of the electric engines 189. As in most submarines the supply of current for driving the electric engines is derived from storage batteries charged by dynamos driven from the petrol engines while the vessels are running on the surface. In the "B" class a special system of encasing these storage batteries was introduced. Their speed averages 12 knots on the surface and 8 knots when submerged. The surface cruising range is 1,300 knots at 10 knots per hour, and the maximum submerged endurance 80-100 knots at 5 knots per hour. Their armament consists of two bow tubes with 4-6 18-inch Whitehead torpedoes. Complement: Sixteen officers and men.

The "B" type are vessels about 50 per cent. larger than the "A" type which preceded them. The "B's" have superstructures extending from the bow to the

conning-tower, forming a narrow deck which tends to disperse the wave which heaped around the blunt noses of the "A's" and original Hollands. Vision when submerged is obtained by two panoramic periscopes, each having an arc of vision of 60 degrees. In the more modern vessels three periscopes are fitted. The twin screws of the "B's" are placed below the centre line of the vessel and consequently operate in deeper water when the vessels are cruising on the surface. This gives them better surface cruising qualities, as in a sea-way the propellers are liable to race if worked too near the surface. The increase in the speed of these vessels over that of the "A's" was of great importance, as in this respect lies the weakness of the submarine. The tactical advantages derived from high speed in actual warfare cannot be over-estimated. The speed of a fleet is governed by that of its slowest unit.

The distinguishing feature of the "B" type is the straight bow, the forward

superstructure, and the *two* periscopes. The B.2 was run down by the liner *Amerika* in the Straits of Dover in October, 1912, and was never recovered.

"C" Class.

(Completed 1906-10.)

C's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38.

This class of submarines is composed of vessels of the improved "B" type. They have a submerged displacement of 320 tons and are 135 feet long and 13½ feet broad. The petrol motors develop 600 H.-P. and give to these vessels a speed of 14 knots an hour on the surface. The power of the electric engines was increased to 300 H.-P., giving a submerged speed of just over 9 knots an hour. The surface cruising range is 2,000 knots at the most economical speed, and the submerged endurance 100 knots at 5 knots an hour. Their armament

consists of two bow tubes with six 18-inch Whitehead torpedoes; and their complement sixteen officers and men.

In the later vessels of the "C" class heavy oil is used instead of petrol, giving a great increase in power without the comparative additional weight; enabling a wider radius of action. The vessels of both the "B" and "C" classes are fitted with air-traps and safety-helmets, giving the crew a possible means of escape in the event of disaster while submerged.

The distinguishing feature of the "C" class is the sloping bow. The C.11 collided with the steamer *Eddystone* in the North Sea in 1909 and was irretrievably lost.

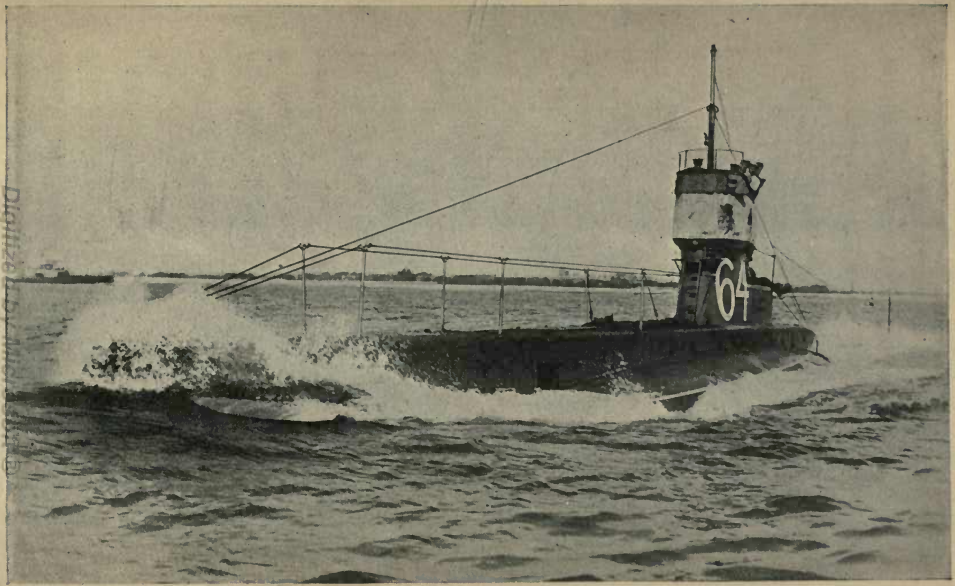
"D" Class.

(Completed 1908-11.)

D's 1, 2, 3, 4, 5, 6, 7, 8.

These are all modern vessels of the sea-going type, and are of considerable fighting value. They, however, differ

slightly from each other: D.1 has a submerged displacement of 595 tons; D.2 of 600 tons; and the remaining vessels of this class of 620 tons. They have an approximate length of 150 feet and a beam of 15 feet. Heavy-oil engines of 1,200 H.-P. drive them at a maximum speed of 16 knots an hour on the surface, and electric motors of 550 H.-P. give them a submerged speed of just over 10 knots an hour. All these vessels have twin-screws situated below the centre line. Their cruising range on the surface is 4,000 miles, and when submerged 120 knots at 7 knots an hour. These vessels were the first to be fitted with a special and more efficient pattern of electric storage battery and a safer type of electric motor. The armament of the "D's" consists of two bow and one stern tube with six 18-inch Whitehead torpedoes. D's 4, 5, 6, 7, and 8 are also fitted with a small quick-firing, high-angle gun for defence against aircraft. This gun is fixed on a disappearing



Photo, Cribb, Southsea.]

THE BRITISH SUBMARINE "C.34."

Displacement, 320 tons; Speed, 14·9 knots; Armament, 2 bow torpedo tubes.
There are 37 vessels of this class, completed between 1906-12.

mounting, enabling it to be quickly and almost automatically lowered into a water-tight cavity in the superstructure before the submarine dives below the surface. The complement of these vessels is twenty-one officers and men.

"E" Class.

(Completed 1912-14.)

E's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18.

These fine ocean-going submarines are the latest additions to the British Flotillas. They have a submerged displacement of 800 tons, are 176 feet long and 22½ feet in beam. The heavy-oil engines of nearly 2,000 H.-P. give them a surface speed of over 16 knots, while the electric engines of 800 H.-P. drive them at a maximum speed of 10 knots an hour when submerged. Their surface cruising range is 5,000 miles at economical speed, and the submerged endurance 140 knots at 8 knots an hour. In point of armament the "E's" are far

more powerful than their predecessors, being fitted with four tubes and carrying six of the largest and most powerful Whitehead torpedoes. They are also equipped with two 3-inch quick-firing guns on high-angle disappearing mountings for defence against air-craft and hostile torpedo-boats and destroyers. They have wireless telegraphic apparatus; and, like the vessels of the "B," "C" and "D" classes, have armoured conning towers and decks. Three tall panoramic periscopes are fitted, and their high superstructures and increased buoyancy when travelling on the surface enable them to keep the sea in almost any weather.

Australian Submarines: A.E.1 and A.E.2.

These vessels are exactly the same as the "E" class. The fact that they both accomplished the 13,000-mile voyage from Barrow to Sydney under their own power and without convoy is

practical proof of the wide range, seaworthiness and general efficiency of the latest British Naval Submarines. The A.E.1 mysteriously disappeared in Australian waters in October, 1914, and has not been recovered.

British Submarines Building:

At the commencement of the great war there were 22 British submarines in course of construction at the various shipbuilding works and naval dockyards. Up to 1909 Messrs. Vickers Ltd., had constructed all the British submarines, but in that year the vessels C.17 and C.18 were laid down at Chatham Dockyard. Since then several other boats have been constructed there, and of those now in hand some are being built by Messrs. Vickers Ltd. at Barrow, others at Messrs. Scott's shipbuilding yards at Greenock, and a few by Messrs. Armstrong, Whitworth and Co. Ltd. at Newcastle-on-Tyne, and at H.M. Dockyard at Chatham.

Hitherto, British submarines, although divided into classes—each of which has shown a marked improvement on the preceding class—have been all of one type—the "Improved Holland." Among the vessels being constructed at the opening of hostilities they were, however, no less than three different types. Those being built at Barrow and Chatham were of the original design with modern improvements, but the submarines under construction at Greenock were of the *Laurenti*, or Italian type, and those at Newcastle-on-Tyne of the *Laubeuf*, or French type. In addition to this wise departure from previous practice, two of the new vessels have been given the names of *Nautilus* and *Swordfish*.

The haze of war has obscured these vessels, and it is impossible to say definitely which of them have taken their place in the active flotillas, and further the necessity for observing the very strictest secrecy regarding new types of

warships at a time like the present makes it advisable to give here only the briefest particulars and not to discuss too freely the peculiarities of their design or their probable capabilities.

"F" Class.

There are several vessels of this class now being constructed. They are the latest improvement of the original Holland design and are sea-going submarines of wide range, high speed and great fighting power. The F.1, which was built at Chatham Dockyard, has a submerged displacement of 1,500 tons. Heavy-oil engines of about 5,000 H.-P. give her a maximum speed of 20 knots an hour on the surface, and electric motors of 2,000 H.-P. drive her at 12 knots when submerged. The armament consists of six torpedo tubes, ten torpedoes, and two quick-firing, high-angle guns.

"V" Class. "W" Class. "S" Class. *Nautilus* and *Swordfish.*

These three classes include the

vessels of entirely different design to those now forming the British flotillas. The "V," or Vickers' type, of which four were under construction at the beginning of the war, are large sea-going submarines with a submerged displacement of over 1,000 tons, and a probable surface speed of 20 knots. The "W" Class, of which four are being built at Elswick, comprise vessels of the French *Laubeuf* type. The "S" Class, building at Greenock, and four in number, are of the Italian, or F.I.A.T. —*Laurenti* type. The two named vessels—*Nautilus* and *Swordfish*—are large sea-going submarines of wide range and high speed. Their submerged displacement is about 1,000 tons, and their speed 20 knots on the surface and 12 knots when submerged. The armament is six tubes, with eight torpedoes, and two quick-firing guns. The complement of all these large submarines is about 25 officers and men.

CHAPTER III

FRENCH SUBMARINES

FRANCE possessed 92 submarines in active service when war was declared. In addition to these, nine large and powerful vessels were in various stages of construction. The flotillas of the French Navy are composed of two different types of vessels: *Submarines Defensive* and *Submersibles*. The former are intended, as their name implies, solely for coast and harbour defence; their radii of action is very small, and they are incapable of action independent of a naval base. The submersibles are like the large sea-going submarines of England and Germany, and have a wide radius of action, high speed, and great offensive power.

The first naval submarine (*Gymnôte*)

was launched in 1888, giving to France the honour of being the first Naval Power to adopt the submarine torpedo-boat as a vessel of war. The pioneers of submarine construction in France were Captain Burgeoise, Engineer Brun, M. Dupuy de Lome, M. Gustave Zédé, and Admiral Aube. The second submarine ordered for the French Navy was the *Gustave Zédé*, launched in 1893. So successful did this vessel prove that another of the same type, and named the *Morse*, was launched at Cherbourg Dockyard in 1899. In the same year four vessels of a new type were laid down in the dockyard at Rochefort, and named *Lutin*, *Farfadet* (re-named *Follet*), *Korrigan*, and *Gnôme*. These, with the exception of the ill-fated *Lutin*, are still in the active flotillas.

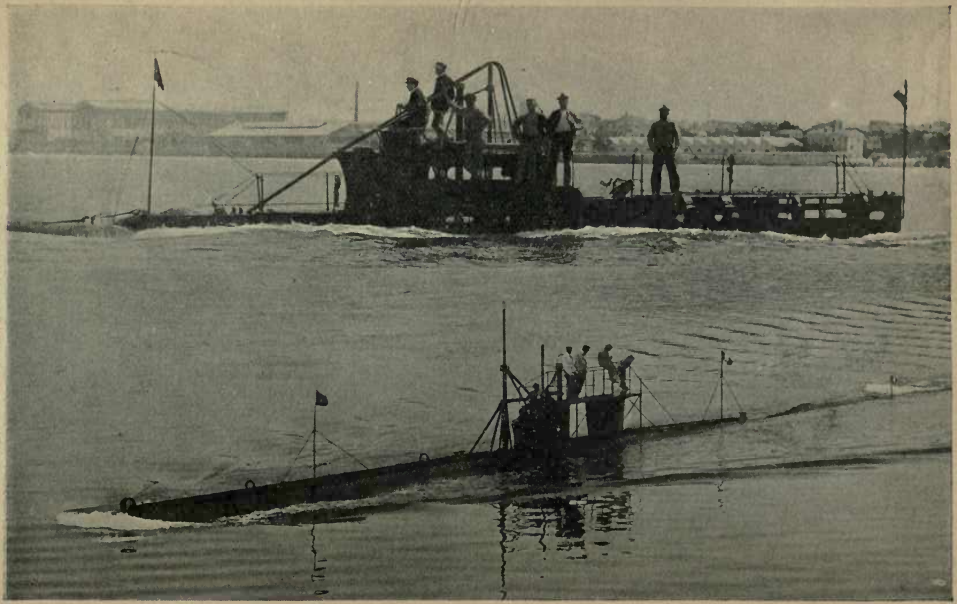
LUTIN CLASS.

