Submarines of the World's Navies

by

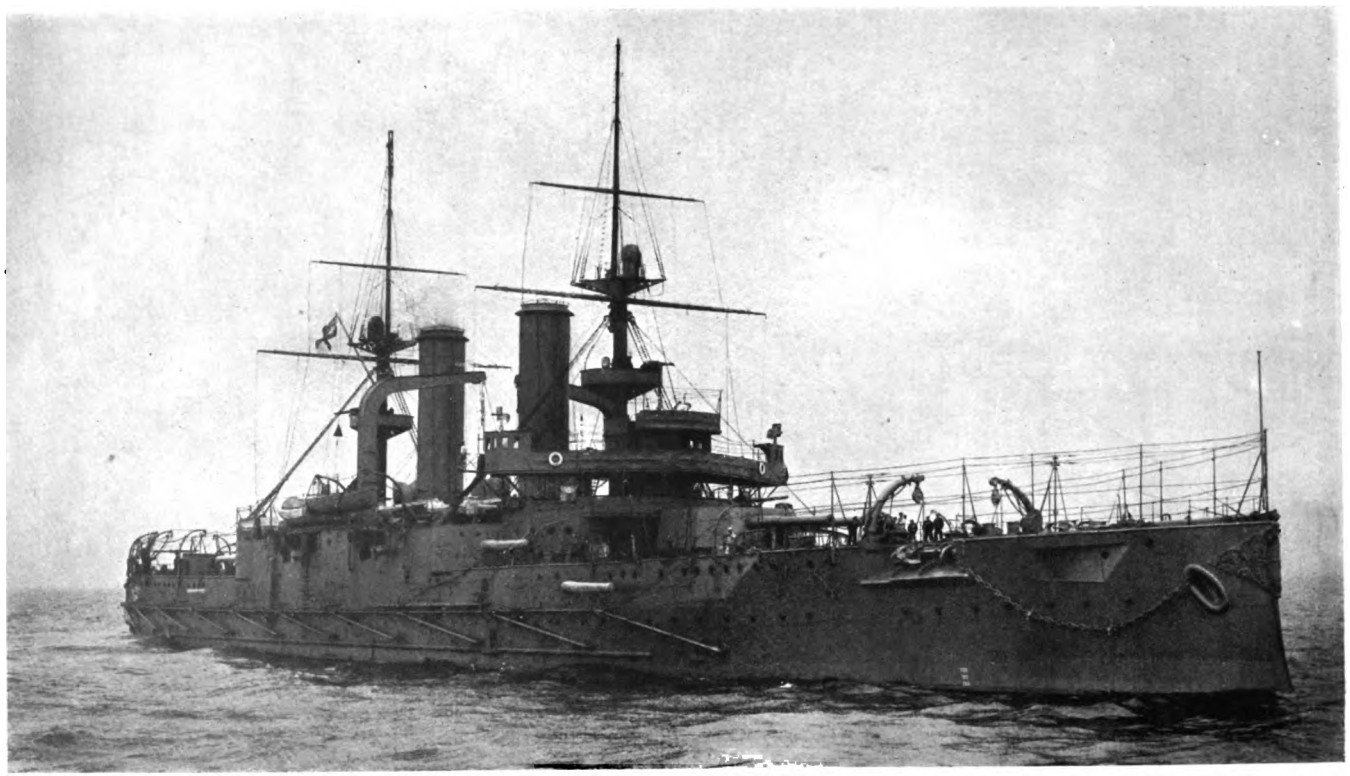
CHARLES W. DOMVILLE-FIFE

with Contributions by

ADMIRAL SIR J. O. HOPKINS, G.C.B., ADMIRAL SIR CYPRIAN BRIDGE, G.C.B.
CAPT. EDGAR LEES, R.N., LIEUT. SIR A. TREVOR DAWSON, LATE R.N.
MONSIEUR I. BERTIN, LATE CHIEF CONSTRUCTOR FRENCH NAVY, ETC.

Illustrated

Philadelphia :
J. B. LIPPINCOTT COMPANY.
London : FRANCIS GRIFFITHS.
1911



"The Prey of the Submarine."
(H.M.S. "Triumph.")

Frontispiece.

NOTE

In the compilation of this work on the Submarine Branch of the Naval Services, I have had occasion to obtain the advice and assistance of many British and foreign naval officers, and constructors, to whom I now tender my acknowledgements for their valuable aid.

I wish specially to thank Admiral Sir J. O. Hopkins, G.C.B., Admiral Sir Cyprian A. G. Bridge, G.C.B., Rear-Admiral Charles Windham, C.V.O.; Captain Edgar Lees, R.N. (late Inspecting Captain of Submarines); Lieut. Sir A. Trevor Dawson,, R.N., of Messrs. Vickers, Sons and Maxim; Monsieur I. Bertin, late Chief Constructor of the French Navy; and the Council of the Institute of Mechanical Engineers, for whose valuable services I feel deeply grateful.

I have received much help from many of the large Shipbuilding and Engineering Firms, of Great Britain, France, Germany, and the United States; and I wish specially to thank the following:—Messrs. Vickers, Sons and Maxim; The Whitehead Torpedo Co., Ltd., Weymouth; Messrs. John I. Thornycroft, The Parsons Marine Steam Turbine Co., Messrs. Siebe Gorman and Co., and Messrs. Yarrow and Co.

I have also cordially to thank the various Naval and Technical Journals of Europe and America.

C. W. D.-F.

PREFACE

THE Submarine has opened up a new era in naval construction, and it is not a very easy matter to get, or give, an unbiased opinion as to the part this comparatively new weapon will play in future naval warfare; but from the fact that all the great Naval Powers are quickly adding to their already powerful Submarine Torpedo Boat Flotillas, and that millions are being spent each year on the building of these "Daylight T.B.'s," it is quite safe to assume that in the next great naval war, submarines will play no small part.

It has been said that the adding of submarine flotillas to the world's navies, was but the pandering of the various Admiralties and Naval Ministeries to the clamour of the public, through the press; which was accentuated by a Foreign Countries' adoption of these so called, "handicapped torpedo-boats."

> **You, you, that have the ordering of her fleet**
> **If you should only compass her disgrace,**
> **When all men starve, the wild mob's million feet**
> **Will kick you from your place,**
> **But then too late, too late.**
>
> ***Lord Tennyson.***

The acquisition of a new arm, or type of ship, by any nation must necessarily be more or less an experiment; and whatever the result of the first trials, no blame, only praise for their enterprise, can be attached to the authorities who have the ordering of the fleet;—but, with the result of these experiments to-hand, the further spending of public money for what has been depreciatingly termed "useless weapons" is a grave matter; and one of which no Admiralty would be guilty.

Nations trust the designing of Battleships, Cruisers, and other types of warships to the hands of their Naval Leaders with every confidence,—then why not the submarine? now that many millions have been spent on this type of craft, and hundreds of officers, and thousands of seamen, have been taught by practice and experience* how to handle them. The only feasible conclusion is that the submarine, in the

* The most important consideration in submarine warfare.

next great naval war, will justify the high expectations of the Naval Officers and Experts, who have been instrumental in the addition of submarine flotillas to the fleets of the world.

In the description of the submarine torpedo-boats, of the various Naval Powers, it has been the object to point out the differences of the vessels, types, and classes; with the purpose of showing their fighting value and efficiency, and of giving an idea of their construction, without occupying undue space, or wearying the non-technical mind with the description of details which are common, in one form or another, to every submarine boat.

"The Division into Flotillas" has been done with the idea of showing how the coast-lines of the different countries are defended by submarine torpedo-boats; and of showing also the "depôts," number of vessels, and radii of action of the different types; including those of the sea-going class.

It has been my object to point out the method of, and time required for constructing submarines, the practice and efficiency of the submarine crews, of the different navies; also to point out the spheres of activity and climatic conditions under which the boats would operate in time of war.

In this section are also given the results of some of the most important trials, such as those of the "C" and "B" class British boats, the modern United States Submarine "Octopus," the comparative trials between a French submarine and submersible, and others; some of which are illustrated by exclusive photographs, reproduced by special permission.

The 'tables' giving particulars of every naval submarine afloat, or on order, while to some extent a repetition of the description of the different vessels, have been compiled for quick reference. The large displacement, and heavy armament of some vessels, give them, in certain cases, a deceptive appearance of fighting value. To counteract this tendency, notes, giving the efficiency, results of trials, etc., have been added to the end of the tables.

Part II. dealing with submarine warfare, has been added with the idea of showing "The Tactical Value of the Daylight Torpedo Boat." This part also discusses methods of submarine attack and defence; defence against submarines; guns to repel submarine-boat attack, plans for the defence of a harbour by submarines. A diagram showing the right-angle attack is added, and the speed difficulty considered.

Submarine construction has also been briefly treated in Part II. Skeleton plans have also been incorporated with the idea of showing the

position of the various mechanisms, the direction of the torpedo-tubes, and the general design and shape of the vessel. Here again I have to thank the many officers who have been kind enough to help me.

The contributors to Part III. are far too well known to need any comment; and I can only thank them for their valuable and interesting articles.

Charles W. Domville-Fife.

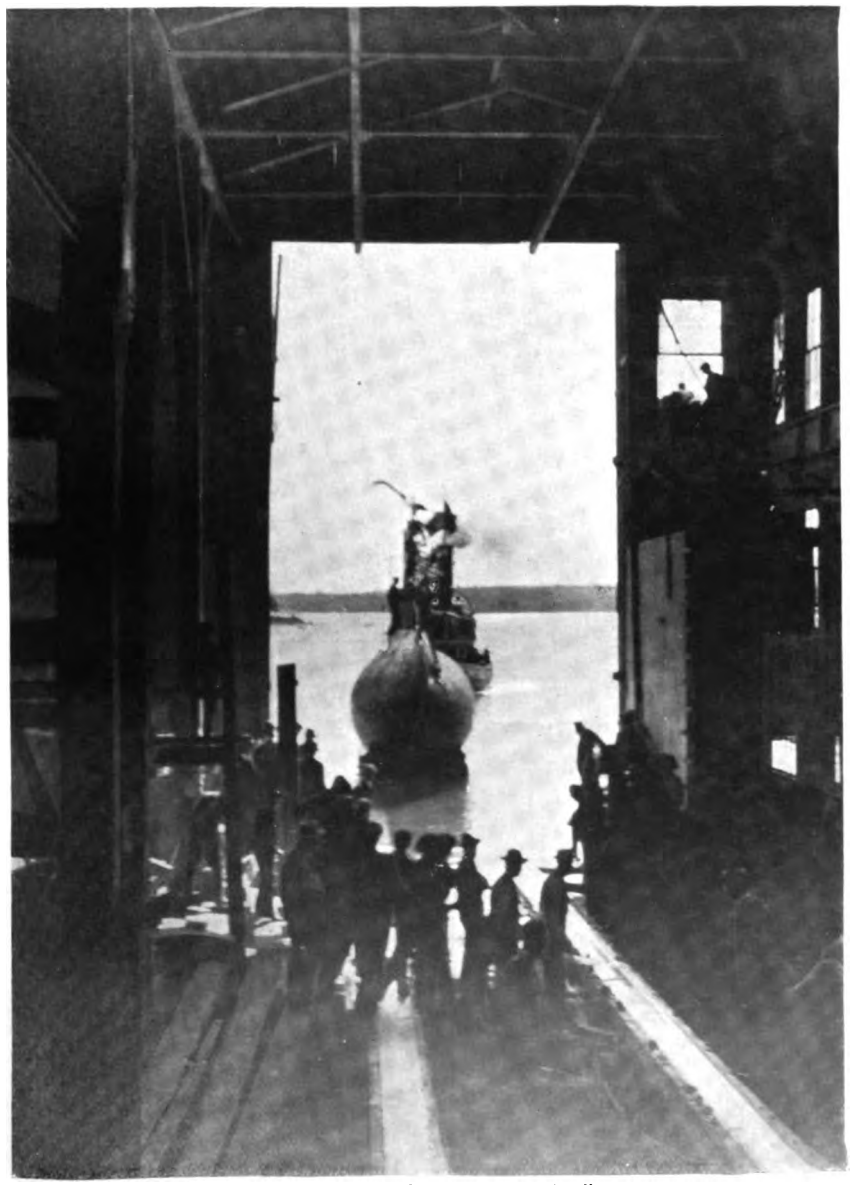
London.

CONTENTS

Part II.

Part III.

LIST OF ILLUSTRATIONS

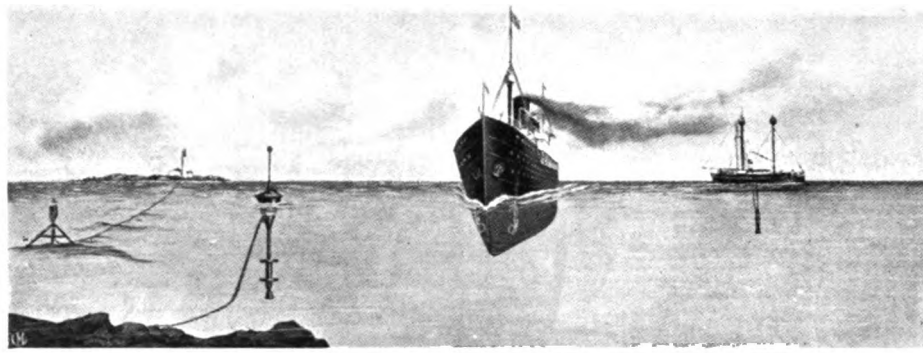


Launch of the U.S.S. "Cuttlefish."

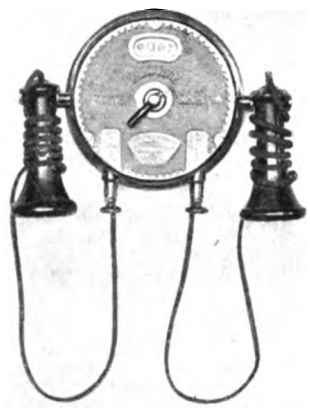
To face page 14.

PART I

Contents of Part I.