(Completed 1901-2.)

Follet. Korrigan. Gnôme.

These are the oldest submarines in the French Navy, and are all of the

A FRENCH SUBMARINE OF THE HARBOUR DEFENCE TYPE.



Photos, M. Bar.]

A FRENCH SUBMARINE OF THE COAST DEFENCE TYPE.

defensive type. They have a displacement of about 185 tons, with electric engines for propulsion both on the surface and when submerged. Their speed is 12 knots on the surface and 8 knots when submerged. Their range of action is about 200 miles at 7 knots. The armament consists of one bow tube and two holders, with four 18-inch Whitehead torpedoes. The complement is nine officers and men.

Française Class.
(Completed 1901-2.)
Française. Algérien.

These two vessels are of the improved *Morse* type, and are intended solely for coast and harbour defence. Their surface displacement is 146 tons, and they have electric engines of 350 H.-P. for both surface and submerged propulsion, giving them a speed of 12 knots and 8 knots an hour, respectively. Their surface radius is about 80 miles at 8 knots. They have one bow tube and

two holders, with four torpedoes. The complement is nine officers and men.

Triton Class.*

(Completed 1901–2.)

Triton. Sirene. Espadon. Silure.

These four vessels were the first of the submersible type and were designed by M. Laubeuf, who has since designed many vessels for both France and other countries (*Laubeuf* type). They have a submerged displacement of 200 tons, and are 111 feet long and 12½ feet in beam. Steam is used for surface propulsion (217 H.-P.) and electricity when submerged. Their speed is 11 knots on the surface and 8 knots when submerged, with a cruising radius of 600 miles at 8 knots. They are armed with four holders fitted with 18-inch Whitehead torpedoes, and have a complement of ten officers and men.

* The *Narval*, the first of this type, has been removed from the effective list.

NAIADE CLASS.

(Completed 1902–4.)

Naiade.	*Loutre.*	*Protée.*
Lynx.	*Perle.*	*Truite.*
Castor.	*Oursin.*	*Meduse.*
Otarie.	*Phoque.*	*Ludion.*
Alose.	*Anguille.*	*Grondin.*
Dorade.	*Souffleur.*	*Thon.*
Bonite.	*Esturgeon.*	

Twenty small harbour defence submarines, having a displacement of about 67 tons. They have petrol and electric motors, giving them a speed of 8½ knots on the surface and 5 knots when submerged. Their armament consists of one bow tube and two holders; four torpedoes are carried. Their complement is six officers and men.

AIGRETTE CLASS.

(Completed 1904.)

Aigrette. Cicogne.

These two vessels are submersibles of the *Laubeuf* type, and were great

improvements on their predecessors, the Triton Class. Their submerged displacement is 351 tons, and their dimensions 118 × 12 × 12 feet. A triple expansion steam engine of 200 H.-P. is used for surface propulsion and an electric motor of 150 H.-P. when submerged. Their speed is 10 knots and 8½ knots. Their maximum surface endurance is 700 miles at 8 knots, and submerged 60 miles at 6 knots. Their armament consists of one bow tube with four 18-inch torpedoes. Their complement is about fifteen officers and men.

Argonaute.

(Completed 1905.)

A submersible designed by M. Bertin (late Chief Constructor French Navy). This vessel, which was first named *Omega*, has a displacement of about 300 tons. She is driven by steam and electricity, and has a speed of 11 knots and 9 knots. Her armament consists of two bow tubes and two holders,

with six 18-inch Whitehead torpedoes. The complement is about seventeen officers and men.

EMERAUDE CLASS.

(Completed 1906–8.)

Emeraude. *Saphir.* *Opale.*
Topaz. *Rubis.* *Turquoise.*

These six vessels are of the *Maugas* type and are sea-going submarines with a submerged displacement of over 400 tons. They have petrol and electric motors of 600 H.-P. and 450 H.-P., respectively. Their surface speed is 12 knots and submerged 8½ knots. Their surface cruising radius is just over 1,000 miles at economical speed. Their armament consists of two tubes and four holders with 8 torpedoes of the usual pattern. Their complement is seventeen officers and men.

CIRCE CLASS.

(Completed 1907.)

Circe. *Calypso.*

These two vessels are of the *Laubeuf* type, and are improvements on the

Aigrette class. They have a submerged displacement of about 450 tons and are 160 feet in length. They are driven by a steam engine of 440 H.-P. (flash boiler and oil fuel) when on the surface, and by electric motors when submerged. Their speed is 11 knots and 8 knots; and the range of action 1,000 miles. Their armament comprises two tubes and four holders with eight torpedoes. The complement is 21 officers and men.

PLUVIÔSE CLASS.

(Completed 1907-12.)

Pluviôse. *Nivôse.* *Ventôse.*
Messidor. *Thermidor.* *Fructidor.*
Brumaire. *Frimaire.* *Florèal.*
Prairial. *Germinal.*

Submarines of the *Laubeuf* type with a submerged displacement of nearly 600 tons. All built at Cherbourg. The *Brumaire* and *Frimaire* are driven by petrol motors of 700 H.-P. when cruising on the surface, but all the others have small steam turbines with

a special type of flash-boiler. Electric motors are used for submerged propulsion. Their speed is 12 knots above and 9 knots below. The armament is seven 18-inch torpedoes. Their complement is 22 officers and men.

FRESNEL CLASS.

(Completed 1908-12.)

Fresnel.	*Berthelot.*	*Papin.*
Monge.	*Ampère.*	*Gay-Lussac.*
Cagnot.	*Faraday.*	*Giffard.*
Montgolfier.	*Newton.*	*Volta.*
Watt.	*Euler.*	*Faucault.*
Franklin.	*Arago.*	*Permouilli.*
Joule.	*Coulomb.*	*Curie.*
	Le Verrier.	

Twenty-two submarines of the largest sea-going *Laubeuf* type. Only three of these are steam driven, the others using heavy-oil engines for surface propulsion. They are in all respects similar to vessels of the *Pluviôse* class, and have a displacement of about 600 tons. Their speed is 12 knots above, and 9 knots

below, and the armament seven 18-inch torpedoes. These vessels are fitted with stern as well as bow tubes. Their surface cruising range is over 2,000 miles.

Amiral Bourgeoise.

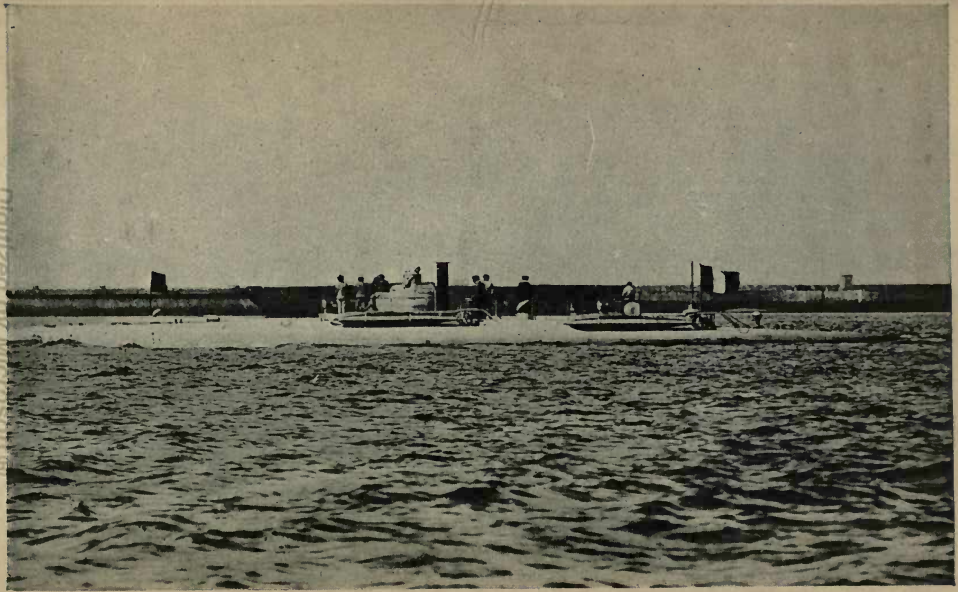
(Completed 1912.)

An experimental boat of the *Bourdelle* type, built at Cherbourg. The submerged displacement is just under 800 tons and the length 190 feet. She is driven on the surface by heavy-oil engines of 1,600 H.-P., which give a speed of 15 knots. The electric motors for submerged propulsion are of 700 H.-P., giving a speed of 10 knots. The armament consists of seven 18-inch torpedoes, and the cruising range is 3,500 miles.

Archimède.

(Completed 1912.)

Another experimental boat built at Cherbourg. The submerged displacement is about 810 tons, and the length and beam 212 feet and 22 feet



Photo, M. Bar.]

A FRENCH SUBMARINE OF THE SEA-GOING TYPE.

respectively. Steam turbines are used for surface propulsion and electric motors when submerged. Her speed is 15 knots above and 10 knots below. The armament is seven 18-inch torpedoes, and the complement 24 officers and men.

Mariotte.

(Completed 1912.)

The third experimental boat, of the *Rodiquet* type, built at Cherbourg. The displacement when submerged is 650 tons and the length about 200 feet. Petrol motors of 1,500 H.-P. drive her at 15 knots an hour on the surface and electric motors of 550 H.-P. at 10 knots when submerged. Her radius of action is 3,000 miles, and her armament seven 18-inch torpedoes, which can be fired from both bow and stern tubes. The complement is about 25 officers and men.

Charles Brun.

(Completed 1912.)

The fourth experimental vessel, built at Cherbourg during 1909-12. The

submerged displacement is 450 tons and the length 145 feet. Steam turbines of 1,300 H.-P. drive her at 15½ knots an hour on the surface, and electric motors of 500 H.-P. at 10 knots when submerged. Her armament consists of six 18-inch torpedoes. The complement is 22 officers and men.

Clorinde Class.

(Completed 1913-14.)

Clorinde. *Cornélie.* *Amphritrite.*
Astree. *Artémis.* *Aréthuse.*
Atalante. *Amaranthe.* *Ariane.*
Andromaque.

These ten vessels are the very latest additions to the French Submarine flotillas. They have a submerged displacement of about 550 tons, a length of 177 feet and a beam of 16 feet. Heavy-oil engines of 1,300 H.-P. give them a speed of 15 knots on the surface, and electric motors of 550 H.-P. enable them to travel at 9½ knots an hour when submerged. They carry eight torpedoes,

and have a complement of 25 officers and men.

GUSTAVE ZEDE CLASS.

(Completed 1913-14.)

Gustave Zede. Néréide.

These two vessels are the largest submarines in the French flotillas. They have a submerged displacement of 1,000 tons, a length of 240 feet, and a beam of 20 feet. Heavy-oil engines give them a surface speed of 16 knots and electric motors a submerged speed of 10 knots. Their armament consists of two bow and two stern tubes with eight 18-inch torpedoes. They are also equipped with two 14-pdr. quick-firing guns on high-angle, disappearing mountings. The cruising range is 4,000 miles, and the complement 27 officers and men.

BELLONE CLASS.

(Completed 1914.)

Bellone. Hermione. Gorgone.

Fast sea-going submarines with a submerged displacement of 610 tons.

They have heavy-oil engines of about 2,000 H.-P., which give them a surface speed of 17½ knots. Electric motors of 950 H.-P. drive them at 12 knots when submerged. Their surface cruising range is 4,000 miles. Their armament consists of eight 18-inch torpedoes and two 14-pdr. quick-firing, high-angle guns. The complement is 30 officers and men.

French Submarines Building.

On the day when war was declared nine submarines were in the early stages of construction. The two most advanced of these were the *Diane* and *Daphne*. These vessels have a submerged displacement of about 800 tons, and the anticipated speed is 18 knots and 10 knots. Their armament will consist of ten torpedoes and four 9-pdr. guns. The complement will be 30 officers and men.

The other seven vessels are of the improved *Gustave Zede* Class. They will have a submerged displacement of over 1,000 tons and a speed of 20 knots

on the surface and 12 knots when submerged. Their armament will consist of ten torpedoes and four 9-pdr. guns. The complement will be about 35 officers and men.

CHAPTER IV

RUSSIAN SUBMARINES

The Imperial Russian Navy at the commencement of hostilities included 37 submarines in active service, and 19 in various stages of construction. The composition and distribution of the submarine flotillas was as follows:—

Baltic Flotilla: 14 Submarines with depôt ships in commission, and 12 vessels building. *Bases:* Kronstadt, Port Peter the Great (Reval) and Port Alexander III. (Libau) (ice free).

Black Sea Flotilla: 11 Submarines with depôt ships in commission, and several new vessels building. *Bases:* Sevastopol and Nikolaieff.

Siberian Flotilla: 12 Submarines

with depôt ships in commission, and 6 vessels building. *Base:* Vladivostok.

The first Russian naval submarine was completed at Kronstadt in 1902, and named the *Petr Kochka.* She was built in sections to facilitate transport over the Siberian Railway, being intended for the defence of Port Arthur, and had a surface displacement of only 20 tons. Her armament consisted of two holders, or Darzewiecki launching apparatus, containing two small Whitehead torpedoes. The maximum speed was 8 knots on the surface and 4 knots when submerged. The second submarine ordered for the Russian Navy was the *Delphin*, which foundered off Kronstadt, but was subsequently raised and is now used as a training ship for the submarine service. These two vessels have been removed from the active flotillas, but the third vessel to be built for the Russian Navy —the *Graf Cheremetieve*—is still in commission.

Graf Cheremetieve Class.

(Completed 1904-5.)

Graf Cheremetieve. Kasatka. Nalim. Skat.

These are the oldest submarines in the Russian Navy, and are small vessels of the Holland-Bubnoff type. They have a submerged displacement of 200 tons. Petrol and electric engines drive them at 9 knots on the surface and 6 knots when submerged. Their armament consists of one bow torpedo tube and two exterior holders, with four 18-inch Whitehead torpedoes.

Ostr Class.

(Completed 1904-6.)

Ostr. Byts-chok. Kefal. Platus. Plotva.

These five submarines are of the American Lake type. The *Ostr* was originally the American Lake Co.'s boat *Protector*. They have a submerged displacement of 175 tons, are 65 feet

in length and 11 feet in breadth. Have petrol engines of 250 H.-P. for surface propulsion and electric motors for use when submerged. Their speed is 11 knots above and 7 knots below. The surface cruising radius is 450 knots at full speed. The armament consists of two bow and one stern tube with four 18-inch Whitehead torpedoes. The *special* characteristics of the American Lake type will be seen on pages 119-120.

Som Class.

(Completed 1904-6.)

Som. Shtshuka.

These two vessels, which are of the Holland-Bubnoff type, have a submerged displacement of about 150 tons. Petrol and electric motors are used for surface and submerged propulsion, and the speed is 9½ knots and 7 knots, above and below, respectively. Their armament consists of two bow tubes with four 18-inch Whitehead torpedoes. Their complement is about fifteen officers and men.

Sterliad Class.

(Completed 1905-6.)

Sterliad. Bialuga. Peskar.

These three vessels are also of the Holland-Bubnoff type. They have a submerged displacement of 150 tons. The petrol motors for surface propulsion are of 160 H.-P. The speed is 9½ knots and 7 knots, above and below, respectively. Their armament consist of two bow tubes with four 18-inch Whitehead torpedoes. Their complement is eleven to fifteen officers and men.

Sig.

(Completed 1906.)

A submarine of the Lake type; similar in almost every respect to vessels of the *Ostr* class.

Makrel Class.

(Completed 1907.)

Makrel. Okun.

Two vessels of the *Improved* Holland-Bubnoff type. They have a submerged

displacement of about 200 tons. The petrol motors are of 300 H.-P., and the electric engines of 150 H.-P. Their speed is 10 knots on the surface and 8 knots when submerged. They are fitted with two bow tubes and two stern *holders*, and carry six 18-inch Whitehead torpedoes. Their complement is fifteen officers and men.

Lossos Class.

(Completed 1907.)

Lossos. Ludak.

Two somewhat smaller submarines of the Holland type. Intended either for the Black Sea or Far Eastern Flotilla. Similar to those of the *Sterliad* class.

Karp Class.

(Completed 1907-8.)

Karp. Karas.

These two submarines are of the Germania, or Krupp type, and have a submerged displacement of 250 tons. They have Krupp-Nuremburg heavy-oil

engines of 400 H.-P., and electric motors of 160 H.-P. Their speed on the surface is 12 knots, and 8 knots when submerged. The surface range of action is about 1,000 miles, and the submerged endurance about three hours at full speed. Their armament consists of two bow torpedo tubes and four torpedoes are carried. Their complement is fifteen officers and men.

Alligator Class.

(Completed 1908-9.)

Alligator. Kaiman. Drakon. Krokodil.

Four submarines of the improved Lake type. They have a submerged displacement of 500 tons. Their speed is 15 knots on the surface and 10 knots when submerged. They are fitted with two bow and two stern tubes, and carry six 18-inch Whitehead torpedoes. Their complement is seventeen officers and men. (See also page 96.)

Minoga Class.

(Completed 1908.)

Minoga. Potschovy.

Two small submarines of the Holland-Bubnoff type, which were built in sections to facilitate transport by rail. They have a submerged displacement of about 150 tons, and a speed of 12 knots and 9 knots, above and below, respectively. Their complement is eleven officers and men.

Akula.

(Completed 1909.)

A large submarine of the Holland-Bubnoff type. Her displacement is about 570 tons, and her speed 16 knots on the surface and 10 knots when submerged. The armament consists of two bow and one stern tube, with six 18-inch Whitehead torpedoes. The complement is 20 officers and men.

Kaschalot Class.

(Completed 1909-12.)

Kaschalot. *Kit.* *Krab.*
Morsh. *Narval.* *Nerpa.* *Tinlen.*

These seven vessels are among the most modern submarines in the Russian flotillas. They are of the Holland-Bubnoff type, and have a submerged displacement of about 500 tons. Heavy-oil engines of over 1,000 H.-P. drive them at a maximum surface speed of 16 knots, and electric motors of 550 H.-P. give them a submerged speed of just over 10 knots an hour. Their surface cruising range is about 3,000 miles. Their armament consists of two bow and one stern tube with six 18-inch Whitehead torpedoes. They are also fitted with a small, quick-firing, high-angle gun for defence against aircraft. Their complement is 21 officers and men.

Russian Submarines Building.

At the commencement of the war there were nineteen Russian submarines in

course of construction. Very little information concerning these boats can be obtained, except that their submerged displacement ranges from 800 to 1,500 tons, and their *anticipated* surface speed is 20 knots. Some of the 800-ton vessels have already been completed, and the first twelve will be named: *Svitza*, *Leopard*, *Pantera*, *Ruis*, *Kaguar*, *Tiqr*, *Yaguar*, *Vepr*, *Wolk*, *Baro*, *Gepard*, and *Tur*. These vessels have a speed of 16 knots on the surface and 10 knots when submerged. Their complement is 25 officers and men.

CHAPTER V

JAPANESE SUBMARINES

THE Imperial Japanese Navy includes a submarine flotilla of seventeen vessels, all except two of which are of the British Holland or Vickers type. Japan commenced the construction of what is now a rapidly increasing and powerful flotilla in 1904 by the purchase of five elementary Holland boats. These, however, are still in the active flotilla and are designated Nos. 1-5. They have a submerged displacement of 120 tons, and are 65 feet in length and 12 feet in beam. Petrol motors of 160 H.-P. drive them at 9 knots on the surface and electric motors of 70 H.-P. at 7 knots when submerged. Their armament consists of one bow

expulsion tube with three 18-inch Whitehead torpedoes.

Nos. 6 and 7.

(Completed 1906.)

These two vessels were the first submarine boats to be built in Japan, but are of the same type as Nos. 1-5, only larger and faster. They have a submerged displacement of 180 tons, a length of 100 feet and a beam of 10 feet. The petrol engines are of 300 H.-P. and the electric motors of 100 H.-P. The surface and submerged speed is 10 knots and 8 knots an hour, respectively. Their armament consists of one torpedo tube with three 18-inch Whitehead torpedoes.

Nos. 8 and 9.

(Completed 1907-8.)

These two vessels are very similar to the British "C" class, and were built by Messrs. Vickers Ltd. They have a submerged displacement of 320 tons; petrol motors of 600 H.-P., and a surface and

submerged speed of 13 knots and 8 knots an hour, respectively. Their armament consists of two bow tubes with four to six 18-inch Whitehead torpedoes. Their complement is sixteen officers and men.

Nos. 10—15.
(Completed 1909-12.)

These six vessels are the same in almost every respect as the later "C" class of British submarines (pages 70-71).

Nos. 16—17*.
(Completed 1912-14.)

These two vessels are of the *Schneider-Laubeuf* or French type. (British "W" class.) Their submerged displacement is about 500 tons, and the horse-power of their surface engines 2,500. The surface and submerged speed is 18 knots and 9 knots respectively. Their armament consists of six torpedo tubes with eight *Schneider* torpedoes. The complement is about 30 officers and men.

* It is very doubtful if these two boats were delivered before the outbreak of war.

The natural adroitness with which Japanese sailors manipulate complicated machinery, combined with their absolute fearlessness, make them ideal for torpedo work.

CHAPTER VI

GERMAN SUBMARINES

On "The Day"—August 4th, 1914—Germany possessed 30 submarine torpedo-boats These were divided into three flotillas, with their headquarters at Kiel, the largest and most modern vessels being attached to the Heligoland or North Sea Flotilla. During 1913, although 24 submarines were stated as being in commission, only about 15 were actively employed, and these mostly in training reserves, the older boats being docked and modernized where possible.. But during the year six new vessels were added to the flotilla and the *personnel* of the submarine service was largely increased. At the same time the inspection of submarines was separated

from that of the other torpedo-boats and a flag-officer was appointed as head of the submarine branch of the Naval Service, with headquarters at Kiel. Thus when the hour came for the great struggle which was to decide the mastery of the seas the whole German Flotilla of 30 vessels, *with a reserve of six new boats which had been secretly hurried forward and were rapidly nearing completion*, was ready to put to sea.

The German Naval Law provided for the construction of 72 submarines by the end of 1917. All the vessels built up to the present time have been known as the "U" class and numbered in rotation. They are painted a brownish-grey colour and have high collier-like bows with massive armoured conning-towers and long superstructures amounting to narrow decks. They have all been built at either Kiel or Dantzig.

Although the first submarine boats built for the German Navy were two vessels of the Nordenfeldt type, launched

in 1890, they were never actively employed with the fleet and have long since been reduced to scrap-iron, and the first vessel which can now be reckoned as a fighting unit of the German torpedo-boat flotilla was a vessel designated the "U.1." This was built at the Germania Shipyard, Kiel, and launched on August 30th, 1905. This was the forerunner of the "U" class, which in most of the essential features resembles the British Improved Holland type.

U.1.

(Completed 1905.)

This U.1 was built as an experimental boat by the famous firm of Krupps. She has a surface displacement of 197 tons, a submerged displacement of 236 tons, and her heavy-oil surface engines are of 250 H.-P. The electric motors for submerged use develop just over 100 H.-P. The speed ranges from 10 knots an hour on the surface to 7 knots when submerged, and her surface

range of action is about 700 to 800 miles. The armament consists of one bow torpedo tube and three (17.7) Schwartzkopf torpedoes are carried. The complement is nine officers and men.

The trials of the U.1 extended over a period of a year and a half, and all proved remarkably satisfactory. During the tests which took place in Eckernforder Bay she succeeded, twice in succession, in torpedoing a moving target while travelling submerged at full speed.

The uncertainty displayed for some years previous by the German Naval Authorities regarding the value of submarine boats gave place to a thorough sense of the important part these "mighty atoms" would play in future naval warfare, and to a strong determination that the German Navy should include a powerful submarine flotilla.

U.2—U.8.

(Completed 1907-10.)

These seven vessels were great improvements on the U.1. Their

displacement is 210 tons on the surface and about 250 tons when submerged. They are fitted with Krupp-Nuremburg heavy-oil engines of 400 H.-P. and electric motors of 160 H.-P. Their speed on the surface is 12 knots and 8 knots when submerged. The surface range of action is 1,000 miles and the submerged endurance about three hours at full speed. Their armament consists of two bow torpedo tubes and four torpedoes are carried. The complement is eleven officers and men.

U.9—U.18.*

(Completed 1910-12.)

These ten vessels are of increased size and power, their submerged displacement being 300 tons, and the horse-power of their heavy oil surface engines is 600. The electric motors develop 200 H.-P. The surface and submerged speeds are 13 knots and 8 knots respectively. The surface range of

* The U.18 was sunk by a British patrol in November, 1914.

action is 1,500 miles, and the armament consists of two bow and one stern torpedo tube with five torpedoes. The U.13 and subsequent vessels of this class are provided with a quick-firing, high-angle gun for defence against aircraft, and have sleeping accommodation for the crew. They may be termed the first German sea-going submarines. Their complement is twenty officers and men.

U.19 and U.20.
(Completed 1912-13.)

There are only two vessels in this class owing to the adoption of certain improvements with the aid of which a partly new type has been evolved. These two vessels have a displacement when submerged of 450 tons. Their oil engines of 650 H.-P. give a speed of 13½ knots an hour on the surface, and their electric motors of 300 H.-P. give 8 knots an hour when submerged. Their surface range of action is 2,000 miles, and their armament consists of two bow

and one stern torpedo tube with six torpedoes, and two 14-pdr. quick-firing, high-angle guns on disappearing mountings. The complement is seventeen officers and men.

U.21—U.24.

(Completed 1912-13.)