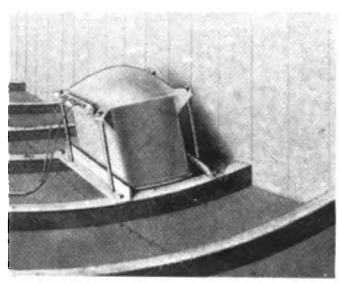


Shore Station Bell Buoy. Receiving Apparatus Lightship Bell
Types of Submarine Signals.



Ear Pieces.

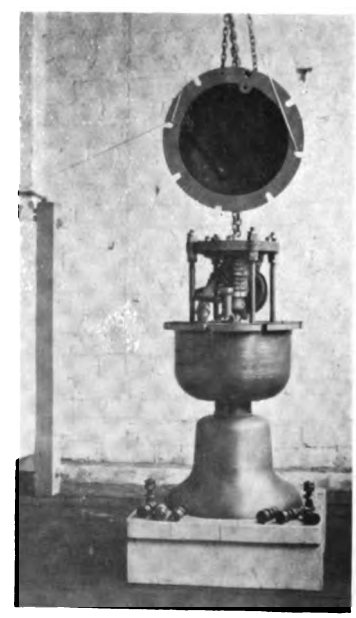
Receiving Signals in the Pilot House.



Transmitter in fore hold of ship.

Lightship Submarine Signal Bell.

By permission of the Submarine Signal Co



Mechanism of a Bell as fitted in Submarine.

To face page 19

BRITISH SUBMARINE FLOTILLAS.

ENGLAND will possess more than sixty submarine torpedo-boats, when those named in the Naval Programme for 1909-10 are built. Unlike the submarines of other nations, the British boats are numbered and classed—not named.

The first submarine torpedo-boat built for this country was launched in 1901; and was designated the "No. 1."

This vessel was built from the designs of Mr. J. P. Holland, of Paterson, New Jersey; and was one of the most successful boats afloat, at that date.

All the British submarines have, up to last year, been built by Messrs. Vickers, Sons and Maxim, at their Naval Construction Works, Barrow-in-Furness. The small dimensions of the first five boats, and the steady growth in size, engine-power, and efficiency, speak well for the strenuous efforts of the constructors to produce submarines worthy of the First Naval Power.

The first British submarines (Nos. 1—5) have a length over all of 63 feet, a beam of 11 ft. 9 ins., and a displacement, when totally submerged, of 120 tons.

They are propelled, when on the surface, by petrol engines with four single acting cylinders, which are water-jacketed; and develop a maximum B.H.P. of 190 at 300 revolutions per minute.

These engines, as well as the electric motors, which are used for propulsion when submerged, are situated below the propeller shafts, which are in the centre of the boats. The engines are connected to the shafts by gearing.

Enough petrol is carried to enable these small craft to travel 400 miles at a speed of 8 knots. They are fitted with a single propeller, with four blades; and attained a maximum speed of 8.5 knots on their trial trip.

These boats are constructed of 7-20 in. steel plates, with frames 18 in. apart; and can safely stand the pressure of water at a depth of 150 feet.

These first five submarines were not "purely experimental" as has been so often stated, for the Admiralty knew the capabilities of this type of craft when ordering these boats; having closely watched the experi-

ments carried out by the United States Government, with the submarine torpedo-boat "Holland," which was the prototype of the first British boats.

The British Admiralty also knew the capabilities and also the incapabilities of all other types of submarines, and it was for this reason that five all of one type were ordered for the Navy.

It is true that a great deal of experimenting was necessary not only to determine the utility of submarines as part of England's Naval Defence; but also with a view to learning by practical experience the eccentricities of subaqueous craft, and deciding on the improvements which could be added in future editions. The following, which appeared in the Naval Estimates for 1901-2 was practically the first official notification that England was to possess a submarine torpedo-boat flotilla:—

"Five submarine vessels of the type invented by Mr. Holland have been ordered, the first of which should be delivered next Autumn."

These were the vessels Nos. 1—5; and in eight years England has constructed a submarine flotilla, *facile princeps*, when compared with that of any other Naval Power.

The four boats, A1—A4, launched during 1903 have an increased length of 37 feet, making their length over all 100 feet.

The beam of these vessels is only 10 feet, against the 11 ft. 9in. of the former boats—thus making the A 1, 2, 3, and 4, much longer and slimmer. The displacement when submerged grew from 120, to 200 tons; and with a B.H.P. of 600, the speed increased from 8 to 11.5 knots on the surface.

All the British submarines have been built from the original designs of Mr. J. P. Holland, but the immense improvements made by the Submarine Branch of the Naval Construction Department, and the numerous practical suggestions of three expert submarine officers in command of the British Submarine Flotilla—have caused the construction of these delicate little vessels to be so altered that they are entirely different from the original designs; and the latest boats are far superior to any other submarines afloat.

The boats constructed during 1904 (A5—A13) are fitted with 16 cylinder horizontal petrol engines, for propulsion on the surface, and electric motors for use when submerged. The petrol engines are of the Vickers make.

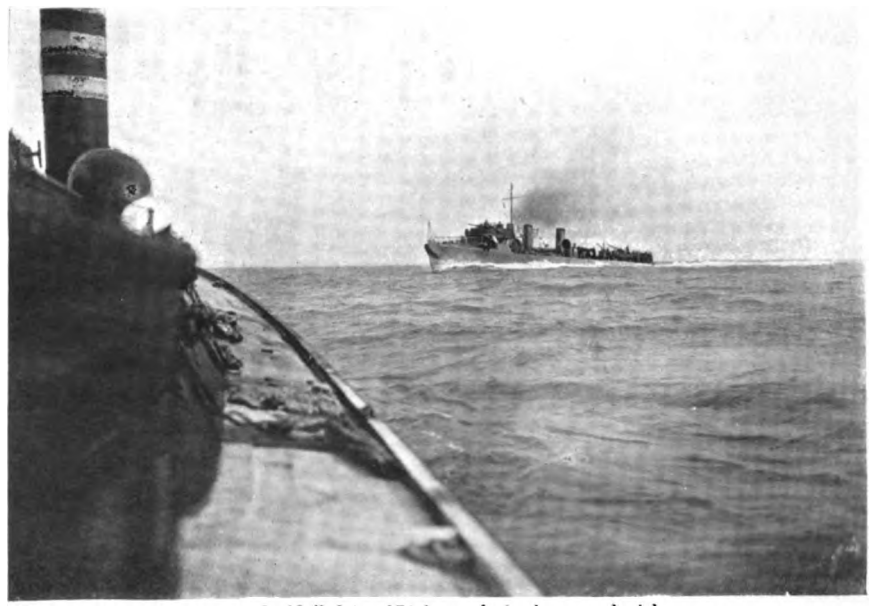
The "A" class are fitted with high conning-towers and short periscopes; which in all British submarines are operated by electricity.

The "B" class—the first of which was launched in 1905—have an

H.M. 1st Class Torpedo Boat No. 6 (Gadfly.)

The first Turbine Torpedo Boat to be ordered by the Admiralty. Length, 168ft. Beam, 17ft. 6in. Draft 6ft. I.H.P. 2500. Speed 27¼ knots.

By permission of Messrs. Thorneycroft.



The "Gadfly" doing 27½ knots during her speed trials.

By permission of Messrs. Thorneycroft.

To face page 21.

increased length of 35 feet, making their total length over all 135 feet. They may be termed the first British sea-going submarines.

The petrol-engine power of these boats is 600; an increase of 400 H.P. over the first British boats.

Although the surface buoyancy of the "B's" is greatly in excess of that of the "A" class, their ability to submerge quickly is in no way impaired —in fact they take less time to accomplish this manœuvre than their sister "A's."

Their radius of action is 1,400 miles, compared with 500 in the case of the former vessels. They also carry one more torpedo. Many are the improvements of the "B" class over the former "A's"; but it would not be wise to give any further particulars, as the policy of the Admiralty is "strict secrecy"; and this wise precaution against foreign nations benefitting from the experience and practice of Great Britain is rigidly enforced.

It is, therefore, sufficient to say that all the improvements suggested by the accidents to vessels of the "A" class, have been embodied in the "B" type. Their conning-tower hatches open side-ways instead of "athwart ships," as in the "A" boats. This prevents the cap from becoming jammed, or forced open by an inrush of water; on the contrary, the tendency would be for the hatch to be closed by any sudden inrush of water through the "mouth" of the conning-tower.

The "B's" proved themselves remarkably good sea-boats. They have travelled many thousands of miles under water since they have been in commission, and no serious trouble has been experienced with them.

The tests carried out with the different classes of British submarines have been very exhaustive. The efficiency of both boats, and crews, is far in advance of that of any other nation*; and whatever may be said to the contrary they are now very efficient weapons of warfare.

An important experiment, worthy of note, was carried out on board one of the "A" type of submarines, with a new substance called "Oxylithe." This chemical production absorbs the carbonic-acid gas of respired air, and at the same time gives off the requisite amount of oxygen to make the air suitable for breathing.

An invention of an oxylithe and petrol engine is now under the consideration of the Admiralty.

In this engine the oxylithe is used to purify the exhaust by absorbing the products of combustion, and restoring the oxygen. By enclosing the

* The Author has had experience abroad as well as in England.

whole in a gas-tight case, the powerful petrol engines now in use for surface propulsion (600 H.P. in latest afloat) are rendered suitable for use, both on the surface, and when submerged.

If this invention really does all that is claimed for it, the radius of action and the submerged speed of submarines would be greatly increased.

This engine has been experimented with by the French and Italian naval authorities; but it is extremely doubtful if it has been adopted.

It is inopportune to say anything further about this invention—either for or against. The question of its adoption—or not—can be safely left to that company of experts, who have made the British Navy, both for economy and efficiency, the pattern of the world—The Admiralty.

Among the many good qualities of the British submarines is their excellent diving ability. It takes but the short space of 3 minutes to submerge them totally when travelling with full buoyancy; in which condition the latest "C" type can travel for over 1,500 miles.

These latest boats are fitted with 16 cylinder horizontal petrol engines of the Vickers pattern, and develop 750 H.P.

The petrol is stored in such a way as to make it impossible for it to mix with the air in the boat, and cause an explosion; as was the case in the A5 off Queenstown. The only danger possible is leakage of petrol through joints, when the vessel is submerged, in which case the sparking of the motor might cause an explosion; but the likelihood of the danger has not been overlooked, for in the latest "C" type the electric motors are of a special design which enables oil of a very high flash point to be used for lubrication, thus preventing the motor from sparking.

Cages containing white mice are also fixed to the roof of the submarines. These vermin can quickly detect any escape of carbon monoxide; and would give warning some time before the leakage became apparent to the crew.

The electric-storage batteries supplying the current for the motors, which are used for propulsion when submerged, are encased in air-tight chambers.

The latest vessels of the "C" class attained a maximum surface speed of 13 knots and 9 knots when submerged.

Their armament consists of two torpedo expulsion tubes, formed at the bows. Four 18in. Whitehead torpedoes are carried; and they are moved into the tubes by a special automatic device.

The conning-tower, through which the crew enter or leave the boat, is 40 inches in diameter, and is constructed of 4in. armour-plate. Two hatches are fitted, one at the base of the tower, for use in case of emergency.*

An automatic apparatus is fitted in these latest boats, to regulate the angle of diving or rising to the surface. A crusher-guage is also fitted which prevents the vessel's submergence to depths where the pressure of water would be more than the "walls" of the submarine could stand. This appliance is, however, hardly necessary, considering that the water round the British Isles seldom exceeds 200 feet in depth.

The "C" boats are fitted with two périscopes instead of one. The reason for this is because the range of vision of this instrument is barely 60 degrees, and thus (as was supposed to have been the case in the accident to the A1) it is impossible for the officer in command of the submarine to keep constantly in view a certain portion of the surface when the vessel is submerged. The two périscopes obviate this difficulty; and had the A1 been fitted with the two instruments it is highly probable the disaster would have been averted.

Special means have lately been provided in most of the British submarines for enabling the crew to open the hatch of the conning-tower under all conditions; even if the submarine was struck and holed in the conning-tower, as in the disaster to the A1. It would be possible for a hatch to be opened in the space of a few seconds; and the crew would then be able, by means of a special submarine escape dress, to come to the surface.

The surface buoyancy of the boats of the "B" and "C" classes is greatly in excess of that of the former "A's," and they are sea-going submarines specially designed for offensive action.

The latest submarine built for the British Navy is designated the "D1." She is longer, of greater displacement, and more efficient than any other submarine in the Naval Service; and embodies features far in advance of any other submarine afloat.

At the present time it would be very unwise to give any further particulars than those in the tables; but it is sufficient to say that she has been built "under cover," and that the utmost secrecy surrounds her.

I can safely say that her 1,200 horse power engines will give her a surface speed of 15 knots, and that her armament will be greatly in excess of that of any other submarine. She will be capable of keeping the sea

* See page 189 for cause of disaster to "A1."

in any weather in which small craft can be reasonably expected to do so.

The "D1" will be an "eye-opener" to foreign powers, who for their own ends talk discouragingly of English submarines; and will afford them not only a surprise, but an example of the advanced state of submarine boat construction in Great Britain; and will show them that in this branch, as in all other branches of the Navy, England intends to maintain her supremacy.

BRITISH SUBMARINE FLOTILLAS

(Map Reference, etc.)

The four dotted circles (A) off Portsmouth, Devonport, Sheerness, and Dover, indicate the submerged radius of British submarines.

The distance from the submarine depôts in the harbour, to the extremity of the circles, is approximately 30 miles. This journey can be accomplished by all British submarines in a totally submerged condition. In most instances, however, it would not be necessary for a submarine to submerge completely until the enemy was sighted in the far distance.