These four vessels are the first of the new type of large sea-going submarines for the German Navy. Their submerged displacement is 800 tons. They are propelled on the surface by heavy-oil engines of 1,200 H.-P., and when submerged by electric motors of 500 H.-P. Their speed above water is 14 knots an hour and below the surface 9 knots. The surface range of action is 3,000 miles and the submerged endurance 120 miles at economical speed. Their armament consists of two bow and two stern torpedo tubes with eight torpedoes, and one 14-pdr. quick-firing gun and two 1-pdr. high-angle guns, all on disappearing mountings, for

defence against hostile destroyers and aircraft. Their complement is twenty-five officers and men.

U.25—U.30.

(Completed 1913-14.)

These six vessels are the latest additions to the German submarine flotilla. They are vessels of 900 tons submerged displacement with heavy-oil engines of 2,000 H.-P., and electric motors of 900 H.-P. Their surface and submerged speed is 18 knots and 10 knots, respectively. The surface cruising range is 4,000 miles. Their armament consists of two bow and two stern torpedo tubes, with eight large size torpedoes, and, in addition, two 14-pdr. quick-firing guns and two 1-pdr. high-angle guns. They have wireless telegraphic apparatus on board, and are specially constructed with long superstructures and high *collier-like* bows to enable them to keep at sea in almost any weather. They are fitted with two or three periscopes, and also possess a small

look-out cap on the top of the lofty conning-tower to facilitate an "awash" attack in the half-lights of dawn and dusk, when the periscope is almost useless. The conning-towers and decks are armoured. Their complement is 30 to 35 officers and men.

U.31—U.36.

(Building.)

These are the six vessels which are rapidly nearing completion, and which were in a much more advanced state, at the opening of hostilities, than was generally known in foreign naval circles. They are the same in almost every respect as the vessels U.25 to U.30. There is, however, another submarine being built for Germany of a totally different design. This is the F.I.A.T. or *Laurenti* boat (Italian), laid down at the beginning of 1914. This vessel is very similar to the four "S" boats being built at Greenock for the British Navy.

No German submarines have in the

past been sent to any Colonial or over-sea station. Therefore, the whole flotilla of 30 to 36 vessels was immediately available for operations in the North Sea and Baltic when war began. The *personnel* of the whole torpedo service is very efficient, great attention having been paid to this branch of the Navy. The three German Submarine flotillas have their headquarters at Kiel, Wilhelmshaven, and Heligoland.

CHAPTER VII

AUSTRIAN SUBMARINES

At the commencement of the War the Austro-Hungarian Navy included six submarines in the active flotilla and five others were being *completed* at the Germania Yard, Kiel, but it is doubtful if they had been delivered. In which event they must be added to the strength of the German flotilla. In addition to these, several larger vessels, mostly of the latest "U" or Krupp design, had been ordered, but were not expected to take their place in the active flotillas before the end of 1915.

Austria commenced the formation of a submarine flotilla in 1908 by the acquisition of two vessels of the *Improved Holland type* from Messrs. Vickers Ltd., and

two others of the American *Lake type.* In the following year two more submarines were ordered, this time from Krupp's Germania Yard. All these vessels were delivered during 1910, and Austria's first submarine flotilla came into being.

U.1 AND U.2.

(Completed 1910.)

These two vessels are of the American Lake type. They have a submerged displacement of 250 tons and petrol surface motors of 720 H.-P. Their speed is 12 knots on the surface and 8 knots when submerged. The armament consists of two bow and one stern torpedo tube. This type of submarine has three special features which distinguish it from all others. It is fitted with a kind of underframe and wheels, and is designed to travel in four different positions: (1) on the surface; (2) semi-submerged, with only a look-out cowl above water; (3) submerged, with nothing but the periscope showing; (4) totally submerged and

running along the sea-bed on wheels, like a submarine motor car. It is drawn down from the surface to the sea-bed by an ingenious system of wire-hawsers and drop-weights, which can be released in the event of accident. A "diving chamber" enables members of the crew to don diving-dresses and leave the submarine when on the sea-bed, for the purpose of laying or destroying submerged mines. The Lake type of submarine is also used in the Russian Navy.*

U.3 AND U.4.
(Completed 1910.)

These two vessels are of the Krupp design, and have a submerged displacement of 300 tons. The horse-power of their heavy-oil surface engines is 600. The electric motors develop 200 H.-P. The surface and submerged speeds are 13 knots and 8 knots respectively. The surface range of action is 1,500 miles, and the armament consists of two bow

* "Submarine Engineering of To-day." By Charles W. Domville-Fife. (London: Seeley, Service & Co. Ltd. 1914).

and one stern tube with five 18-inch torpedoes. Their complement is fifteen officers and men.

U.5 AND U.6.

(Completed 1910.)

These are submarines of the Improved Holland type. Their submerged displacement is about 316 tons; length 135 feet, and beam 13½ feet. The horse-power of the petrol engines is 600 and that of the electric engines 189. The speed averages 12 knots on the surface and 8 knots when submerged. The surface cruising range is 1,300 knots at 10 knots an hour. Their armament consists of two bow tubes with four to six 18-inch Whitehead torpedoes. Their complement is sixteen officers and men.

U.7—U.11.

(Completed 1914. Delivery doubtful.)

These five vessels are of the Krupp-Germania type, and are similar to those completed for the German Navy in

1912-13. They are large sea-going submarines with a submerged displacement of 800 tons. They are propelled on the surface by heavy-oil engines of 1,200 H.-P., and when submerged, by electric motors of 500 H.-P. Their speed is 14 knots and 9 knots, above and below, respectively. The surface range of action is 3,000 miles, and the submerged endurance 120 miles at economical speed.

Their armament consists of two bow and two stern torpedo tubes, with eight torpedoes, and one 14-pdr. quick-firing gun and two 1-pdr. high-angle guns, for defence against hostile destroyers and air-craft. Their complement is twenty-five officers and men.

One or two Austrian submarines are supposed to have been sunk by the Allied Fleet during the first few weeks of the war, but exactly which vessels they were is not known.

Several other submarines have been ordered in foreign countries for the

Austrian Navy, but cannot be delivered while the war lasts.

Submarine Flotillas of Neutral European Powers.

Country.	Vessels Built.	Vessels Building.
Italy ...	20 (100-300 tons)	8 (large size)
Denmark ...	9 (100-300 tons)	several
Holland ...	6 (100-300 tons)	4 (large)
Sweden ...	7 (150-300 tons)	3 (large)
Greece ...	2 (Laubeuf)	—
Norway ...	1 —	4 (Germania)
Portugal ...	1 —	3 —
Turkey ...	—	3 —
Spain ...	—	3 —

CHAPTER VIII

SUBMARINES IN ACTION

SUBMARINES have two great advantages over all types of surface warships; they can become invisible at will—or sufficiently invisible to make gun or torpedo-practice, except at very close quarters, almost entirely useless—and they can, by sinking, cover themselves with armour-plate of sufficient thickness to be absolutely shell-proof. These are the two main points in favour of the submarine. There are, however, many minor features. Although submarines are known in the naval services as "daylight torpedo-boats," for their *greatest* value lies in their ability to perform the same task in the "light" as the ordinary surface torpedo-boats and destroyers can do under

cover of darkness or fog—that of creeping up close to an enemy, and launching a torpedo unobserved—they have been given, during recent years, so much greater speed, armament, and range of action, that they can no longer be looked upon as small boats just suitable for daylight torpedo attack in favourable circumstances. Their surface speed has been increased from 10 to 20 knots, making them almost as fast as the surface torpedo-boat. This, combined with manœuvring powers and general above-water invisibility, has enabled them to take over the duty of the surface torpedo-boat—that of delivering night-attacks on the surface. After nightfall a submarine attack is almost impossible owing to the periscope—the eyes of the submarine—being useless in the dark.

The increase in the armament of the submarine—from the single bow torpedo tube with two torpedoes of short range and weak explosive charge, to the four bow and two stern tubes with eight or ten

torpedoes of long range and high explosive charge—has greatly increased their chances of successful attack on surface warships, first, by giving them four or six shots ahead, then the possibility, in the event of all these torpedoes missing, of a dive under the object of attack, and two more shots at close range from the stern tubes (still retaining two torpedoes); and, secondly, by increasing the distance from which the first projectile can be launched, owing to the increased range of the modern torpedo. There are also the advantages derived from the battery of quick-firing guns installed on the decks of modern submarines. Although at the present time these guns are only of small power they nevertheless afford a means of defence—and even of attack under favourable circumstances—against hostile surface torpedo-boats, destroyers, and air-craft. In fact, a flotilla of submarines could undoubtedly now give a very good account of

itself if attacked either on the surface or when submerged by one or two prowling destroyers. The increase in the power of the guns carried by submarines, which will certainly come soon, will enable this type of craft to take up the additional duties of the destroyer —that of clearing the seas of hostile torpedo-boats and carrying out advanced scouting—for which work their ability to travel submerged and in a state of invisibility for distances of over 100 miles makes them eminently suitable.

The enormous increase in the size and range of action of submarines, combined with the improvements effected in the surface cruising qualities, have enabled these vessels to be taken from the "nursery" of harbour and coast defence and placed with the sea-going flotillas and battle-fleets. In the short period of ten years the tonnage of submarines has risen from 100 to over 1,000 tons, and the range of action from 400 miles at economical speed to

5,000 miles. Exactly what this means is more easily realized when it is stated that the earlier types of submarines could scarcely cross the English Channel and return without taking in supplies of fuel, and in rough weather were forced to remain in harbour, whereas the modern vessel can go from England to Newfoundland *and back* without assistance, and can remain at sea in almost any weather, as was first demonstrated by the successful voyage of the British submarines A.E.1 and A.E.2 to Australia, and has since been proved by the operations of the British submarine flotilla in the North Sea.

In addition to the cruising range there is, however, the question of habitability. In this respect the progress has been equally as rapid. In the older boats no sleeping accommodation was provided for the crew, and food supplies and fresh water sufficient only for a few days were carried. In the

latest British, French and German vessels proper sleeping and messing accommodation is provided, and supplies of all kinds and in sufficient quantity to last a month are carried. Although work on these craft is still very cramping for the crew, the increase in the deck space and in the surface buoyancy has greatly minimised the discomforts of service in the submarine flotilla.

With regard to safety, it has already been shown that a submarine is only held below the surface by the power of her engines and the action of the water on her diving-rudders. This means that in the event of anything going wrong *inside* the vessel she would automatically rise to the surface; but should the hull be pierced in any way, either by shot or by collision, and an overwhelming inrush of water result—overcoming the buoyancy quickly obtained by blowing out the water-ballast tanks—then the vessel must inevitably sink, and the

question of whether or not the crew can save themselves becomes a problem to which no definite answer can be given, although a special means is provided in all modern vessels belonging to the British Navy. Speaking generally, it may, however, be said that if the disaster occurs suddenly, and the vessel sinks into very deep water rapidly, the chances of life-saving are extremely small; but if the water is comparatively shallow, as along the coast (100 to 150 feet), the likelihood of many of the crew being able to save themselves with the aid of the *special escape helmets and air-locks* is fairly good.

We now come to the most important improvement made in the fighting qualities of these vessels since first they came into being, viz. the wonderful increase in the surface and submerged speed. In the older craft the surface speed did not exceed 8 to 10 knots an hour, whereas it now amounts to 16 to 20 knots, and the submerged speed has risen from 5 knots to 10 to 12 knots. It is a little difficult

for any but a naval man to realize exactly what this increase in the speed of submarines really means, and it is equally as difficult to adequately describe it here in non-technical language. It is a mere platitude to say that in order to attack a surface warship the submarine must first get within torpedo range of it; and yet it is on this very point that the strategy and tactics of submarine warfare revolve. A clever naval tactician once described the submarine as a "handicapped torpedo-boat." The two points on which he based this opinion were—the (then) slow speed of these vessels compared with that of the surface warship, and its almost total blindness when submerged. These two defects were for some years the principal drawbacks of all the submarines afloat; but since that naval expert pronounced submarines to be "handicapped torpedo-boats," great changes, great improvements have been made. The speed of the submarine has increased by over 100 per cent., and they have been given

longer and wider range of vision by the introduction of two and three improved periscopes instead of one elementary instrument. Nevertheless, the speed difficulty is still a very real one, as will readily be seen when it is taken into consideration that the speed of a submarine when attacking submerged is frequently only half, or even a third, of that of her enemy. In order to more clearly illustrate this and lift for a moment the veil of secrecy which enshrouds the methods of attack adopted by this type of craft, it will be necessary to describe what is known as the *right-angle attack.*

Attacking at Right Angles.

The difficulty of attacking a surface warship steaming at right angles to the course of the submarine will be clearly understood by referring to the following diagrams. The first shows an attack on a warship travelling at 20 miles an hour, such as a big battleship or a cruiser

Any increase in the speed of the surface vessel not only adds to the difficulty of the attacking submarine, but also the direction from which the attack must be made. This feature is shown in the second diagram, which illustrates a submarine attack on a vessel steaming at 30 miles an hour, such as a fast destroyer or fleet scout. On the other hand, a decrease in the speed of the on-coming surface vessel tends to either make easier the task of the attacking submarine, or else to increase the distance from which the attack can be delivered. This is shown in the third diagram, which assumes the speed of the surface vessel to be only 15 miles an hour, such as a merchantman, troopship, food-ship, collier, or old warship.

Fig. 1 represents a submarine attacking a hostile warship (or fleet) steaming at 20 (statute) miles an hour. "A" is the line of vision. The submarine sights the warship at a distance of just over 11 miles on her port bow. "B" shows the hostile

vessel's course, which is 10 miles to point marked "C," and each division beyond equals 1 mile.

Directly the submarine, which is assumed to be lying in an *awash condition*, sights the object of attack, she totally submerges and steers forward at a speed of 10 miles an hour. The loss, and gain, of the submarine on the different courses, can be seen in the table above the chart.*

The spaces between the black dots show the most favourable points of attack. It will be noticed in the table that both vessels are equal at point "C," but for many reasons this is not the best point of attack. The gain of about six minutes on the longer course enables the submarine not only to manœuvre into the best possible position for the attack, but

* As it is almost impossible for a submarine, when totally submerged, to steer a *perfectly* straight course, the table above each chart shows the approximate average loss and gain on each mile. It must also be remembered that the submarine in actual practice need only reach the torpedo firing line.

also to discharge more than one torpedo if necessary.

Fig. 2 shows the extreme limit at which a submarine could, with reasonable chances of success, attack a destroyer, or other vessel, steaming at 30 (statute) miles an hour, having sighted her at a distance of 16 miles in the position shown by the line of vision "A."

The distance to "C" is 15 miles for the surface vessel, and 5 miles for the submarine. Here, again, the two vessels would be equal; but the most favourable point of attack is shown by the two black dots—where the submarine has gained two minutes.

Fig. 3.—The submarine sights the object of attack at a distance of 14½ miles, in the position shown by the line of vision "A." The surface vessel has a speed of only 15 miles an hour (merchantman). In this case the surface vessel accomplishes the 10-mile journey along course "B"—arriving at point "C" 20 minutes in advance of the

submarine. The table shows how the submarine, by changing her course and "throwing" the surface vessel on her beam, gradually reduces the loss, until, at the point marked with the two black dots, she is but 4½ minutes behind. At this distance she could fire her torpedoes at long range, with some likelihood of success.

Although these charts show approximately the extreme limits of the right-angle attack, a submarine could, of course, proceed for some distance on the surface at a much faster speed; but considering the rate at which the two vessels would be approaching each other, the submarine which attempted it would run considerable risk of being detected, and thus destroy her chances of a successful attack. Considering also the time lost in sinking from the "light" to the totally submerged condition, in coming to close quarters, the gain in speed would not amount to as much as may at first seem probable.*

* "Submarines of the World's Navies." By Charles W. Domville-Fife. (London: Francis Griffiths.)

These charts are drawn and calculations made assuming the following points:—

(1) The weather—fine and bright.
(2) Not taking into consideration strong tides, currents, etc.
(3) The enemy on the alert.
(4) Submarine waits at point "D" in an awash condition.
(5) Owing to 1, 2, and 3 above, the submarine travels from point "D" in all courses in a submerged condition.

The most favourable position for a submarine flotilla is to manœuvre close up to a fleet at anchor, or to get within 1,000 yards of a fleet—steaming across its course; but both of these ideal positions for attack are extremely difficult to obtain, and consequently in all the less favourable positions speed is the deciding factor. Strategems will undoubtedly play an important part in submarine warfare. An example of this has already been afforded when the

German submarines resorted to the dishonest trick of laying in wait behind a trawler engaged in laying mines, over which *the flag of a neutral state* had been hoisted as a blind. This resulted in the loss of three British cruisers with over 1,000 lives. It would, however, be quite in accord with the rules of *civilised* warfare for a submarine to shelter behind a "decoy"; to attack simultaneously with a seaplane; or to approach an enemy behind one of its own merchant ships.

The Porpoise Dive.

The manœuvre known as the "Porpoise Dive" is merely the sudden rising of a submarine in order to enable her commander to get a better view of the surface than that afforded by the periscope. The submarine on approaching the object of attack rises quickly to the surface by the action of her horizontal rudders, then dives again, only remaining above water for a few seconds to enable her com-

mander to get a glimpse of the enemy, and to take bearings. The submarine can then get within torpedo-range, with simply the tiny periscope projecting from the surface. This manœuvre is now seldom necessary, owing to the long and wide range of vision of the two or three periscopes fitted in modern submarines.

Difficulty of the Fixed Torpedo Tube.

With the exception of one or two vessels, which it would be unwise to specify, all the submarines engaged in the present war have what are called *fixed submerged tubes.* This means that the tubes from which the torpedoes are discharged are fitted *inside* the submarine *on a line with the centre of the boat*, and cannot be moved or aimed in any way apart from the boat itself. It therefore becomes necessary for the submarine to be *aligned* by the steering rudders on the object of attack before the torpedoes can be discharged. In simpler vein, torpedoes

can only be fired by a submarine straight ahead or straight astern. Hence a submarine, with a hostile warship coming up on its beam, is compelled to turn and face its opponent (or turn its stern towards her) before delivering an attack.

Submarine Flotilla *v.* Surface Fleet.

It is absolutely necessary for submarines acting in company to have each its allotted task; and for a wide space of water to be left between each boat; as it is impossible, at present, for one submarine to know the exact position of another when both vessels are submerged. Therefore, if each boat was not previously instructed how to act, there would not only be the likelihood of the greater portion of an attacking flotilla firing their torpedoes at one or two vessels of the hostile fleet and allowing the remainder either to escape or to keep up a heavy and dangerous fire unmolested, but also of collision and of torpedoeing each other

by accident. There is no means of inter-communication between submarines when submerged, and a battle between submarines is almost impossible.

Surprise Attack.

In this case invisibility is the element of success. Admiral Sir Cyprian Bridge, G.C.B., in a letter to the Author once said: "When submerged the concealment of the submarine is practically perfect. If she has not been sighted up to the moment of diving, she will almost certainly reach, unobserved, the point at which she can make her attack." And this opinion—shared for many years by all experts—has been amply proved in the present war.

A submarine must, however, blend with the surrounding sea in its ever-varying colours, lights and shades, in order that she may be as invisible as possible when cruising on the surface. The French Naval Authorities experimented off Toulon with a luminous paint of a

sea-green colour; but this, although causing the hull to be almost totally invisible in certain weather, was found to be useless, as, on a bright day with a blue sky, the green showed up clear against the bluish tint of the surrounding sea. After many months of experimenting, a pale, sea-green, non-luminous paint was chosen as the best colour for French submarines. The British Admiralty also carried out a few experiments in this direction, and came to the conclusion that a dull grey was the most invisible shade. The German authorities decided in favour of a grey-brown.

When travelling submerged, with only the thin periscopic tube above the surface, it is almost impossible to detect the approach of a submarine *before* she gets within torpedo range; and when cruising on the surface she is equally as invisible at a distance of a few miles. These qualities enable the submarine in nearly all cases where her speed permits, to effect a surprise attack on a hostile battle-

ship or cruiser *when not closely screened by fast destroyers*, whose duty it is to be ever on the watch for submarines.

As to the tactics which would be employed by a submarine (or flotilla) in attacking a hostile warship (or fleet), it is impossible to say, for, like the impromptu attacks of all "mosquito craft," the exact method, or manœuvre is arranged to suit the circumstances, and it is very seldom that two such attacks are carried out alike. Generally speaking, however, a hostile warship could be easily sighted, on a fairly clear day, from the flying-bridge of a submarine at a distance of 10 miles; but it would be practically impossible to detect the submarine from the deck of a warship at that distance. On sighting her object of attack the submarine would sink to the "awash" condition, and proceed for from $2\frac{1}{2}$ to 5 miles, as might be deemed expedient. She would then submerge and steer by her periscopes, each of which has a field of vision

of 60 degrees. He would be a very keen look-out who would be able to detect the few square inches of periscopic tube at a distance of three miles. As this distance lessened, it might be advisable, if the sea was *very* calm and if the object of attack was stationary, for the submarine to slacken speed, so as to prevent any spray being thrown off by the periscopic tube. Assuming, however, that the optical tube was seen by the enemy, it would be extremely difficult to hit it with gun-fire at a distance of one or two miles, or to damage the boat itself, which would probably be immersed to a depth of 12 or 15 feet. At a distance of about 2,000 yards, or just over one mile, the submarine would discharge her first torpedo, following it up with another at closer range from the second bow tube. A rapid dive would then probably be necessary in order to avoid the hail of shot which would plough up the waters around her. If the first two torpedoes missed their mark the submarine might

either dive completely under the object of attack and then fire her stern tubes at close range, or else manœuvre below the surface for an attack from some other point.

One of the effects produced on fleets or individual warships in war time by the ever present possibility of submarine attack is, however, that they never remain at anchor or even stationary in an exposed position, and seldom—if wise—proceed without destroyers as advance and flank guards. These precautions double the difficulties of a successful submarine attack.

CHAPTER IX

ANTI-SUBMARINE TACTICS

In all warfare, new weapons of attack are, sooner or later, met by new methods of defence. The submarine and the aeroplane are at present the only weapons against which there is no true means of defence, and yet one is being used as an antidote for the other without, however, any very striking success so far. The seaplane may be able to distinguish the dark patch in the sea caused by the hull of the submarine *in clear water*, but she cannot destroy it, neither can she signal the *exact* locality to an accompanying destroyer flotilla, owing to the speed with which seaplane and submarine pass over and under each other; furthermore, in rough weather or

in shallow muddy water no sign of the submarine when submerged is visible from above. The great value of the seaplane as an antidote for submarines lies, however, first in the fact that the water of the open sea is usually clear, and the *submarine shadow* is visible from above, and, secondly, in the great speed of these aircraft which enables them to quickly cover miles of sea in their search for hostile submarines and to report their presence in a given locality by wireless to all ships operating within range.

When the enormous superficial area of a zone of war, such as the North Sea and English Channel, is duly considered, however, the difficulty in quickly and reliably locating from the air the few scattered "submarine shadows" will be easily realized. To make this method of locating submarines even fairly reliable an enormous fleet of seaplanes would be required. Again seaplanes do not, in themselves, constitute

a means of defence against submarine attack, they merely increase the likelihood of detection, but, in actual warfare, it has now been proved that for every submarine detected by seaplanes two others pass quite unobserved.

Many means of attack on submarines have been proposed; and no doubt some of these, in certain cases, would prove effective; but none can be relied upon. Therefore, one of the points in favour of the submarine still remains without its antidote. This is the *moral effect;* for if there is no absolutely reliable means of defence, there can be no feeling of security for surface warships or merchant vessels when anywhere within the danger zone of the submarine.

Let us now examine briefly what practical methods of defence a modern warship has against submarine attacks. Great speed is undoubtedly a surface ship's most reliable defence; and when combined with a frequent change of course, would greatly reduce the chances

of a successful under-water attack. Should hostile submarines be on the line of advance they would not know whether to wait and chance the enemy approaching within torpedo range or whether to run to starboard or port. This is, if the surface warship was steaming in an erratic course—not a zigzag course, for then it might be possible to estimate, within torpedo range, the position of the ship at a given point if the "tacks" were regular.

Should submarines be seen approaching, a surface vessel would do well to turn her stern to the attacking flotilla, presenting as small a target as possible, and deflecting the torpedoes by her propeller race.

The escape of the Battle Cruiser *Queen Mary* and the Light Cruiser *Lowestoft*, during the action in the Heligoland Bight, as described in the dispatch of Vice-Admiral Sir David Beatty, K.C.B., demonstrates what may be done by the skilful use of the helm

on surface warships to frustrate submarine attacks. So interesting, and informative as to the actual fighting between British warships and hostile submarines, in this dispatch that I give it here in full. It should, however, be studied in conjunction with the comprehensive report—the first in the history of Naval warfare detailing submarine attack and reconnaissance—from Commodore Roger J. B. Keyes, C.B., of the British submarines, given on page 28.

"H.M.S. *Lion*,
1st September, 1914.

"SIR,—I have the honour to report that on Thursday, 27th August, at 5 a.m., I proceeded with the First Battle Cruiser Squadron and First Light Cruiser Squadron in company, to rendezvous with the Rear-Admiral, *Invincible*.

"At 4 a.m., 28th August, the movements of the Flotillas commenced as previously arranged, the Battle Cruiser Squadron and Light Cruiser Squadron

supporting. The Rear-Admiral, *Invincible*, with *New Zealand* and four Destroyers having joined my flag, the Squadron passed through the pre-arranged rendezvous.

"At 8.10 a.m. I received a signal from the Commodore (T), informing me that the Flotilla was in action with the enemy. This was presumably in the vicinity of their pre-arranged rendezvous. From this time until 11 a.m. I remained about the vicinity ready to support as necessary, intercepting various signals, which contained no information on which I could act.

"At 11 a.m. the Squadron was attacked by three Submarines. The attack was frustrated by rapid manœuvring and the four Destroyers were ordered to attack them. Shortly after 11 a.m., various signals having been received indicating that the Commodore (T) and Commodore (S) were both in need of assistance, I ordered the Light Cruiser Squadron to support the Torpedo Flotillas.

"Later I received a signal from the Commodore (T), stating that he was being attacked by a large Cruiser, and a further signal informing me that he was being hard pressed and asking for assistance. The Captain (D), First Flotilla, also signalled that he was in need of help.