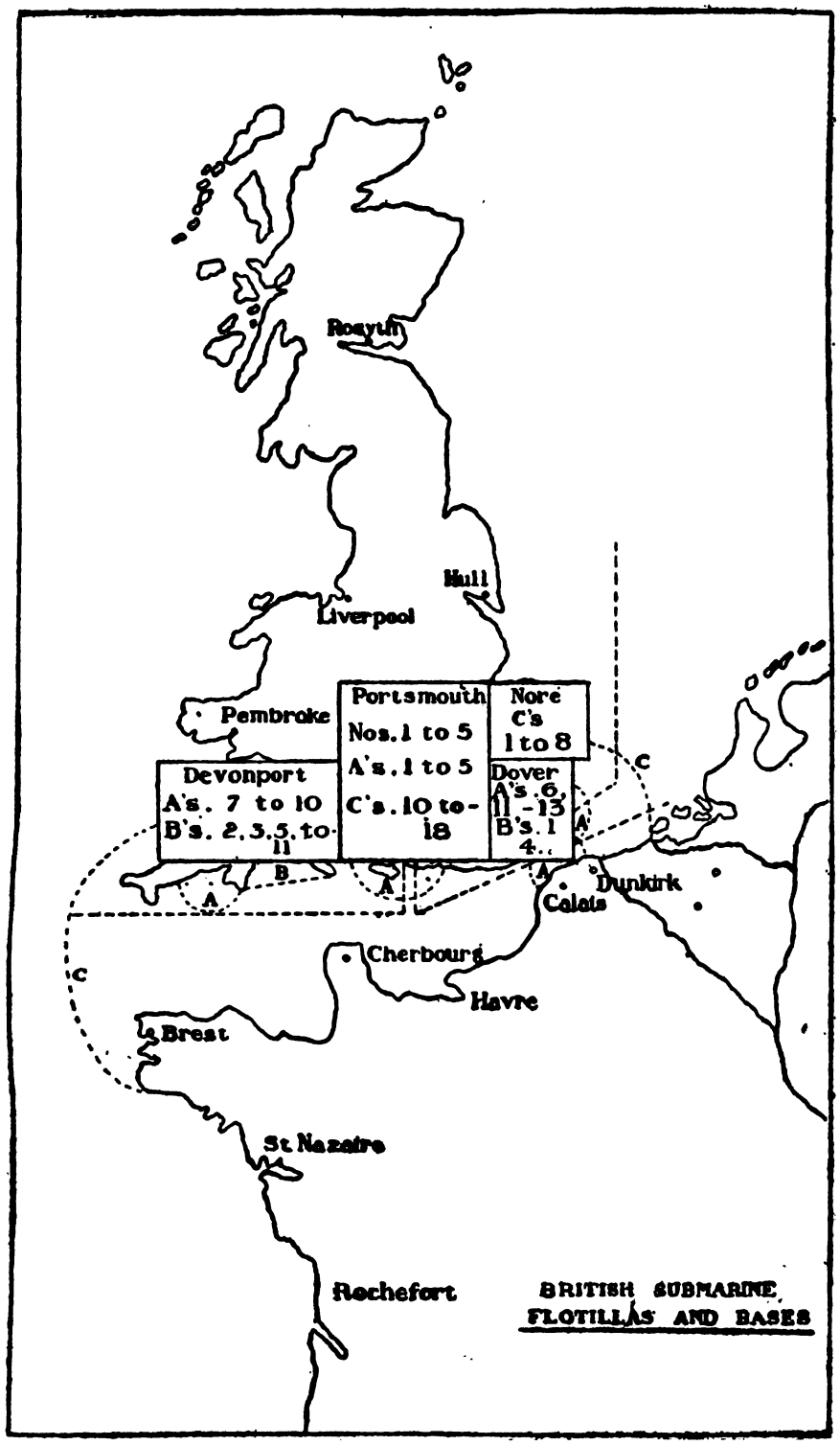
When defending Portsmouth, during manœuvres, the submarines usually lie just inside these dotted circles.

The endurance submerged of the "A" class is about 6 hours; and of the "B" and "C" classes 10 hours.

The two dotted lines (B)— one running past the east coast of the Isle of Wight (Sandown Bay), and the other from Portland to the "Start"— show the usual practice ground of the submarines of the Portsmouth and Devonport Flotillas. Great care should be taken by captains of surface vessels when navigating inside this area.

The dotted lines (C), from Cornwall to the French north-west coast, near Brest, and from Orfordness over to Flushing (Holland), represent the limits of the independent surface radius of all the British submarine torpedo-boats, except the latest vessels of the "C" class. Anywhere in the English Channel between these two dotted lines can be reached by the submarine flotillas independent of a Depôt ship, or surface warship. If the British map is compared with the one illustrating the radii of action of the French boats, the great superiority of the British submarines, when operating in flotillas, will be seen at once.

Some of the latest French boats are undoubtedly equal in every way to those of Great Britain; but there are many of the older boats, which have so small a sphere of activity that they are practically useless, except for harbour defence in the event of a close blockade. Even then their



A Submarine Base has now been established at Dundee. where 12 vessels of the "C" class are stationed—Thus the entire coast from the Orkneys to Land's End is protected by Submarine torpedo-boats.

fighting value is very doubtful; whereas all the British boats, (with the exception of the first five, which were more or less, experimental) have been built for offensive action, and they can now manœuvre together with the same automatic regularity as Destroyer Flotillas, Cruiser Squadrons, or Fleets. The straight dotted lines (D) represent the "C" class of the Portsmouth, Devonport, Dundee, and Sheerness flotillas. These vessels are perfectly equipped, sea-going submarines of great fighting value; being able to take part in actions fought within 1,000 miles of any naval base—or in other words, to take part in ocean warfare.

The following is the future composition of the British Submarine flotillas (under Submarine redistribution scheme).

PORTSMOUTH FLOTILLA.

Depôt, Haslar Creek. Living-quarters for Officers and Crew, Blockhouse Fort. Depôt Ship—H.M.S. "Bonadventure."

Flotilla under Home Fleet. (Sea going).		Flotilla at Home Ports.	
C10, C12, C13, C14, C15, C16, C17, C18.		Nos. 1, 2, 3, 4, 5. A's 1, 2, 3, 4, 5.	
		Total to 1910 ...	18

The "D1" is stationed at Portsmouth for experimental purposes.

DEVONPORT FLOTILLA.

Depôt Ships and Living-quarters for Submarine Crews, H.M.S. "Forth" and H.M.S. "Onyx."

Flotilla under Home Fleet (Sea going).		Flotilla at Home Ports.	
B2, B3, B5, B6, B7, B8, B9, B10. B11.		A7, A8, A9, A10.	
		Total to 1910 ...	18

DUNDEE FLOTILLA.

Depôt Ship - - - H.M.S. "Vulcan."

Flotilla under Home Fleet (Sea going). C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30		
Total to 1910		12

HARWICH FLOTILLA.

(NORE FLOTILLA).

Depôt Ship and Living-quarters for Submarine Crews, H.M.S. "Thames."

Flotilla under Home Fleet. (Sea going). C1, C2, C3, C4, C5, C6, C7, C8, C9.			
		Total to 1910 ...	9

DOVER FLOTILLA.

Depôt Ship and Living-quarters for Submarine Crews H.M.S. "Mercury."

B1, B4. A6, A11, A12, A13, C31, C32, C33, C34, C35, C36, C37, C 38.			
		Total to 1910 ...	14

Portsmouth, Devonport, Dundee, Harwich, and Dover are at present the only submarine depôts; but other bases are under consideration, these are Portland, Pembroke, and Rosyth. The Portsmouth Depôt is a first class harbour, and base for submarines, situated in Haslar Creek, which runs out of Portsmouth Harbour on the west side, near the entrance, and behind Blockhouse Fort, in which living quarters are found for the officers and crew of the submarine flotilla.

Nine large subterannean petrol storage tanks have been constructed,

for holding a large reserve of petrol for the submarines. Workshops for small repairs, and other necessities of a submarine base have been built. A large floating dock, 250 feet long and 50 feet broad, is also stationed at this depôt. This dock, which was built by Messrs. Vickers, Sons and Maxim, is capable of lifting a vessel of 1,000 tons. Another similar dock is under construction at Barrow; and when completed will be sent to Devonport.

No submarine crews in the world are more efficient in submarine navigation than those of the British Navy. For whereas the personnel of many foreign submarine flotillas are constantly engaged in testing some new apparatus, or in carrying out experiments with a view to overcoming some minor difficulty, the British crews are continually engaged in manoeuvres with complete vessels; under the conditions that would obtain in war. The experimenting, testing, etc., is mostly carried out by a special crew from the construction works. Thus, directly the submarine enters one of the five bases, her experimental stage is practically past; and except for a few minor trials the naval crew have their whole time to practice for war.

Again, the manoeuvres carried out by Foreign submarine flotillas are different from those carried out by the submarines of this country. For example—The French "flotille de sous-marines" usually attacks a stationary enemy, or one travelling at reduced speed. The British submersibles always "find" and attack an enemy moving at full speed.

It is useless to practice an attack on a stationary foe; for in time of war a hostile fleet would not remain at anchor when exposed to an attack by submarines.

An element of danger attending submarine navigation in vessels of the "diving type" like those of the British flotilla, has been removed by the order that surface runs should not be made in the true awash-trim condition, but that these runs should be carried out at a 'trim' at which the petrol engine could be safely used. The danger of the awash run has long been recognized and pointed out by experts; and travelling on the surface in the true awash-trim condition has seldom been practised in the British boats.

New regulations have been issued regarding the service of submarine crews. Men will only be retained in this branch for five years; they will then be sent back, to serve for two years in the general service before being allowed to re-enter the submarine branch.

Launch of H.M.S. "Triumph," showing the unprotected area of a Battleship's Hull, below the water line.

To face page 28

This is as it should be, for service in submarines is trying work, both physically and mentally. The two years afloat in the ordinary service will not only enable the men to recoup, but will keep up their knowledge of general naval matters.

The building of submarines for the French Navy dates back to the launch of the "Gymnôte" in 1888—21 years ago. In England since the launch of the "No. 1" in 1901—8 years.

France,—England's rival for submarine supremacy—during 21 years of experimenting and construction has built 51 submarines; and England during 8 years, has built, and has in commission, no less than 60 submarines, a flotilla *facile princeps* if compared with the flotilla of France; for 70 per cent. of the French boats are, owing to their small dimensions, power, and radii of action, strictly limited to coast and harbour defence.

All the British submarines have been built for offensive action, and would be capable of taking part in an engagement fought some 200 miles from a naval base; for the policy of the British Fleet is not defence, but attack.* The sea-going submarine, as has been the case with all other units of the British Fleet, will gradually increase in displacement and power, until its sphere of activity far exceeds the present limits.

Why has England been able to build a submarine flotilla in 8 years, equal to that which France has taken 21 years to construct?

This is a question that many people will ask; and the answer is that Englands builds a submarine in 18 months, whereas France takes three years.

In France state engineers design the boats, different private firms construct the interior mechanisms; and the State Dockyards construct the hull and fit together the whole submarine. This triple alliance necessarily causes great delay; and then, again, the long period required to build a French submarine, causes many of the small interior fittings to become obsolete before the vessel is launched, and new ones have then to be fitted, either by the crew after the boat has been commissioned, or else at the State Dockyards. This is one of the reasons why the French crews are constantly engaged in testing some new apparatus; and by so doing, neglecting their real office, that of men to fight the submarines—not to build them.

The organization, and concentration of energy exercised in the construction of the British submarines, is the main reason why England has done in half-a-dozen years, what France has taken a score to accomplish.

*As pointed out by Captain R. H. S. Bacon, D.S.O., in a paper before the Institution of Naval Architects.

FRENCH SUBMARINE FLOTILLAS.

"I would rather command a flotilla of one hundred Submarines than a large fleet of Battleships."—*Contre-Amiral F. E. Fournier.*

FRANCE possesses nearly as many submarines as England. The flotilla of the French navy totals 51 vessels built; and 48 building, or ordered to be laid down; and is, next to ours, the largest fleet of under-water fighting ships in the world. The French submarine flotillas are composed of three different types of vessels. These are as follows:—

(1) Submarines Defensive.
(2) Submarines Offensive.
(3) Submersibles.

Each of these types is intended, in the event of war, to play a different part.

The submarine torpedo-boats of the defensive class are intended, as their name implies, solely for coast and harbour defence. These boats are incapable of action independent of a naval base; as they are fitted only with electric power for propulsion, both on the surface and when submerged; and have no heat engines, or other means of re-charging their batteries.

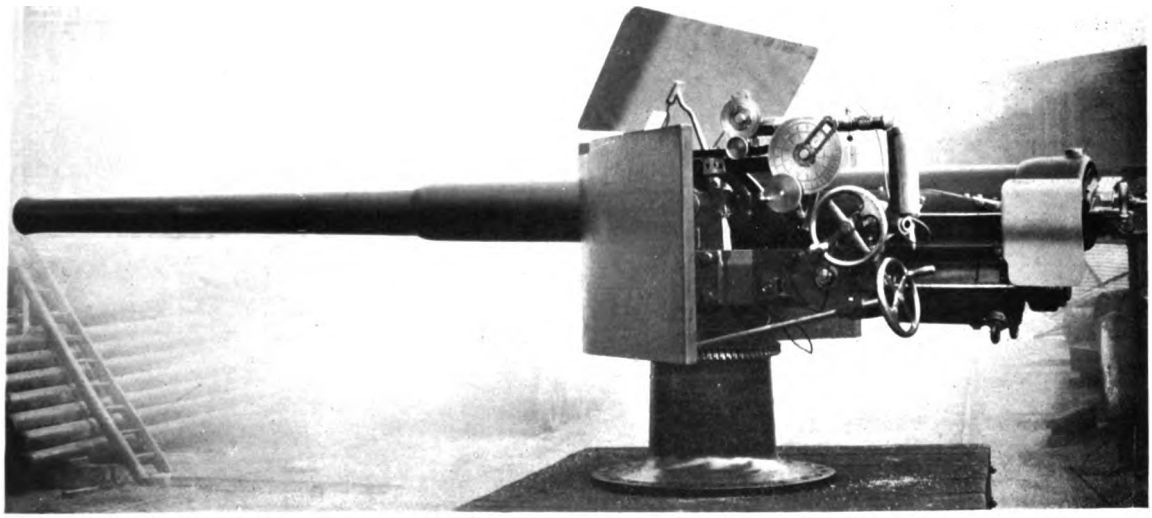
Their radius of action is very small; and their cruising qualities at sea are, therefore, unimportant. Their speed in very few cases exceeds eight knots on the surface or awash; and their fighting value is very small.