"From the foregoing the situation appeared to me critical. The Flotillas had advanced only ten miles since 8 a.m., and were only about twenty-five miles from two enemy bases on their flank and rear respectively. Commodore Good-enough had detached two of his Light Cruisers to assist some Destroyers earlier in the day, and these had not yet re-joined. (They rejoined at 2.30 p.m.). As the reports indicated the presence of many enemy ships—one a large Cruiser—I considered that his force might not be strong enough to deal with the situation sufficiently rapidly, so at 11.30 a.m. the Battle Cruisers turned to E.S.E., and worked up to full speed. It was evident

that to be of any value the support must be overwhelming and carried out at the highest speed possible.

"I had not lost sight of the risk of Submarines, and possible sortie in force from the enemy's base, especially in view of the mist to the South-East.

"Our high speed, however, made submarine attack difficult, and the smoothness of the sea made their detection comparatively easy. I considered that we were powerful enough to deal with any sortie except by a Battle Squadron, which was unlikely to come out in time, provided our stroke was sufficiently rapid.

"At 12.15 p.m. *Fearless* and First Flotilla were sighted retiring West. At the same time the Light Cruiser Squadron was observed to be engaging an enemy ship ahead. They appeared to have her beat.

"I then steered N.E. to sounds of firing ahead, and at 12.30 p.m. sighted *Arethusa* and Third Flotilla retiring to

the Westward engaging a Cruiser of the *Kolberg* class on our Port Bow. I steered to cut her off from Heligoland, and at 12.37 p.m. opened fire. At 12.42 the enemy turned to N.E., and we chased at 27 knots.

"At 12.56 p.m. sighted and engaged a two-funnelled Cruiser ahead. *Lion* fired two salvoes at her, which took effect, and she disappeared into the mist, burning furiously and in a sinking condition. In view of the mist and that she was steering at high speed at right angles to *Lion*, who was herself steaming at 28 knots, the *Lion's* firing was very creditable.

"Our Destroyers had reported the presence of floating mines to the Eastward and I considered it inadvisable to pursue her. It was also essential that the Squadrons should remain concentrated, and I accordingly ordered a withdrawal. The Battle Cruisers turned North and circled to port to complete the destruction of the vessel first engaged.

She was sighted again at 1.25 p.m. steaming S.E. with colours still flying. *Lion* opened fire with two turrets, and at 1.35 p.m., after receiving two salvoes, she sank.

"The four attached Destroyers were sent to pick up survivors, but I deeply regret that they subsequently reported that they searched the area but found none.

"At 1.40 p.m. the Battle Cruisers turned to the Northward, and *Queen Mary* was again attacked by a Submarine. The attack was avoided by the use of the helm. *Lowestoft* was also unsuccessfully attacked. The Battle Cruisers covered the retirement until nightfall. By 6 p.m., the retirement having been well executed and all Destroyers accounted for, I altered course, spread the Light Cruisers, and swept northwards in accordance with the Commander-in-Chief's orders. At 7.45 p.m. I detached *Liverpool* to Rosyth with German prisoners, seven officers, and 79 men,

survivors from *Mainz*. No further incident occurred.—I have the honour to be, Sir, your obedient Servant.

"(Signed) DAVID BEATTY,
"Vice-Admiral.

"The Secretary of the Admiralty."

Quick-firing guns of the 3-inch and 6-inch type are certainly the best weapons for an attack on submarines. In combination with "sharp look-outs," they could be used with effect from the elevated positions on the fore part of warships. The periscopic-tube of the submarine always proves a target for gun-fire; but a grey steel tube, 3 inches in diameter, at a distance of 1,000 yards requires "excellent" marksmanship to hit. That it can be done is proved by the sinking of the German submarine U.15 by the British Cruiser *Birmingham* in the North Sea. The effect of a shot carrying away the periscope is to blind the submarine, at least in one eye, she can then be *run-down* by the surface

warship or destroyed by rapid gun-fire at close range.

Of course, if submarines were caught napping on the surface the guns of surface warships could quickly sink them; but another incident, similar to that which opened the naval engagements of the Russo-Japanese War, cannot be looked for in the naval engagements to come.

For a fleet engaged in bombarding or blockading, one of the best methods of defence would be to lower the torpedo nets, not close round each vessel, but suspended from "picket-boats" at a distance from the bombarding or blockading fleet. "Picketing" is also considered a good defence during daylight, but neither of these methods are reliable. A submarine might be able to dive unobserved under, or past, the destroyers acting as pickets, and it is this chance which causes these under-water craft to be a source of constant anxiety.

The torpedo-boat destroyer should prove a nasty enemy to the submarine.

In warfare it is the duty of these 30-knot vessels to look after their under-water opponents.

It has been suggested that internal armour could be fitted to warships below the water-line, which would render the hulls able to withstand mine or torpedo explosions. At present this is practically impossible, as the great weight of this additional armour, combined with the ever-increasing size of guns and weight of above-water protection, would necessitate a vessel of such enormous displacement as to be quite impossible, if the important factor —high speed—has also to be maintained.

The defence of harbours against submarines is a problem which does not present nearly so many difficulties as the defence of moving ships. Portsmouth, for example, is closed by means of a submarine boom-defence, which is stretched across the mouth of the harbour. The entrance to the River Elbe (leading to the Kaiser Wilhelm

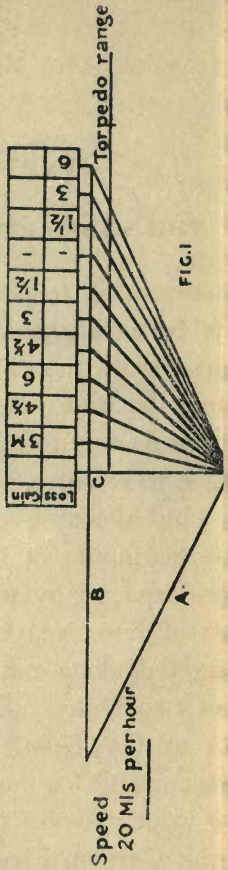
Canal) is effectively closed to British submarines by boom-defences, mines, and submerged wire entanglements. Narrow waterways, such as the Straits of Dover, can be closed by the laying of contact-mines, and even broader seas can be made dangerous to submarines by the same method. An example of this is afforded by the laying of a British mine-field somewhere between the Goodwin Sands and the Dutch Coast, to prevent German submarines from penetrating into the English Channel.

There are so many reliable means of defending harbours and narrow waterways against submarines that it is unnecessary to say anything further here. But to protect moving ships at sea, under all conditions, certainly presents a most profound puzzle.

CHAPTER X

THE SUBMARINE TORPEDO

The submarine torpedo has become one of the principal naval arms. Not only does it supply the chief offensive power of the submarine, the torpedo-boat and the destroyer, but it is also carried as a separate arm, with a special highly-trained crew, by almost every warship afloat. At the beginning of hostilities the Naval Powers engaged owned considerably over 80,000 of these weapons, and *one* factory in England alone can make them at the rate of two a day. During the first few weeks of the *Great War* the torpedo was responsible for the sinking of warships to the value of over one million sterling. Had the German Fleet been on the high seas instead of in harbour and protected



Right-Angle Attack by Submarines.

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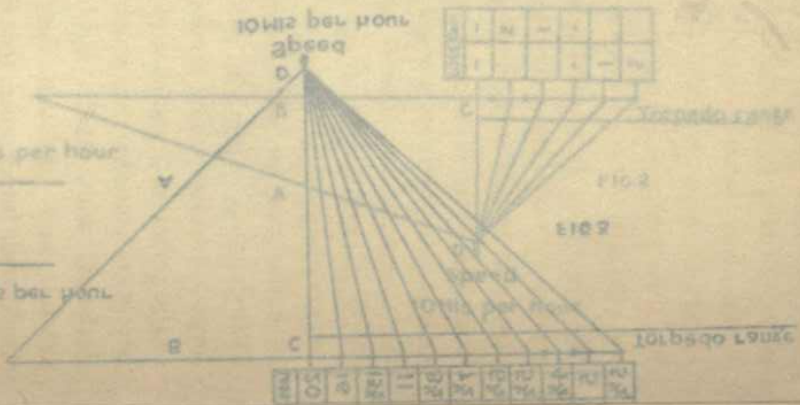


from torpedo raids by carefully-prepared submarine defences, there is little doubt but what several more of the enemy's ships would have been sunk by this weapon. The fact that at first the British light cruisers suffered rather heavily—though in total loss of ships and men less than the German Navy—does not point to any advantage derived either from the type of torpedo used or from skill in this mode of warfare possessed by the Germans, but clearly to the timidity of the German main fleet, which was at the very beginning of hostilities withdrawn from the zone of war and placed behind fortifications, where it was safe from torpedo attack. The British Fleet, true to the policy of "attack and not defence," began operations the moment war was declared, with results so brilliantly successful, and of such far-reaching and world-wide importance, that enumeration is well-nigh impossible. But while all these operations were in progress the British Fleet was more or less exposed to torpedo

attack by any hostile submarines or fast surface craft which might succeed in getting past the cordon of protecting destroyers, while the German Fleet was safe, but ignominiously impotent. That the naval losses of Great Britain, with all her fleets at sea, have not been far greater than they have is in itself a victory of the greatest magnitude—a victory due entirely to consummate naval skill.

The modern torpedo varies in length from 14 to 19 feet, and weighs up to half a ton. It has an extreme range of 4,000 yards, or just over 2¼ miles. There are three types of torpedoes in use by the fleets at war. The British use the *Whitehead Torpedo*, the French the Whitehead and the *Schneider*, the Russians and the Japanese use the Whitehead; the Germans have a type of their own, known as the *Schwartzkopf*, and the Austrian arm is principally the Whitehead. All these types are alike in their essential features, and therefore need not be described separately.

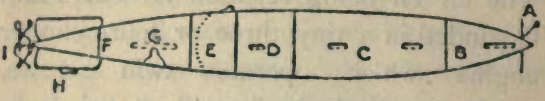
The latest pattern 18-inch Whitehead torpedo is propelled by compressed air stored in that section of the weapon known as the *air-chamber* (see diagram). The air on being released is heated and expanded in a tiny three or four-cylinder engine which operates twin screws, moving "clockwise" and "anti-clockwise." The "war-head" contains about 200 pounds of wet gun-cotton which is exploded on the torpedo striking an object. The essential features of the Whitehead torpedo are shown in the diagram.*

This torpedo maintains a speed of 42 knots for 1,000 yards, 38 knots for 2,000 yards, 32 knots for 3,000 yards, and 28 knots for 4,000 yards. Thus, if discharged at a distance of half a mile it reaches its object in about 45 seconds.

Torpedoes are fired—or ejected—into the sea from surface or submerged tubes, and on striking the water are

* "Submarines of the World's Navies." By Charles W. Domville-Fife. (London: Francis Griffiths.)

propelled by their own engines in an absolutely straight course towards the target. The exact mechanism of the submerged tube—which is used in



Sketch showing the essential parts of a Whitehead torpedo. *A*. Pistol, detonator, primer, which causes the explosion of "B" when the torpedo strikes an object. *B*. Explosive head, filled with wet gun-cotton. (The "war-head" is substituted by a weighty dummy during practice.) *C*. Air chamber with compressed air, at a pressure of approximately 1350 lbs. per square inch, for action. The chamber is tested to stand a pressure of 1700 lbs. per square inch. *D*. Balance chamber, containing mechanism for regulating the depth of submergence at which the torpedo is adjusted to run. *E*. Engine-room, containing propelling machinery (I.H.P. 60 in latest 18-in. type). *F*. Buoyancy chamber—a practically empty chamber—to give the necessary buoyancy to the torpedo. *G*. Gyroscope. An instrument for correcting any deviation of the torpedo from the line of fire. *H*. Rudders, and mechanism for operating. *I*. Twin-screws, operating "clockwise" and "anti-clockwise."

surface warships as well as in submarines—is a naval secret. When fired from a surface tube the torpedo sinks immediately to a depth of about 10 to 14 feet, and maintains this depth until it strikes its object. When fired from a

submerged tube it rises—if necessary—to the same level. A torpedo always proceeds towards its object of attack at a depth of a few feet below the surface. This, combined with speed, renders it almost impossible to destroy an approaching torpedo by gun-fire. So marvellous is the mechanism of these little weapons that in anything like favourable circumstances they may be *depended upon*, if well aimed, to strike within a yard or two of the spot aimed at. This accuracy is due almost entirely to the gyroscope, which, briefly described, is a rotating wheel automatically controlling the torpedo's course.