SUBMARINES OFFENSIVE.

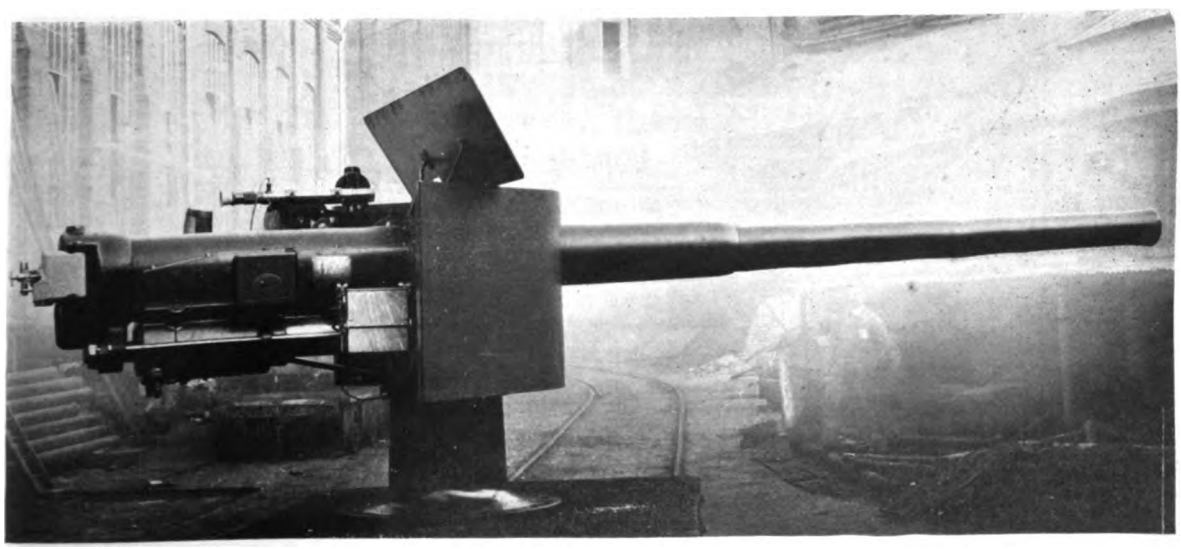
The submarines of the offensive type, are the latest, and most efficient vessels; and they differ very little from the boats of the submersible class.

"Les sous-marines offensives" are fitted with either steam or oil engines for propulsion on the surface, and electric motors for use when submerged. These vessels are able, with their heat engines, to re-charge the electric storage batteries when running on the surface, and are thus capable of acting independently of a base.

The latest boats of this type have a radius of action of 2,000 miles; are longer, have more surface buoyancy, and are fitted with flying-bridges, or super-structures, for comfort when cruising on the surface, or in an



4-in Quick-Firing Gun, showing breech, etc., the weapon recommended by Messrs. Vickers, Sons & Maxim, Ltd., for repelling Submarine and Torpedo Boat attacks.



General View—4 in. Q.F. Gun.

To face page 30

awash condition. Their speed is also increased, being in most cases 12 knots above, and eight and a half knots below. The submarines offensive would, in time of war, be let loose to harass the mercantile marine of the enemy; as well as for the purpose of attacking the hostile fleets, when operating within their sphere of actvity.

SUBMERSIBLES.

The submersible type of vessel is the most important, having by far the greatest fighting value.

"Les torpilleurs autonome submersibles" are capable of acting as ordinary torpedo-boats on the surface, and of navigating like submarines when submerged. These boats are all fitted with heat engines for use above water, and for re-charging the batteries; and with electric motors for propulsion below. They have much greater buoyancy in the "light-condition," (ballast tanks empty) and are capable of taking part in actions fought a long distance from a naval base. They may be termed sea-going submarines.

The latest boats of this type, now in commission, have a radius of action of 2,000 miles; and those on order are designed to enable them to perform a journey of 2,500 miles, at a speed of 12 knots.

It is advisable to mention here that the submarines of the British and many other navies, are really vessels of the submersible type, as they are fitted with heat, as well as electric engines; and their surface buoyancy is greatly in excess of French submarines and slightly less than that of the submersibles. The latest acquisitions to this branch of the British Navy have a wider sphere of activity.

SUBMARINES (FRENCH).

To France, belongs the honour of being the first Naval Power to adopt the submarine torpedo-boat as a vessel of war. The original pioneers of submarine navigation in France were Captain Burgeoise, and Engineer Brun. The latter gentleman constructed the 'Plongeur,' which was launched in 1863. It was not until 1888, however, that the first French naval submarine was launched. This vessel was named the 'Gymnote,' and was designed by M. Dupuy de Lome; who unfortunately died before his plans were quite completed; but his more than half finished designs were taken in hand by his friend, M. Gustave Zédé, a retired naval engineer.

This clever designer added many improvements to the original

design; and some years later offered the completed plans to the Minister of Marine, Admiral Aube—the father of French submarines.

M. Zédé's plans were accepted; and France, by this move, opened a new era in naval construction.

The Gymnote was launched in 1888, and has the following dimensions:—Length 56 ft. 6 in., Beam 6 ft., Displacement 30 tons.

This vessel, after being put through very exhaustive trials, was placed aside as an experimental boat; and she is now used as a training ship, for officers and crew of the French Navy, who volunteer for service in the submarine flotillas.

The next vessel to be ordered bythe French Government was the now famous Gustave Zédé, which was launched at Toulon in 1893. At first this vessel, which was designed by Engineer Ramazotti, proved very unsatisfactory, and met with many mishaps; but some years later, owing to certain drastic changes, the Gustave Zédé turned out a brilliant success, and is now attached to the "1.re. flotille de sous marines de la Méditerranée."

This vessel is 160 feet long; and has a beam of just over 12 feet.*

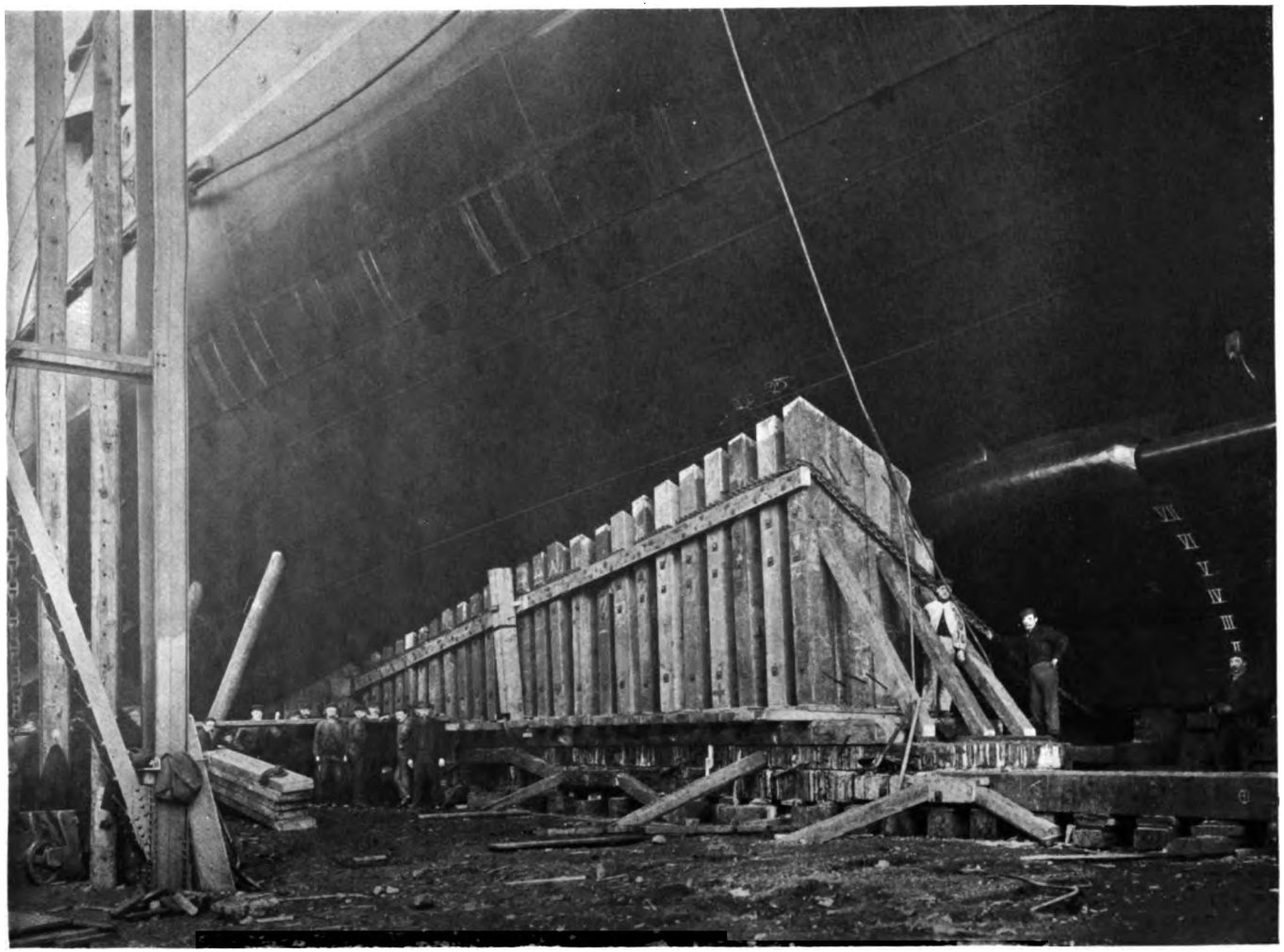
The armament of the Gustave Zédé is composed of three 18 inch Whitehead torpedoes, which are launched from an expulsion tube in the bow.

The next submarine built for the French navy was the Morse; which was constructed from the plans of M. Ramazotti; the designer of the Gustave Zédé. This, the third French submarine, was launched in Cherbourg Dockyard in July, 1899.

The Morse differs very little from its predecessor, the Gustave Zédé. Admiral Fournier witnessed a successful attack by the submarine Morse on the Gunboat Coeyte, at Havre in July 1901. The submarine approached the harbour at night-time; and succeeded in torpedoeing the gunboat, which was lying at anchor.

In the year 1899 four submarines were laid down in the dockyard at Rochefort. These vessels included the ill-fated Lutin and Farfadet; the other two being named the Korrigan and Gnôme. They are very similar to those designed by Engineer Ramazotti. Their armament consists of four torpedoes; two of which are carried inside and discharged through an expulsion tube, while the others are carried in "holders" fixed to the outer skin of the vessel, and discharged by a special releasing apparatus.

* For further particulars see table, pp. 74-5.



The Hull of a Battleship—what would have to be armoured to withstand mine or torpedo explosions.

To face page 33.

The radius of action of these submarines is very small, being only 30 miles at 12 knots; or 200 miles at seven knots. Their motive power, both on the surface and when submerged, is electricity; and they are fitted with a single propeller, which is rotated at 300 revolutions per minute. The Gnôme and Lutin are now attached to the "1re flotille de sous marines de l'océan"; and the Korrigan and Farfadet to the "2e flotille de sous marines de la Méditerranée." They were launched in 1901-2, and are all submarines of the defensive class. The Française and Algerian, which were launched in 1901, were paid for by a fund started by the well-known French journal, *Le Matin*, and they are submarines defensive of the improved "Morse" type.

Their radius of action is, on the surface, 80 miles at 10 knots, submerged, 30 miles at 7 knots. These two boats were built at Cherbourg, and are now attached to the "1re Flotille de sous marines de la Manche."

Twenty small submarines of the "Naiade" type were ordered by the French Government in 1901. These vessels, which were all launched during 1902-3-4, have the following small dimensions:—Length, 76 feet; beam, 7 ft. 6 in.; depth, 8 feet; displacement 67 tons. Their surface engines have an I.H.P. of 60. They are named the: Alose, Anguille, Bonité, Castor, Dorade, Esturgeon, Grondin, Loutre, Ludion, Lynx, Méduse, Naïade, Otarie, Oursin, Perle, Phoque, Prote, Souffleur, Thon, Truite.

The armament of these small boats consists of 4 torpedoes; which are expelled from a single tube in the bow and two "holders." Their maximum trial speed was 8.5 knots on the surface, and 5 knots when submerged.

A Panhard-Levassor petrol motor is used when running on the surface; and an electric motor for propulsion when submerged. They are fitted, like many of the French submarines, with a heavy lead keel for adding stability when submerged; and for releasing in case of accident.

These tiny submarines have proved remarkably successful. Their manœuvring powers on the surface are excellent; and they are good divers, being able totally to submerge in 3 minutes*

Their radius of action is very small; and they are all submarines of the defensive class.

The next boats to take their place in the French Submarine Flotillas were three vessels designated the "X," "Y," "Z." These boats, although

* See pp 91-3.

commenced in 1901, were not completed until 1904-5, having taken two to four years to build. Although an improvement on the older type of submarines, these vessels were not nearly so successful, or such 'revolutionizers' as was anticipated. Their improved powers for quick submersion, which manœuvre they accomplish in the short space of two minutes, constitutes their greatest improvement.

The "X" was designed by Engineer Ramazotti, and is fitted with twin screws. On her trial trip she attained a maximum speed of 10 knots on the surface, and 8 knots when submerged. Two Benzoline engines of 110 H.P. (each) are used for propelling the boat when on the surface; and two electric motors for propulsion when submerged. Her armament consists of six 45 c/m (17 7in.) Whitehead torpedoes, which are discharged through two expulsion tubes.

The "X" is a submarine of the "offensive" class; and has a radius of 500 miles, at economical speed. She is attached to the 1st Flotilla of Submarines of the English Channel, the rendezvous of which is Cherbourg.

The submarine "Y" was designed by that clever naval constructor, M. Bertin, and is the only naval submarine in the world that uses compressed air and alcohol as a motive power; both on the surface and when submerged.

Much secrecy surrounds this new type of vessel; but I learn, on good authority, that the compressed air is derived from reservoirs of liquid air, and that the air and alcohol motors are the invention of Professor Darsonval, of the Collège de France.*

The trials of this vessel have also been surrounded with much secrecy; but as far as can be ascertained, the "Y" at first proved a distinct failure, though after drastic changes had been made with her machinery she was able to take her place in the "1re Flotille de sous marines de la Méditerranée." The "Y" attained a maximum trial speed of 11.8 knots above, and 8 knots below. Her endurance on the surface is 400 miles, at economical speed; and it is stated that she can remain submerged for 20 hours.† Her armament is the same as the "X," so need not be repeated. She is a submarine of the "offensive" class.

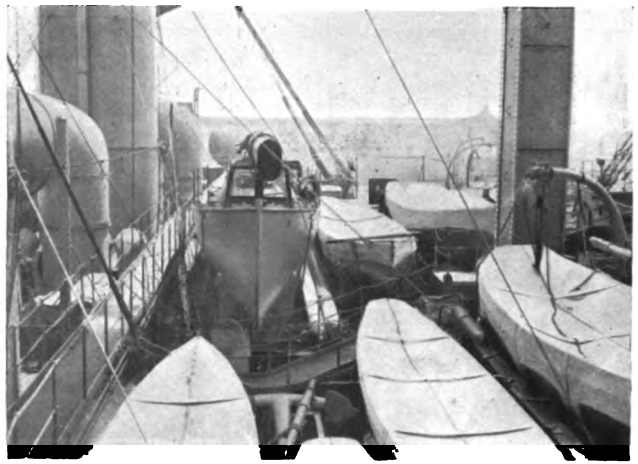
The "Z" was designed by Engineer Mangas, and was constructed at Rochefort. She has the following dimensions:—Length, 136 feet; beam, 10 feet; surface displacement, 202 tons.

This vessel is fitted with only one propeller, and an eight cylinder

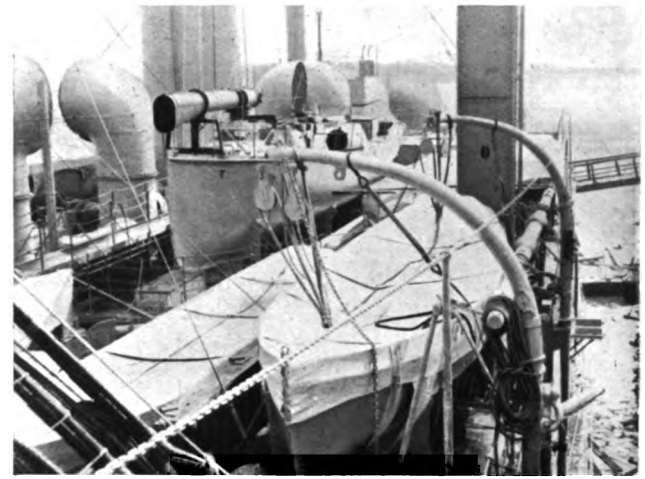
* This is questionable.

† Doubtful.

METHODS OF DEFENCE AGAINST SUBMARINE-BOAT ATTACK.

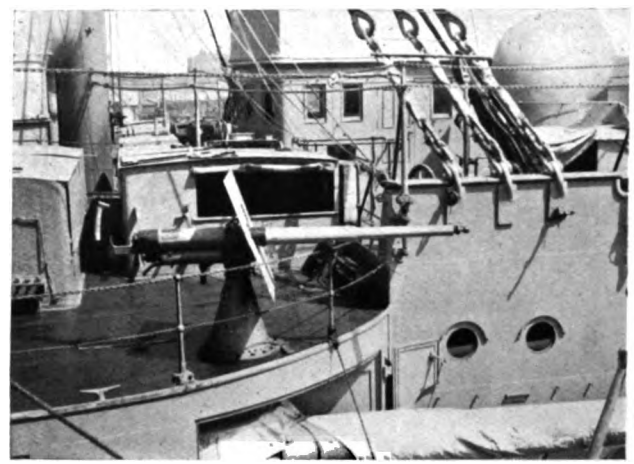


A Motor Torpedo Boat—one of the many suggested defences against the Submarine.



Side View Motor Torpedo Boat.

Turning her stern to an attacking Submarine in the hope of deflecting the torpedoes by her propeller race, and to present as small a target as possible.



The Quick Firer.

To face page 35.

horizontal petrol motor is used for propulsion on the surface, and an electric motor when submerged. She attained a maximum speed of 11.8 knots on the surface, and 8 knots when submerged. Her armament is six 45 c/m (long) Whitehead torpedoes; and she is fitted with two expulsion tubes. Air, for breathing purposes, is stored in large steel cylinders, fitted on each side of the vessel; and is delivered, when necessary, through pipes, which are carried completely round the boat, into small rose-pieces; which are fitted with tiny fans, to circulate the fresh air. The vitiated air is expelled by small pumps operated by electricity. The air for expelling the torpedoes is also stored in these main-air reservoirs.

The trials of the "Z," which took place at Cherbourg during the summer of 1905, did not prove very successful. She gave very doubtful results, as far as stability on the high seas was concerned; and she behaved in an extremely lively and erratic manner when submerged. On one occasion she remained motionless for 60 seconds at a depth of 25 feet, with her engines going at full speed ahead, and her diving rudders brought over for a quick rise. This was attributed to a strong undercurrent and to "drag" caused by the submarine's proximity to the sea-bed.

A new type of engine, which can be used both for propulsion on the surface and when submerged, has recently been tried on board one of the latest French submarines.

This "oxylithe" and petrol engine was designed by Monsieur Joubert, and is described under "British Submarines."

The "Oxylithe" is used to purify the exhaust of the petrol-engine, and to restore the requisite amount of oxygen. By enclosing the engine and a "purifier" in a gas-tight case, a petrol motor entirely independent of outside air is produced.

This engine is designed to enable the powerful petrol engines now used for propulsion on the surface to be used also for submerged runs.

SUBMARINE v. SUBMERSIBLE.

A series of comparative trials was carried out at Cherbourg, between the submarine Emeraude, and the submersible Pluviôse; with a view to proving which of the two types was the most efficient.

These tests proved conclusively the great superiority of the submersible over the submarine.

The course of both vessels, when travelling submerged, was somewhat erratic; but whereas the submersible Pluviôse took 4¼ minutes to sink to

the totally-submerged condition, the submarine Emeraude only took 3 minutes; though for manœuvring on the surface, and for reliability, the submersible proved incontestably superior.

This trial proved, beyond doubt, that the rôle of a submarine in future naval war will be strictly limited to coast and harbour defence.

The submarine Emeraude is a vessel of the "offensive" class, and is attached to the Flotilla at Cherbourg.

The latest submarines built for the French Navy are six large vessels of the offensive class. They are named the Emeraude, Opale, Rubis, Saphir, Topaze, and Turquoise. These boats are, by far, the largest and most efficient submarines in the French Navy. They have a displacement of 390 tons on the surface; and 420 tons when submerged.* An 8-cylinder petrol motor of 600 H.P. is used for propulsion on the surface; and an electric motor when submerged. Their armament is increased to six 45 c/m Whiteheads; and they are fitted with two bow expulsion tubes (starboard and port), and four Drzewiecki launching apparati; two pointing ahead and two astern. The "Emeraude" has, when undergoing her speed trials, attained a maximum of 12 knots above and 8½ below. Their endurance on the surface will be 1100 knots, and their endurance submerged 3½ hours at 8 knots.

When running on the surface these vessels can re-charge their accumulators. The "Emeraude" type is, undoubtedly, far superior to any other submarines in the French Navy. For coast defence, and for attacking hostile ships within easy distance of their base, these newest French submarines should prove of immense value.

Two other small submarines are in the course of construction at Cherbourg (Guêpe 1 and 2). These are from the designs of M. Petithomme (?) As will be seen from the table, they are to have a displacement of only 44 tons. These baby-submarines will, of course, be of the defensive class; and are intended solely for harbour defence. (Brest.†)

SUBMARINES AND SUBMERSIBLES—ONE.

At the beginning of this chapter on French Naval Submarines, I gave a brief account of the difference between a submersible and a submarine.

This distinction has in the latest types of boats almost entirely disappeared. It will be remembered that the main difference was that the

* For dimensions see table, pp. 76-7.

† I learn on good authority that the two "Guêpe" boats are for harbour defence at Brest.

submersibles were fitted with heat engines, for propulsion on the surface, and for re-charging their batteries; whereas the submarines had only electric power, and were thus dependent upon a naval base. This difference existed with the older type of boats; but with the adoption of the oil-engine for propulsion on the surface, both in the case of the submarines "X" and "Z," and also in the latest "Emeraude" type, this distinction has ceased to exist.

The surface buoyancy of the submersible has also been sensibly decreased, and that of the submarine considerably increased; thus destroying the last main difference between the two types.

The distinction is now merely in details; and the two classes have almost merged into one—the future under-water fighting ship, "Le submersible de Haute mer."

SUBMERSIBLES (FRENCH).

(Torpilleurs Automne Submersibles.)

The first submersible torpedo boat built for the French Navy was the "Narval," which was launched at Cherbourg during the latter part of 1899. This vessel, which was designed by M. Laubeuf, was the direct outcome of a competition instituted by M. Lockroy (Minister of Marine) in 1896.

The Minister thought by means of this competition, open to the genius of France, to obtain the designs for a perfect submersible vessel.

A comprehensive programme "d'expérience" was drawn up, which all designs would be expected to fulfil when put into practice. It was to act also as a guide to competing inventors.*

The designs sent in were very numerous, and many small prizes were awarded.

Although the result of this competition did not produce the "ideal submersible," it brought out many valuable suggestions; and created a new type of French torpedo-boat—"Torpilleur automne submersible."

The Narval, the first of this type of vessel, can navigate on the surface exactly like an ordinary torpedo-boat, semi-submerged, with nothing but the conning-tower and funnel above the water; and also totally submerged like a submarine.

The Narval is built with a double hull; the outer-casing being shaped like an ordinary torpedo-boat; and the inner shell, cylindro-conical.

* Full programme in "La Marine de Guerre," Edourd Lockroy, Paris.

The space between the two skins is utilized for water ballast; a certain amount being let in when it is desired to sink to the semi-submerged condition, with just the funnel and conning-tower above the surface. To totally submerge, the water is allowed to circulate between the two hulls.

The Narval has a displacement when on the surface (light condition) of 106 tons; and when submerged 200 tons.* A triple expansion steam engine of 250 I.H.P., is used when cruising on the surface; the heat being supplied by 5 liquid fuel furnaces, fired by heavy petroleum. The boiler is of the "flash" type. An electric motor is used for propulsion when submerged; the current being derived from Fulmen accumulators, which can be re-charged from a dynamo, driven by the surface engine.

She attained a maximum trial speed of 12.8 knots on the surface, and 8 knots when submerged. Her surface endurance is 125 miles at full speed; and 600 miles at 8 knots. She can remain submerged for 4 hours.

The armament of the Narval consists of four Darzewieki launching apparati, fitted on the arched back of the vessel; one on each side of the conning-tower, and two further aft. These hold 45 c/m (long) Whitehead torpedoes.

The Narval has two great faults. One is the length of time taken to submerge totally, a minimum of 20 minutes being required for this manœuvre. The other is that the steam engine, used when on the surface retains the heat to such an extent that it is often impossible for the Narval to submerge until the engine has cooled; which frequently brings the time taken to dive up to thirty-five minutes.

Many are the important trials which have taken place with this vessel; and on more than one occasion she has scored a brilliant success.

The Narval, which is considered by the French naval authorities to be a very successful boat, is attached to the submarine flotilla at Cherbourg.

During 1901 four more submersibles were launched. These vessels are very similar to the Narval (see table), and are named the Sirené, Triton, Espadon, and Silure. They take but 9 minutes to submerge totally. This constitutes their greatest improvement over their prototype.

The steam engines of these vessels are cooled by compressed air. This is one of the main reasons for the reduction of time taken to submerge.

They are all attached to the flotilla at Cherbourg. ("A" flotilla, see map.)

* See table, pp 74-5, for further dimensions.

No submersible vessels were launched during 1902 or 1903; but the following year two vessels, the Aigrette and Cicogne, designed by M. Laubeuf, were launched at Toulon. These boats are far superior to any other submersibles now in commission. Their dimensions are as follows:—Length, 118ft.; beam, 12ft. 6in.; depth, 8ft. 6in.; displacement, 172 tons. Triple expansion steam engines of 200 I.H.P. are used for propelling the vessels when on the surface; heat being supplied by liquid fuel furnaces, fired by heavy petroleum. The boiler is of the "flash" type (like in the Narval). When it is desired to submerge, these engines are cooled by compressed air.

The armament of these two vessels consists of one torpedo-tube, fixed in the bows; and four, 45 c/m torpedoes are carried.

The Aigrette and Cicogne have a surface speed of 10 knots; and a submerged speed of 8½ knots.

Their maximum endurance is as follows:—

Surface, 150 miles at 10 knots.
„ 700 miles at 6 knots.
Submerged, 60 miles at 6 knots.

The Aigrette and Cicogne, like the Narval, can navigate in three different positions:—

1. On the surface.
2. Semi-submerged with only conning-tower showing.
3. Totally submerged.

Many very important trials have taken place with these vessels; and up to the date of writing they have proved superior to any other French submersibles in commission.

During the summer of 1905, the Aigrette underwent a long series of comparative trials with the submarine "Z" at Cherbourg; and proved beyond doubt the great superiority of the submersible type; although her stability when submerged was by no means perfect.

The manœuvring powers on the surface of these two boats are excellent; and compared with their predecessors, they are good sea-boats.

An experimental dive of 100 feet was successfully accomplished by the Cicogne off Toulon.