Although for many years torpedoes have been carried by nearly all types of service warships, none of them were really ideal for this kind of warfare. A new field for the torpedo was, however, opened out by the introduction of the submarine boat. In order to be effective the torpedo must be discharged from a

distance under 4,000 yards—preferably from a point less than half this distance from the object of attack. This means that the vessel carrying the torpedo would have to get within a mile, or at least a mile and a-half, of her object of attack before discharging a torpedo. For a surface vessel to accomplish this in the face of a heavy cannonade from quick-firing guns would be extremely risky. To make a quick rush to close quarters, if possible, by several vessels from different points, was the only chance of delivering a successful torpedo attack on a hostile warship; unless, of course, she was favoured by fog or darkness *at the right moment*—favourable conditions which would seldom obtain in actual warfare. Again, every increase in the speed of the big surface warship rendered the task of the ordinary torpedo-boat and destroyer more difficult because in the event of a threatened attack the larger vessel would make use of her speed to keep out of torpedo range while

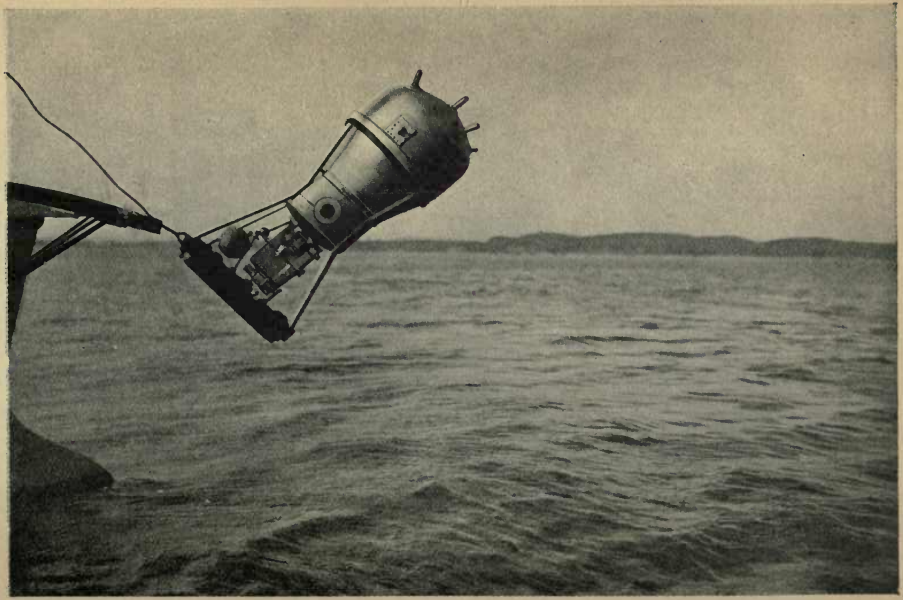
her powerful guns were repelling the attacking torpedo-boat.

The *hour* of the torpedo came with the *perfection* of the submarine. All the conditions of an ideal torpedo-boat were fulfilled—*invisibility* rendering daylight attacks possible; *almost perfect immunity from gun-fire* enabling the torpedo to be discharged at closer range; *submerged discharge* removing the likelihood of the weapon being exploded by accurate gun-fire before being discharged; *speed on the surface* enabling the "carrying" vessel to manœuvre for position; *moderate speed when submerged* enabling an attack under all reasonably tactical conditions; and *comparatively large displacement* giving good cruising qualities, wide range of action, and enabling a large number of torpedoes and tubes being carried.

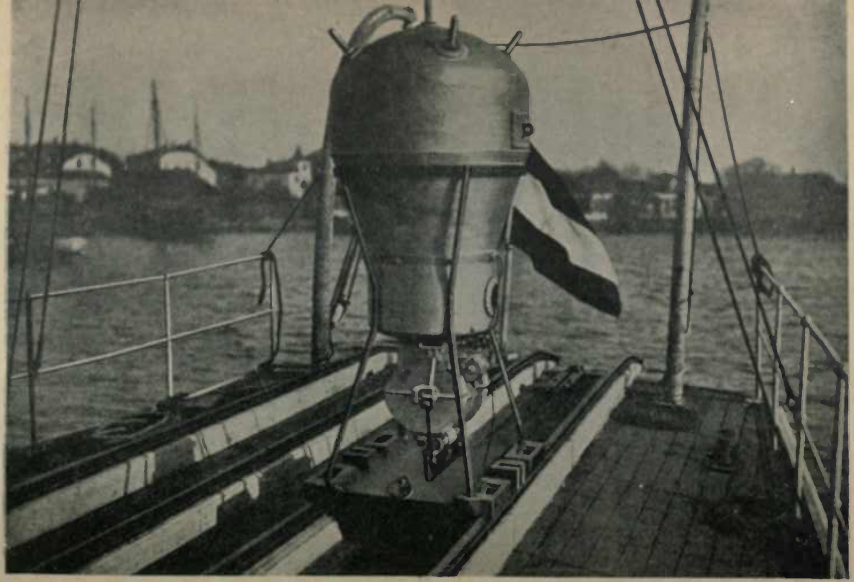
CHAPTER XI

SUBMARINE MINES

If the Russo-Japanese war was the first to fully demonstrate the value of the explosive mine, the Great European Conflict has certainly brought this weapon to the forefront in the rapidly growing science of submarine warfare. During the first few weeks of the naval fighting several warships, beginning with H.M.S. *Amphion*, and many merchant vessels representing millions of pounds sterling, were destroyed by these weapons. Had it not been for the foresight of the British Admiralty in providing a very large fleet of mine-sweepers, aided by seaplanes, there can be no doubt but what the shipping of all countries—



LAUNCHING A GERMAN TROTYL MINE.



A GERMAN SUBMARINE TROTYL MINE ON THE DECK OF A MINE-LAYER.

These mines contain the famous T.N.T., or Trotyl explosive.

neutrals and belligerents alike—would have suffered far greater losses.

The indiscriminate scattering of mines across the trade routes, as carried on by Germany immediately on the outbreak of war, and before hardly any of the ships at sea belonging to neutral countries could be warned to avoid the zone of operations, has never before been so ruthlessly resorted to by a big civilised power.

The system of defence consists of the mooring of these mines in such positions as to make it almost impossible for hostile ships to pass without either striking or coming within the destructive zone of one or more of them. What are known as *floating mines* are those set adrift to be washed about by the tide. They explode immediately on being struck by a passing vessel, and, of course, do not discriminate between friend and foe. The systems of destroying hostile mine-fields consist of *counter-mining*, or placing other mines in the enemy's field and destroying it by

their explosion, and by *sweeping*. The latter method is the one mostly employed in modern warfare. The boats taking part in the *sweep* place themselves one on each side of the mine-field, and between them hangs a long wire rope, weighted in the centre to keep it well submerged. They then move forward, sweeping the mines to the surface or exploding them harmlessly. It is, however, very dangerous but highly necessary work.

There are two kinds of submarine mines, one is designed to explode on being struck by a passing vessel, and is called a *contact mine*, and the other is fired from the shore by an electric current, and is known as an *observation mine*. The explosive principally used is wet gun-cotton or Trotyl, owing not only to the safety with which they can be stored and manipulated, but also to the fact that they seldom explode in sympathy with neighbouring mines, requiring to be actually fired. The importance of this will

be more fully realised when it is remembered that in warfare it is often necessary to explode certain mines over which hostile ships are endeavouring to pass, while leaving others in fairly close proximity intact, ready to repel a second invasion or to destroy ships nearer to them. The actual explosion is caused by an electric current, either from the shore or from a battery in the mine itself, causing the detonation of fulminate of mercury in conjunction with a small priming charge of dry gun-cotton. Mines are often laid in a series, connected to a battery on the sea-bed in the centre of the line of defence.

The *observation mine* is mostly used for defending the approaches to harbours, as an observer on shore can watch the movements of hostile warships and explode each mine when the vessel passes over it. *Contact mines*, on the other hand, are used wherever an enemy's fleet is likely to pass. They are anchored to the sea-bed by means of a cable and heavy

weight, and are allowed to float a few feet below the surface. They explode immediately on contact. At times an unscrupulous or demoralised enemy will simply throw a number of these mines overboard and allow them to float at the mercy of wind and tide. They then become a terrible danger to the shipping of all nations, as once they are left unwatched it is extremely difficult to tell with any degree of certainty where they will eventually proclaim their presence by devastating explosions. Happily for the whole seafaring world, this method is seldom resorted to, as mines set adrift in this way become a danger to both friend and foe. In the Russo-Japanese war several ships were destroyed by their own mines.

There are many different kinds of submarine mines, both of the observation and the contact type. Some are spherical in shape and others cylindrical. Some are moored close down to the sea-bed with a very heavy explosive charge

(200-500 lbs. of gun-cotton), and have a small buoyant globe floating above them, which, when struck, fires the mine below. Others, known as secret-mines, are kept continually moored in the water-ways leading to important naval harbours, and are only allowed to rise sufficiently high from the sea-bed to be struck by passing vessels in times of emergency. The type most generally used is, however, the ordinary *offensive contact mine*, which contains a powerful explosive charge and is anchored in the path of hostile warships. These mines are usually automatically sown in large numbers over a wide area of sea by the mine-laying fleets.

CHAPTER XII

MINE-LAYING FLEETS

THE *regular* mine-laying fleets of the powers at war are composed of the following vessels, all of which are fitted with special apparatus for the work. Submarine mines can, however, be laid by any vessel, and it is therefore almost impossible to say exactly what ships are engaged in this work. Both Germany and Austria have converted a large number of their merchantmen into mine-layers. England, in reply, has converted a large number of small steamers into *mine-sweepers*. Russia is a strong believer in explosive mines, and has strewn the gulfs of Finland and Riga with them. Japan, being on the offensive, is employing more mine-

sweepers than layers. France has an elaborate system of submarine mine defence for all her important harbours, and maintains a small fleet at each base, known as the "defence mobile." These vessels are all capable of both mine-laying and sweeping.

The submarine mine is primarily the defence of the weaker naval power, and therefore a fleet acting on the defensive, either temporarily or permanently, requires more mine-layers than mine-sweepers, but the reverse is naturally the case with a fleet acting on the offensive. Although this may be taken as a general rule, it does not imply that a strong naval power like Great Britain, whose policy is attack and not defence, needs no mines or mine-layers. On the contrary, the laying of *counter* mines is one of the ways of destroying an enemy's mine-field; and even the strongest fleet cannot guard every portion of a long coast line with many harbours exposed

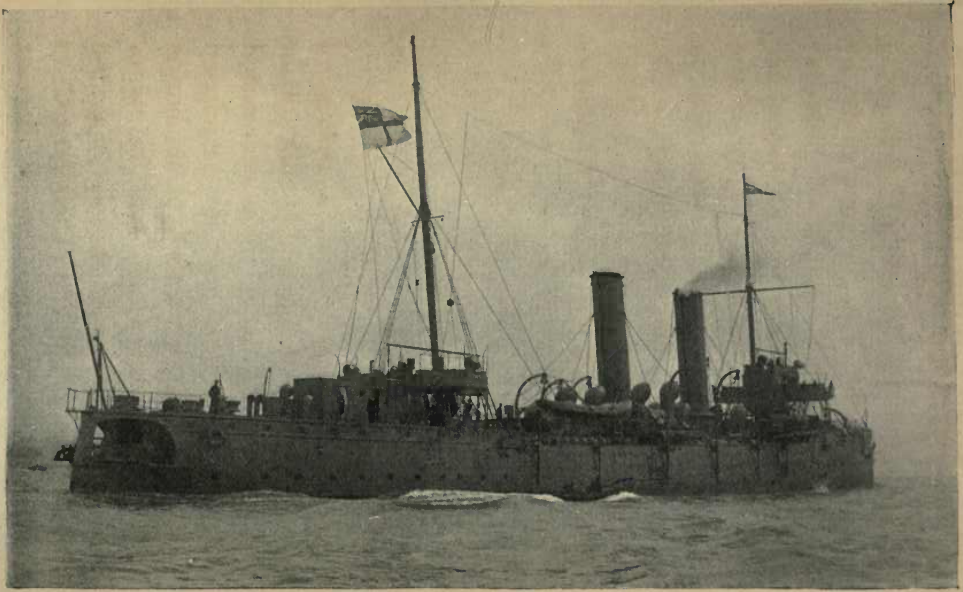
to attack. The judicious laying of mine-fields will often prevent raids by hostile submarines and torpedo-boats; and will limit the theatre of operations, as was done by the British Navy in the southern portion of the North Sea in October, 1914. The axiom that a really strong navy needs to be strong in *every* branch, therefore holds good in this, as in all other respects.

Mine-Laying Fleets.

Great Britain.

Apollo. *Thetis.* *Andromache.*
Latona. *Naiad.* *Intrepid.* *Iphigenia.*

These are all second class cruisers of from 3,400 to 3,600 tons, built about 1891-2, which have been converted into mine-layers. They are equipped with a very large number of submarine explosive mines, which can be automatically lowered into the water as the vessels steam along. Their speed is about 15 knots, and their armament consists of four 4·7-inch quick-firing



Photo, Cribb, Southsea.]

THE BRITISH MINE-LAYER H.M.S. *IPHIGENIA*.

The mine-dropping gear can be seen in the stern.

guns. Their complement is about 150 officers and men.

GERMANY.

Pelikan (1890). *Nautilus* (1906).
Albatross (1907). *Arkona* (1903).