The vessel was kept at this depth for 15 minutes; and after coming to the surface, plunged again to a depth of over 60 feet, and travelled for some considerable distance.

A substance called "Oxylithe" was successfully tried on board the submarine at these tests.

Oxylithe is a powder which absorbs the carbonic-acid gas of respired air, and, at the same time, gives off oxygen.

No damage to ship, or crew, was sustained during this "deep submergence" test. The Aigrette is attached to the Channel Flotilla at Cherbourg. ("A" flotilla, see map.) The Cicogne to the Mediterranean Flotilla at Toulon ("D" flotilla see map).

Another submersible launched for the French Navy is the Omega, which is an improved vessel of the Laubeuf type; and was launched at Toulon during the latter part of 1905.

This vessel, which is still undergoing certain trials, is a large and powerful type of French submersible. Her dimensions, although given in the table, I will repeat again for convenience:—

Length, 140 feet.
Beam, 13 feet.
Depth, 9 feet.
Surface displacement, 300 tons.
Submerged displacement, 375 tons.

The Omega is propelled, when on the surface, by a 330 H.P. triple expansion steam engine, and "flash" boiler; when submerged, by an electric motor. The current is from Fulmen accumulators.

She is fitted with a single screw, and attained a maximum trial speed of 11.9 knots above and 9 knots below. Her maximum endurance on the surface is 650 miles, at economical speed. She is armed with two torpedo expulsion tubes; and two Darzewiecki launching apparati. Six Whitehead torpedoes, of the usual pattern, are carried. This vessel will probably be attached to the 1st Mediteranean flotilla at Toulon.

Two large submersibles, Circé and Caylapso, have just been completed at Toulon. These vessels have a displacement of 344 tons; and are fitted with engines of 440 h.p. They attained a speed of 15 knots on the surface and 10 knots when submerged. They have a sphere of activity of over 1,000 miles. The armament of these new boats is increased to two torpedo tubes fitted in the bows; and five torpedo launching apparati with seven torpedoes are carried. They underwent their trials early in 1909.

The most recent additions to the French Flotillas (some of which are not yet quite completed) are the Pluviôs, Ventôse, Germinal, Thermidor, Vendémiaire, Frimaire, Brumaire, Floréal, Fructidor, Measi-

dor, Prairial, Ampére, Papin, Monge, Fresnel, Gay-Lussac, Bethelot, and Nivôse.

These vessels which were laid down in 1907 have the following dimensions:—

Length, 160 feet.

Beam, 16 feet.

Displacement, 398 tons.

They are fitted with petrol motors of 700 h.p.; and a speed of 15 knots and 10 knots, above and below respectively, is attained. Their armament consists of two expulsion tubes, and five launching apparati. These submersibles, which will probably all be commissioned in 1910, have a completement of two officers and 22 men; and their maximum endurance on the surface will be 1,500 knots.

Three even larger submersibles have just been laid down, Nos. 87-89, two at Cherbourg and one at Rochefort. These are from the designs of the Naval Technical Councils, and are 200 feet long and will have a submerged displacement of 800 tons. They are expected to attain a speed of 15 knots on the surface, and ten knots when submerged. Their maximum endurance on the surface will be 2,500 knots; and they are specially designed for offensive action.

A French daily paper published an account of a conversation with M. Thomson, Minister of Marine, regarding the construction of 800 ton submersibles. M. Thomson said: "We are obliged to go forward on pain of losing the still appreciable lead which we have over foreign navies, as regards submarines. It is necessary to increase the displacement—both of the large and small units. In increasing the displacement we increase both the speed and the sphere of activity. As soon as we possess these, our naval strength will be notably increased." By an order issued by M. Bertin, late Chief Constructor of the French Navy, large steel rings will in future, be fitted to all French submarines, and submersibles, so that in the event of an accident like that which befell the Farfadet, the work of salvage would not only be simplified, but rendered quicker.

There are ten other submersibles on order, Nos. 90-99; but they will not be laid down until the large 800 ton experimental boats are completed. These last ten vessels will probably not be completed before 1913, long before which the other types of submarines will have become unserviceable.

FRENCH SUBMARINE FLOTILLAS.

(Map Reference, etc.)

The inner circle, round the naval bases, indicates the submerged radius of all vessels of the submarine flotillas. The distance from the harbour to the extremity of the circle is approximately 25 miles. This distance can be accomplished under-water by all except the very oldest type of French submarines.

In time of war, any spot on the borders of or within this circle, would certainly be in a zone of extreme danger.

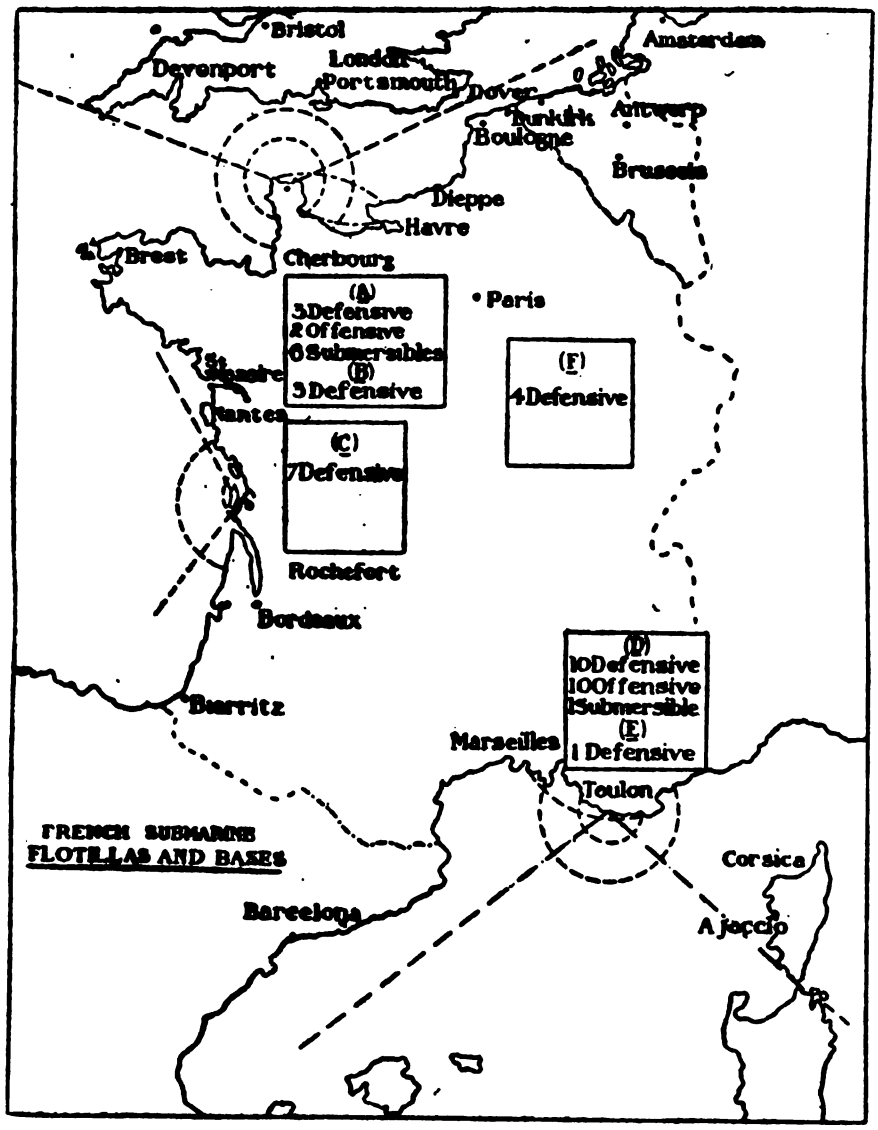
The thin dotted lines from Cherbourg to Havre and from Toulon to Marseilles, make the usual practice ground for French submarines and submersibles. A good "look-out" should be kept by super-marine vessels when navigating in this vicinity.

The outer dotted circle represents the surface radius at full speed of all vessels of the defensive class. In war time, hostile fleets within this circle would have to keep a "bright look-out."

The straight dotted lines represent the surface radius of vessels of the offensive type which are intended for attack, as well as defence.

This crude map shows how the naval bases of France are guarded by submarines of the defensive class; and the coast by submersibles, and submarines of the offensive class. These latter types would also be used for attack.

The bases shown on the map are the present depôts of the submarine flotillas; but there are, of course, other torpedo bases, which in time of war would be used as submarine depôts. The number of vessels named in the map are those of fighting value in commission at the beginning of 1909; by the end of the year these will be greatly increased, as a glance at the large table (page 76-7) will show.



The number of Submersibles and Submarines of the offensive class named above has been greatly increased quite recently but the radii of action are about the same.

The following is the composition and distribution of the French submarine torpedo-boat flotillas.

1st Flotilla of Submarines of the English Channel.

1re Flottille de sous-marines de la Manche.

Depôt—CHERBOURG.

A (Map and table letter).

Submarine "Morse"	‡	Submersible "Sirène"	‡
" "Française"	‡	" "Triton"	‡
" "Algérian"	‡	" "Espadon"	‡
" "X"	*	" "Silure"	*
" "Z"	*		
Submersible "Aigrette"		Several vessels of the "Emeraude" and "Ventôse" class.	
" "Narval"			

‡ Defensive. * Offensive.

Submersibles are vessels of the offensive class. Chief Torpedo Depôt Ship "Foudre."

2nd Flotilla of Submarines of the English Channel.

2e Flottille de sous-marines de la Manche.

Depôt—CHERBOURG.

B (Map and table letter).

Submarine "Ludion"	‡	
" "Naïade"	‡	
" "Phoque"	‡	Several vessels of the "Emeraude" and "Ventôse" class.

1st Flotilla of Submarines of the Ocean.

1re Flottille de sous-marines de l'Ocean.

Depôt—ROCHEFORT.

C (Map and table letter).

Submarine "Gnôme	‡	Submarine "Castor"	‡
" "Lutin"	‡	" "Otarie"	‡
" "Meduse"	‡		
" "Oursin"	‡		
" "Loutre"	‡		

‡ Submarines Defensive.

1st Flotilla of Submarines of the Mediteranean.
1re Flottille de sous-marines de la Méditerranée.

Depôt—TOULON.

D (Map and Table letter).

Submarine "Gustave Zédé"	‡	Submarine "Bonite"	‡
" "Gymnôte"	‡‡	" "Thon"	‡
" "Y"	*	" "Alose"	‡
" "Grondin"	‡	" "Truite"	‡
" "Anguille"	‡	Submersible "Cigogne"	*
" "Souffleur"	‡		
" "Dorade"	‡	Several vessels of the "Emeraude" and "Ventose" class.	

‡‡ Used mostly as a Training Ship for Officers and Men of the French Submarine Flotillas.
‡ Defensive. * Offensive.

2nd Flotilla of Submarines of the Mediteranean.
2e Flottille de sous-marines de la Méditerranée.

Depôt—BIZERTA.

E (Map and table letter).

Submarine "Korrigan" *	†	Several new vessels to be added shortly.
" "Farfadet"	†	

* Now undergoing Repairs and Alterations (after accident).

1st Flotilla of Submarines of the China Seas.
1re Flottille de sous-marines des mers de Chine.

Depôts—SAIGON and TONKIN. (Two vessels attached to each Port).

F (Map and table letter).

Submarine "Esturgeon"	†	Submarine "Protée"	†
" "Lynx"	†		
" "Perle"	†		

† Defensive. (Intended solely for Harbour Defence).

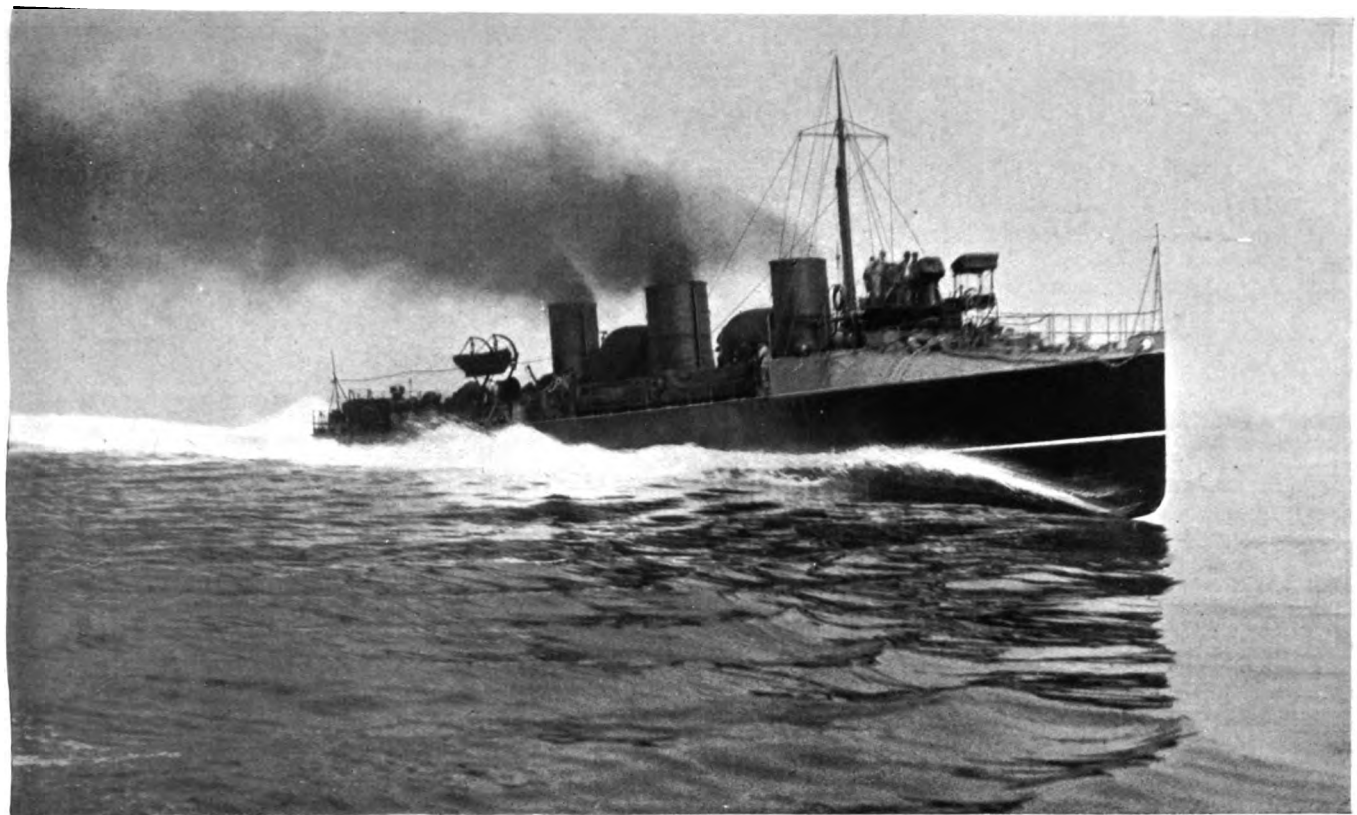
All the French submarine flotillas are constantly engaged in exercises, comparative trials, and immersion tests. These manœuvres are entirely different from those carried out by the British submarine flotillas; for whereas the French boats usually attack a stationary "enemy," or one travelling at reduced speed, the British submersibles always "find," and attack an enemy moving at full speed. Needless to say, the French method is calculated to bring off a successful attack each time, which, of course, makes good newspaper copy, but is not practice under the conditions of real war; for, as the British say:—"a hostile fleet would not remain stationary when exposed in any way to an attack by submarines."

The French submarine manœuvres much resemble those of America, in which "deep dives" play an important part. Submersion to great depths is also a favourite French experiment; and boats are constantly being exercised in deep-sea plunging.

The submersible Cigogne has accomplished a dive of over 100 feet; and the submarine "Y" two dives, in succession, of 72 feet. This "water sport" does not form part of the British submarine exercises, nor should it; for a submarine that could dive 200 feet would probably not be of such fighting value as a boat that could only dive to a depth of 40 feet. Of course, the British vessels are constantly exercised in travelling submerged, "porpoise diving," etc.; but erratic dives to great depths are not considered in British naval circles to be of any value, either as a practice or as an experiment; for in time of war deep plunges would never be required. The peculiar accident which happened to the submarine Algérien in Cherbourg Harbour, during March, 1907, when owing to some fault in the moorings, and to the "hatch" being left open, the submarine sank during the night, has caused an order to be issued that henceforth all submarines or submersibles shall be provided with a flash-light for use during the night, and that a special watch, to be relieved every four hours, shall be set on all submarines lying in the harbour.

The time of service in the French submarine flotillas is not limited to a short period, as is now the case in the submarine branch of the British navy, where men will in future only be allowed to remain for a period of five years. They are then to be drafted into the general service for two years, before being allowed to re-enter the submarine branch.

This method is undoubtedly the best; for work in submarine torpedo-boats is, to say the least of it, very trying; and the varying nerve strain to which submarine crews are constantly exposed would render them totally unfit for further service after many years in this branch.



By Permission of The Parsons Marine Steam Turbine Company.

The ill-fated Torpedo Boat Destroyer "Viper" steaming at 30 knots. These 30-knot boats would be employed in time of war in looking after their under-water opponents.

To face page 46.

The accompanying map will give some idea of the disposition of the French submarine flotillas, and the method by which the French coast-line is guarded by submarines. It would be impossible for a hostile fleet to approach any portion of the coast of France without exposing itself to an attack by submarines. The moral effect that the knowledge of this would produce, is, perhaps, one of the greatest fighting assets of this type of craft. Although France possesses, and has on order, more submarines than any other naval power, the superiority is only in numbers; for the French flotillas are composed of vessels which vary so much in displacement, and in all important points, that co-operation, which is the essence of naval strength, is in most cases impossible. The British flotillas, on the contrary, are composed of homogeneous types; and although the latest vessels are far more efficient than the earlier boats, there is a certain uniformity of design. Notwithstanding this, however, there are many very efficient submarines, and submersibles in the French flotillas; some of them, as will be seen from the comparison table, equal in every way to the submarines of England.

The large number of vessels of this kind on order, and the many new boats that have already been laid down, proves the naval policy of France regarding submarines.

French Submarine Stations, Torpedoes, &c.

Submarine Depôts.

Cherbourg, Rochefort, Toulon, Bizerta, Saigon, and Tonkin.

Torpedoes used in French Submarines.

45 c/m (long) Whitehead torpedoes. Extreme effective range, 2,000 yards. Speed, 30 knots, if set for 1,500 yards.

Personnel.

The personnel of the French Submarine Flotillas is very efficient. (See under "Flotillas.")

RUSSIAN SUBMARINE FLOTILLAS.

THE submarine flotillas of the Imperial Russian Navy comprise 23 boats already built, either of the submarine or submersible type, and six on order or building. These figures do not include the small vessels constructed some 20 years ago, to the designs of that clever naval architect, M. Darzewiecki.

The first submarine torpedo-boat launched for the Russian Navy was a small vessel named the "Petr Kochka," designed by Lieutenant Holbasiev and M. Kutenikov (naval engineers), and completed at Kronstadt in 1902.

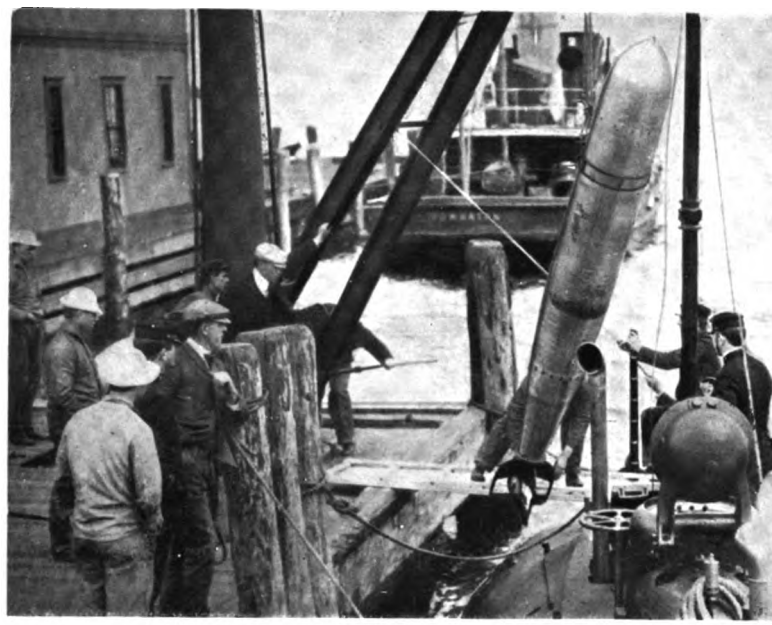
This boat has the following dimensions:—

Length 50 feet.
Beam 14 feet.
Depth 10 feet.
Surface displacement 20 tons.

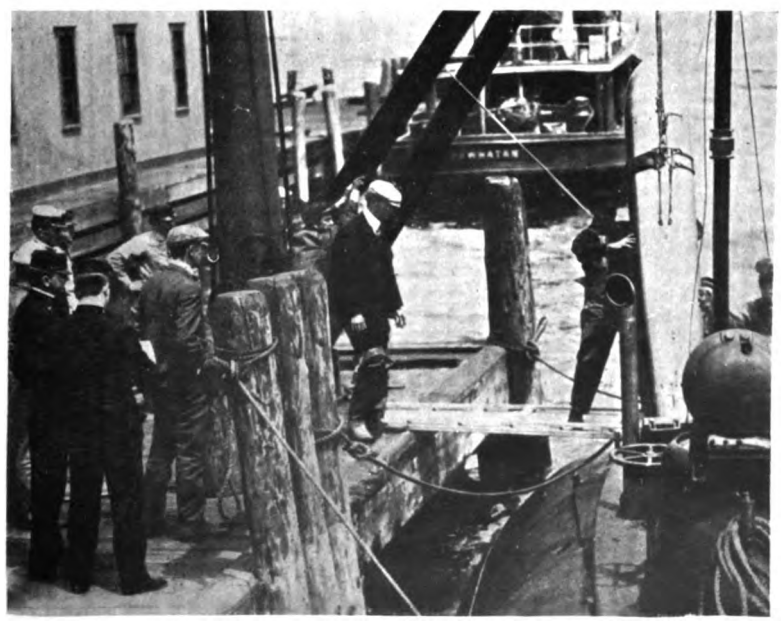
The Petr Kochka is built in nine sections, to facilitate transport over the Siberian railway, as she was intended for the defence mobilé of Port Arthur. The three forward sections contain the mechanism for operating large horizontal planes, which are used for diving or rising. The centre sections contain the machinery used for propulsion, which consists of two electric motors, supplied with current from accumulators of the Bari type. She attained a maximum trial speed at Kronstadt of 8.6 knots on the surface, and six knots when submerged. Her endurance above water is only 15 knots, which strictly limits her use to that of harbour defence.

The armament of the Petr Kochka consists of two special launching apparati, fitted one on each beam, and capable of being trained over a large arc. The torpedoes, which are of the 18 inch (short) Whitehead pattern, are placed in these holders, pointing in opposite directions (fore and aft.) This is done with the idea that the submarine would fire her first torpedo when approaching the enemy, and if that shot were unsuccessful, the Petr Kochka would be saved the danger of waiting in the same vicinity for a second discharge by diving under the enemy and firing on the other side with her stern holder.

This little submarine proved very successful on most of her trials. Her diving qualities exceed those of later and more efficient craft.



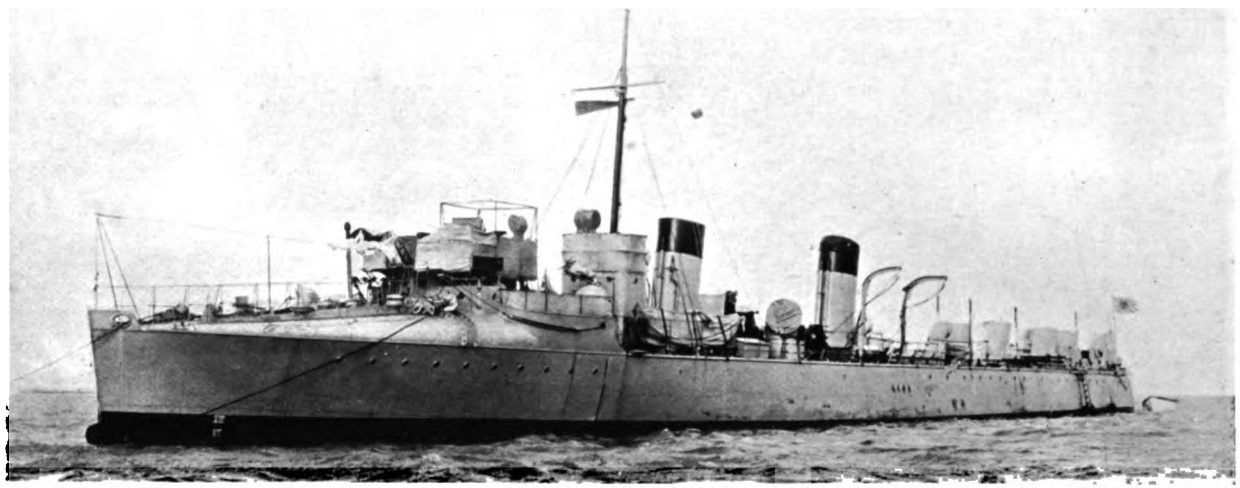
A Ticklish Operation in the shipment of a Whitehead.
By special permission.



Whitehead Torpedoes being placed on board. U.S.S. "Moccassin."
By special permission

To face page 48.

Royal Italian Torpedo Boat Destroyer "Espero." Length, 208 ft. Beam, 19 ft. 4 in. Draft, 6 ft. 3 in. I.H.P. 6,000. Speed on official trial. $30\frac{3}{4}$ knots.



Japanese Destroyer "Murakums." Length, 210 ft. Beam, 19 ft. 6 in. Draft, 7 ft. I.H.P. 5750. Speed on official trial, 30.60 knots.

To face page 49.

The Petr Kochka was part of the defence mobile of Port Arthur*

The next submarine launched for the Imperial Navy was the Delphin, that unlucky vessel which caused the death of so many Russian sailors at Kronstadt. The accident, however, was not due to the faulty design of the boat, but to the incompetence of her crew, and was caused through an unusually large number of men being on board, and the ballast tanks being flooded while the hatch was open. The water rushed in through the opening, and sank the vessel. She was raised, however, and is now stationed at Kronstadt as a training ship. As this vessel is no longer a fighting-unit, it is unnecessary to give any further particulars than those contained in the table.

The next submarine, was the "Graf Cheremetiev," which is a vessel of the (American) Holland type; known in Russia as the Biriliff type.

This boat was commissioned to the Baltic torpedo-boat flotilla in 1904 and has the following dimensions:—Surface displacement, 175 tons; length, 77 feet; diameter, 14 feet.

A four-cylinder vertical petrol-engine is used for propulsion on the surface, and an electric motor when submerged. Her speed is nine knots above, and seven knots below. She is armed with one torpedo tube, situated in the bow, and three 18 inch (long) Whiteheads are carried.

This vessel proved very successful during her trials, which took place in the Baltic during 1902. Her efficiency, compared with that of the other Russian submarines built at that date, surprised the Russian officers who watched the evolutions. Seven other boats of the same type were ordered. These are named the Peskar, Kefal, Sig, Plotva, Buichok, Ohun, and Makrel.

Previous to the completion of these last named vessels, the Russian Government purchased the "Lake" type of submarine boat, Protector.

According to the "Daily Telegraph," Baron Ferson, of the Russian Embassy, who was present at the launch of the submarine "Protector," made the following observation:—"The Protector is a wonderful fighting machine; and I don't believe the United States will ever let her go away from her own shore."