All these vessels, with the exception of the *Arkona*, which was a protected cruiser, have been specially built for mine-laying work. Their displacement is about 2,000 tons. The *Pelikan* has a speed of 15 knots, the *Albatross* and *Nautilus* of 20 knots, and the *Arkona* of 21½ knots. They are all fitted with special gear for dropping the large number of mines carried, and their armament consists of from four to eight 21-pdr. quick-firing guns. Their complement is about 200 officers and men.

AUSTRIA.

The Austro-Hungarian Navy possesses only one regular mine-laying warship—the *Chamaleon*, which was being completed when war was declared. She is a vessel of 1,800 tons displacement,

with a speed of 20 knots. Her mine-launching gear is of the most modern and efficient type, and she is armed with several quick-firing guns.

Since the beginning of hostilities Austria has converted several old warships and merchantmen into mine-layers.

France and Russia.

Neither of these powers possess proper mine-laying vessels, but on the outbreak of war several old warships and small merchant steamers were used for that purpose.

CHAPTER XIII

MINE-SWEEPING FLEETS

For clearing away the mines dropped by an enemy special vessels are employed. Each vessel is fitted on both sides with a curious contrivance known as the "picking-up gear." This apparatus is lowered into the water, and "picks up" any mines which may lie in the path of an oncoming fleet. When a mine-field is discovered by either destroyers or seaplanes these vessels are immediately dispatched to destroy it; and they are aided, in the case of the British Navy, by a large flotilla of steam trawlers. Many of these auxiliary vessels are not fitted with the *picking-up gear*, but go to work in pairs. Two vessels, connected together by a long wire rope weighted in

the centre to keep it submerged, range themselves on each side of a mine-field, and by steaming ahead in a parallel line sweep up the mines floating between them. This process can be carried on simultaneously by a large number of trawlers, covering a very wide area of sea. In the meantime the attached destroyers and seaplanes can be searching for new fields. It often happens during sweeping operations that mines are brought into contact with each other and violent explosions occur. Sometimes the vessels engaged in this hazardous work will themselves strike one of the mines, but it is more often the *searching* flotillas which meet with sudden disaster in this way. Fully equipped mine-sweepers usually precede a fleet of battleships and big cruisers through dangerous and narrow seas, within the likely zone of hostile mines.

The British Mine-Sweeping Fleet comprises the following vessels:—*Circe* (810 tons), *Jason* (810 tons), *Speedy* (810

tons), *Leda* (810 tons), *Gossamer* (735 tons), *Seagull* (735 tons), *Skipjack* (735 tons), and *Speedwell* (735 tons).

These eight vessels are obsolete torpedo-gunboats which have been specially fitted out for the work of mine-sweeping. There is also a large flotilla of steam fishing trawlers engaged. Some of these vessels were purchased by the Admiralty before the war, and were also equipped for mine-sweeping; but many others were, by special arrangement, handed over to the Navy on the outbreak of war. The whole of the mine-sweeping fleet is manned by a special section of the Royal Naval Reserve, known as the "Trawler Section," which consists of about 142 *skippers* and 1,136 men. This is, of course, in addition to the several thousand naval sailors employed on the regular mine-sweepers, named above, and also to those employed on the large number of additional small steamers taken over for this work by the Admiralty at the commencement of hostilities. It is

estimated that the task of keeping the North Sea clear of mines during the first four weeks of the Great War required over 100 vessels and 5,000 sailors, in addition to the usual destroyer and submarine patrols with their crews, and also to the seaplanes with their pilots and observers.

Almost any steamship can be quickly converted into an effective mine-sweeper, and for this reason it is impossible to give here more than the very briefest information concerning the vessels employed in these operations by the other Naval Powers at war. Russia had fifteen special mine-sweeping vessels building when war broke out; but, doubtless, many small merchant ships have since been used for this purpose. France employed a number of mine-sweepers in the Adriatic; and Japan used some in clearing the approaches to Tsing-tau. Germany and Austria, of course, did not need many vessels of this kind, as the Allied Navies laid

comparatively few mines and German oversea commerce ceased to exist almost as soon as war was declared. It was in the North Sea, during the first phase of the naval war, that the value of a big British mine-sweeping fleet made itself so wonderfully apparent.

CHAPTER XIV

COMPARATIVE FIGHTING VALUE OF THE SUBMARINE FLEETS AT WAR

TEMPERED and tried in the forge of war the submarine has at last been lifted from the experimental stage of naval construction to the fore-front of fleets in being. For over twenty years naval experts, marine engineers and scientists have been wrestling with the vast and complex problems of submarine construction, navigation and warfare, and have, at a cost of many lives and many millions sterling, produced submersible warships of steadily increasing size and power, until to-day 264 of these vessels, of over a dozen different and more or less secret designs, with displacements ranging from 100 to 1,000 tons are in

the fighting line of the Fleets at war. Thousands of sailors have been trained to fight beneath the seas; torpedoes, guns, engines, and even the air to breath, have been adapted for submarine work. A comparison, therefore, of the strength and fighting power of the submarine fleets engaged for the first time in this great struggle for the mastery of the seas is of more than passing interest.

BRITISH NAVY.

Sea-going Vessels.

Submarines of 1,000-1,500 tons ("F" class), range 6,000 miles, speed 20/12 knots, armament 6 torpedo tubes and 2 q.-f. guns: (nearly completed)	6
Submarines of 800 tons ("E" class), range 5,000 miles, speed 16/10 knots, armament 4 torpedo tubes and 2 q.-f. guns: (in commission)	19
Submarines of 500-600 tons ("D" class), range 4,000 miles, speed 16/10 knots, armament 3 torpedo tubes and 1 q.-f. gun: (in commission)	8
Submarines of 300-400 tons ("C" class), range 1,700 miles, speed 14/9 knots, armament 2 torpedo tubes: (in commission) ...	37
Total Sea-going Submarines	70

COAST DEFENCE VESSELS.

Submarines of 300 tons ("B" class), range 1,000 miles, speed 12/8 knots, armament 2 torpedo tubes: (in commission)	10
Submarines of 200 tons ("A" class), range 350 miles, speed 11/7 knots, armament 2 torpedo tubes: (in commission)	8
Total Coast Defence Submarines	18
Total number of vessels in British Flotillas	88

It must, however, be pointed out that six vessels of the sea-going "F" class have not yet taken their place in the active flotillas; and that eight vessels of the "E" class were on duty on foreign stations when war commenced.

FRENCH NAVY.

SEA-GOING VESSELS.

Submarines of 600-1,000 tons (*Diane* class, *Bellone* class, and *Gustave Zede* class), range 4,000-5,000 miles, speed 18/10 knots, armament 4 to 6 torpedo tubes and 2 to 4 q.-f. guns: (completing)	7
Submarines of 500-600 tons (*Clorinde* class), range 3,500 miles, speed 15/9½ knots, armament 4 torpedo tubes: (in commission) ...	10

Submarines of 600-800 tons (vessels: *Mariotte*, *Archimède*, *Charles Brun*, and *Admiral Bourgeoise*), range 3,000-3,500 miles, speed 15/10 knots, armament 4 torpedo tubes: (in commission) 4

Submarines of 600 tons (*Fresnel* class), range 2,000 miles, speed 12/9 knots, armament 4 torpedo tubes: (in commission) 22

Submarines of 500-600 tons (*Pluviôse* class), range 2,500 miles, speed 12/9 knots, armament 4 torpedo tubes: (in commission) 11

Total Sea-going Submarines 54

Coast Defence Vessels.

Submarines of 450 tons (*Circe* class), range 1,000 miles, speed 11/8 knots, armament 2 torpedo tubes and 2 torpedoes in holders: (in commission) 2

Submarines of 400 tons (*Emeraude* class), range 1,000 miles, speed 12/8½ knots, armament 2 tubes and 4 holders: (in commission) 6

Submarines of 300-400 tons (*Argonaute* and *Aigrette* class), range 700 miles, speed 10/9 knots, armament 1 to 4 torpedo tubes: (in commission) 3

Total Coast Defence Submarines 11

Harbour Defence Vessels.

Submarines of 150-200 tons (*Triton* class, *Française* class, and *Lutin* class), range 100-600

miles, speed 11/8 knots, armament 3 to 4 torpedo tubes or holders: (in commission) ... 9

Submarines of 50-100 tons (*Naiade* class), range 100 miles, speed 8½/5 knots, armament 1 torpedo tube and 2 holders: (in commission) 20

Total Harbour Defence Submarines ... 29

Total number of vessels in French Flotillas 94

RUSSIAN NAVY.

Sea-going Vessels.

Submarines of 800-1,500 tons (*Tigr* class), no particulars: (completing) 12

Submarines of 500-600 tons (*Kaschalot* class), range 3,000 miles, speed 16/10 knots, armament 3 torpedo tubes and 1 q.-f. gun: (in commission) 7

Submarines of 400-500 tons (*Alligator* class), range 3,000 miles, speed 15/10 knots, armament 4 torpedo tubes: (in commission) ... 4

Submarines of 300-400 tons (*Akula* class), range 2,500 miles, speed 16/10 knots, armament 3 torpedo tubes: (in commission) 1

Submarines of 200-300 tons (*Karp* class), range 1,000 miles, speed 12/8 knots, armament 2 torpedo tubes: (in commission) 2

Submarines of 200 tons (*Makrel* class), range 800-1,000 miles, speed 10/8 knots, armament 2 torpedo tubes and 2 holders: (in commission) 2

Total Sea-going Submarines 28

COAST AND HARBOUR DEFENCE VESSELS.

Submarines of 150-200 tons (*Minoga* class, *Lossos* class, *Sig*, *Sterliad* class, *Som* class, *Ostr* class, and *Graf Cheremetieve* class), range 400-600 miles, speed 11-9 knots on surface and 6-7 knots submerged, armament 1-3 torpedo tubes and holders: (in commission) 19

Total Coast Defence Submarines 19

Total number of vessels in Russian Flotillas 47

JAPANESE NAVY.

SEA-GOING VESSELS.

Submarines of 500 tons (Nos. 16-17), range 3,500 miles, speed 18/9 knots, armament 6 torpedo tubes and holders: (completing) ... 6

Submarines of 300-400 tons (Nos. 10-15), range 1,700 miles, speed 14/9 knots, armament 2 torpedo tubes: (in commission) 6

Submarines of 300 tons (Nos. 8-9), range 1,500 miles, speed 13/8 knots, armament 2 torpedo tubes: (in commission) 2

Total Sea-going Submarines 14

COAST AND HARBOUR DEFENCE VESSELS.

Submarines of 180-200 tons (Nos. 6-7), range 800 miles, speed 10/8 knots, armament 1 torpedo tube: (in commission) 2

Submarines of 100-150 tons (Nos. 1-5), range 500 miles, speed 9/7 knots, armament 1 torpedo tube: (in commission) 5

Total Coast Defence Submarines 7

Total number of vessels in Japanese Flotillas 21

GERMAN NAVY.

Sea-going Vessels.

Submarines of 900 tons (U.25—U.30 completed, and U.31—U.37 completing), range 4,000 miles, speed 18/10 knots, armament 4 torpedo tubes and 4 q.-f. guns: (in commission and completing)... 13

Submarines of 800 tons (U.21—U.24), range 3,000 miles, speed 14/9 knots, armament 4 torpedo tubes and 3 q.-f. guns: (in commission) 4

Submarines of 400-500 tons (U.19—U.20), range 2,000 miles, speed 13½/8 knots, armament 3 torpedo tubes and 2 q.-f. guns: (in commission) 2

Submarines of 300 tons (U.9—U.18), range 1,500 miles, speed 13/8 knots, armament 3 torpedo tubes and 1 q.-f. gun: (in commission) 10

Submarines of 200-300 tons (U.2.—U.8), range 1,000 miles, speed 12/8 knots, armament 2 torpedo tubes: (in commission) 7

COAST DEFENCE VESSELS.

Submarines of 200 tons (U.1), range 700-800 miles, speed 10/7 knots, armament 1 torpedo tube: (in commission) 1

Total number of vessels in German Flotillas 37

AUSTRIAN NAVY.

SEA-GOING VESSELS.

Submarines of 800 tons (U.7—U.11), range 3,000 miles, speed 14/9 knots, armament 4 torpedo tubes and 3 q.-f. guns: (completing—delivery doubtful) 5

Submarines of 300-400 tons (U.5—U.6), range 1,500 miles, speed 12/8 knots, armament 2 torpedo tubes: (in commission) 2

Submarines of 300 tons (U.1—U.4), range 1,500 miles, speed 13/8 knots, armament 3 torpedo tubes: (in commission) 2

Submarines of 200-300 tons (U.1—U.2), range 800 miles, speed 12/8 knots, armament 3 torpedo tubes: (in commission) 2

Total number of vessels in Austrian Flotillas 6

When war commenced all the vessels of the German Flotillas (30 to 37) were

concentrated in the North Sea and Baltic. The Austrian Flotilla of six vessels was in the Adriatic. Great Britain had in home waters 74 submarines and 14 others on duty in the outer seas. France had several of the 92 vessels composing her powerful flotillas at her oversea colonial naval bases. Russia had 14 submarines in the Baltic, 11 in the Black Sea, and 12 in the Far East. The Japanese Flotilla (17) was concentrated in Japanese waters.

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