The Protector, which now has Kronstadt for its base, is re-named the "Ostr," and has the following dimensions:—Length, 65 feet; Beam, 11 feet; displacement on surface 115 tons; submerged 170 tons.

The Ostr is not shaped like most submarine-boats, that is, cylindro-conical; but has a deck-superstructure, which makes her resemble the hull of a cruiser (see illustration page 117).

* This Submarine is generally believed to have been captured during the Russo-Japanese War.

She is designed to travel in four positions, as follows:—

(1.) On the surface, as an ordinary torpedo-boat.

(2.) Awash.

(3.) Submerged, as a submarine.

(4.) On the sea-bed (running on wheels).

The special, and most unique feature of the Ostr, is her ability to travel on the sea-bed. For this purpose she is fitted with two large wheels situated on a line with the keel, and protected, somewhat, by the peculiar shape of the vessel.

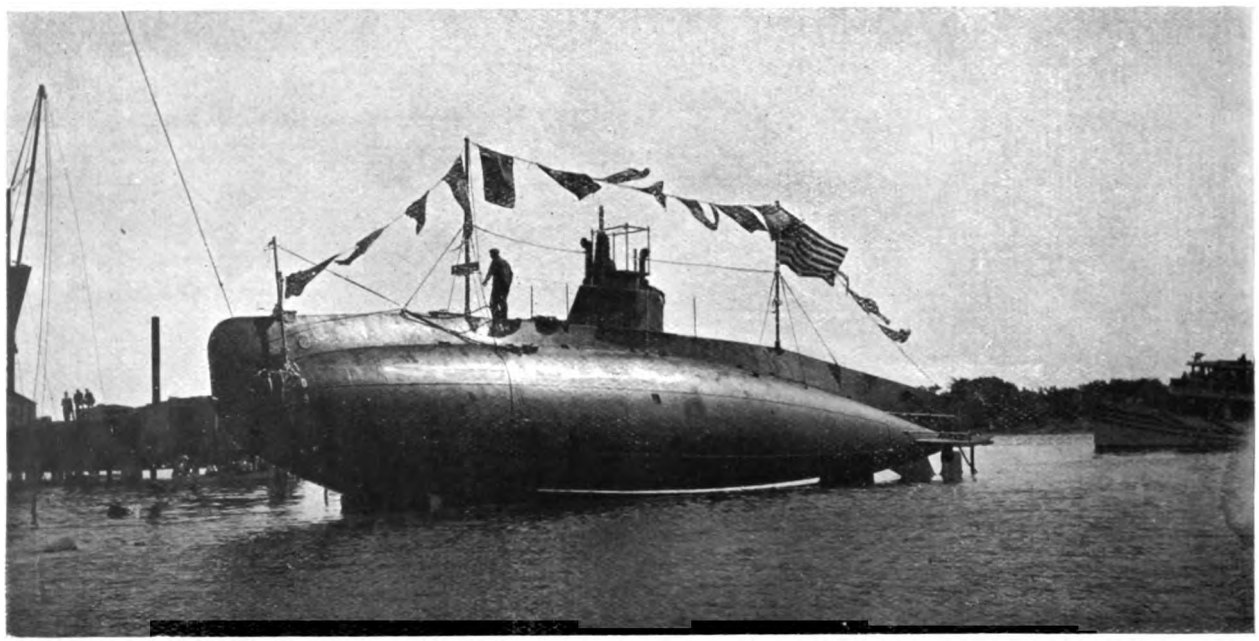
When it is desired to travel on the sea-bed, two large conical weights, which are fitted in cavities of the keel, and are connected to power reels by wire hawsers, are lowered, and the ballast tanks of the submarine are then partly flooded, until the vessel is in an awash-condition; she is then dragged down to the sea-bed by winding on the reels. Another method of sinking the Protector is by filling the ballast tanks, and letting her dive to the bottom; but this the Inventor does not recommend, as the vessel is very liable to descend too rapidly.

The utility of this new mode of submarine navigation will be better understood, when it is explained for what purpose the "Ostr" is being used by the Russian Imperial Admiralty. (See p. 52.)

The Ostr is supplied with two petrol engines, having a combined horse power of 250 for use when running on the surface, and two electric motors of 75 h.p. (combined) for propulsion when submerged. She is fitted with lateral hydro-planes, for use when submerged (navigating between surface and sea-bed). Another important, and novel feature of this submarine is a special diving compartment, from which members of the crew, when equipped in a diving dress, can gain access to the seabed when the vessel is submerged. By this means it is possible to lay or destroy mines, or to conduct salvage operations.

When it is desired to use this compartment, the air-tight door connecting it with the other portion of the boat is shut, and compressed air is allowed to fill the chamber, until the pressure of air inside equals that of the outside water. A trap door is then opened and the diver has access to the sea.

The armament of the Ostr consists of three torpedo tubes, Starboard, and Port bow, and one stern tube; three 18 inch Whitehead (long) are carried. The reason for pointing one tube astern, is the same as that described under the first Russian submarine Petr Kochka. The Ostr is fitted with a conning-tower, above which is a small armoured observation dome.



The "Cuttlefish" after the launch, exhibiting the shape and size of the latest type of U.S. Submarine.

To face page 50.

A heavy leaden keel (as in French boats) is carried, which by pulling a lever could be released in case of accidents. The surface radius of the Ostr is 430 miles at full speed, and the capacity of her storage batteries is 75 h.p. for four hours; but she could remain submerged (resting on the sea-bed) for over seven hours.

The official trials of this vessel proved remarkably satisfactory. In her deep sea submergence test she remained at a depth of 130 feet for nearly an hour; and in her open sea trials, which took place in the Baltic, she proved her excellent qualities for surface cruising. (See pp. 78-9 for further particulars).

The remarkably successful trials of the Ostr caused the Russian Government to order nine other submarines of the same type (Improved). The names and particulars of these vessels can be seen in the table.

SUBMERSIBLES (RUSSIAN).

The Holland-Biriliff type, the first of which I described under Russian Submarines, may be really termed submersibles; but beyond the particulars given in the table, little is known concerning these boats. As far as can be ascertained, however, they have proved remarkably successful.

The semi-submersible "Platus," built at the Neva Works, St. Petersburg, and launched in 1906, was designed by Engineer Drzewiecki; and has the following dimensions:—Length, 80 feet and diameter, 14. This vessel, unlike the submarines or submersibles of any other nation, is not intended to submerge totally, but only to travel in two positions: on the surface, like an ordinary torpedo-boat, or semi-submerged, with just her armoured conning-tower above water, and deck awash (also armoured). In time of war she would attack in this position, trusting the small conning-tower would be unobserved. She has but one mode of propulsion—a triple expension steam engine, with boilers of the flash type. Her armament consists of four torpedo discharging apparati, from the designs of the inventor of the boat. 18in. (long) Whitehead torpedoes are carried.

This boat has a maximum endurance on the surface of 600 miles (or semi-submerged). She is, however, nothing but a handicapped torpedo-boat of little fighting value, as the "wave" thrown off when travelling semi-submerged is quite sufficient, without the projecting conning-tower and short funnel, to ensure her being observed by an enemy, who certainly would not be "asleep" while steaming in a submarine danger zone.

The latest Russian submersibles are the vessels Okun and Makrel,

which are boats of the Holland Biriliff type. No particulars of these are at present available.*

There are nine other submarines, or submersibles, built, or on order for the Imperial Russian Navy. Three of these named Kambala, Karas and Karp are of the "Germania" type. The remaining six, some of which are already afloat, are named:—Drakon, Minoga, Akula, Krokodil Kaiman, and Alagator.

DIVISION INTO FLOTILLAS (RUSSIAN).

The Russian submarines have, up to the present, nearly all been stationed at Kronstadt; but when the seven new vessels on order have been completed, the Russian submarines and submersibles will be divided into three flotillas:—1st Baltic Flotilla, Black Sea Flotilla, and Eastern Flotilla. The principal use of these flotillas will be for the defence mobilé of Kronstadt, Sevastopol, and Vladivostok.

The Ostr (ex-Protector) is stationed at Kronstadt, and is now used for periodical examinations of the submarine defences (mines, etc.), fortress foundations, and other submarine operations required in that large fortress. She is also used as a submarine school-ship, for officers and men of the submarine flotilla.

At Kronstadt two large lighters have just recently been fitted with powerful steam capstans, and supplied with wire hawsers, for raising submarines in case of accidents.

MAP REFERENCE.

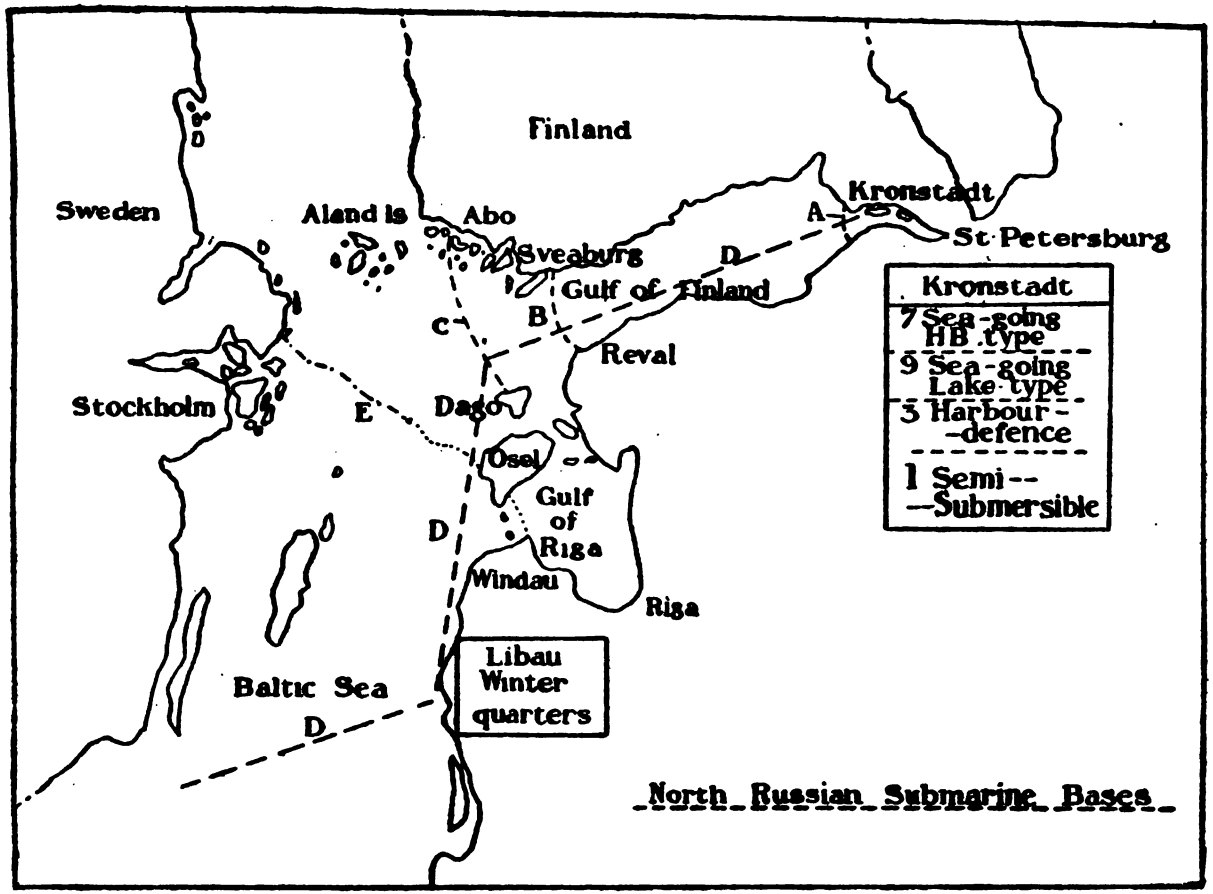
The dotted line "A" represents the submerged radius of the 19 submarines of the sea-going type, and is, approximately, 30 miles from the depôt in Kronstadt.

The three harbour-defence submarines have a submerged radius of only a few miles, and are therefore practically useless, although they are intended to guard the narrow sea-canals leading from Kronstadt to St. Petersburg.

The line "B" represents the maximum independent surface radius of the Russian submarines, except the three small harbour defence boats. Supplies and petrol, however, can be taken in at the two fortified bases, Sveaborg and Revel.

The Kronstadt submarine flotilla is thus capable of action much further afield.

* Much secrecy surrounds the names and numbers of Russian Submarines actually launched, consequently the above is only approximate, being based upon the best information which I have been able to obtain.



The three new vessels, Kambala, Karas, and Karp, have now been stationed at Kronstadt, thus greatly augmenting the sea-going flotilla

The line "C" represents the independent surface radius of the semi-submersible "Platus," which vessel could also take in supplies at either Abo or Dargo. At the latter place there is a special apparatus for submarine signalling.

The line "D" represents the extreme limit, independent of depôt-ships, or other floating bases, of all the Russian sea-going submarines.

To enable this journey to be accomplished, supplies would be taken in at Reval, and Libau, (or Port Alexander the III), which is the winter base of a portion of the Kronstadt submarine flotilla, and is shortly to be made a permanent submarine Depôt.

The American "Lake" type of submarines, which were built at Bridgeport, Connecticut, U.S.A., were handed over to the Russian authorities at Libau, where a special submarine depôt has recently been constructed.

The crinkled line "E" shows, approximately, the southern limit of the solid ice, which blocks the gulfs of Finland and Riga during the winter months. Large masses of ice frequently drift further south, but seldom solidify into "fields."

Russia, owing to climatic conditions, can employ submarines with greater advantage than countries with more temperate climates.

For several months in the year, her northern harbours are naturally defended by ice, and during these months the submarines can be docked and thoroughly overhauled—an annual operation which is very essential to the efficient working of these delicate little craft.

For another four months out of the twelve, the almost perpetual daylight would render the chances of a successful attack by surface torpedo-boats very remote. At the same time the peculiar light, combined with the brackish state of the water of the Baltic, would render the submarine even more invisible—if possible—than in Southern seas.

Russian Submarine Stations, Torpedoes, &c.

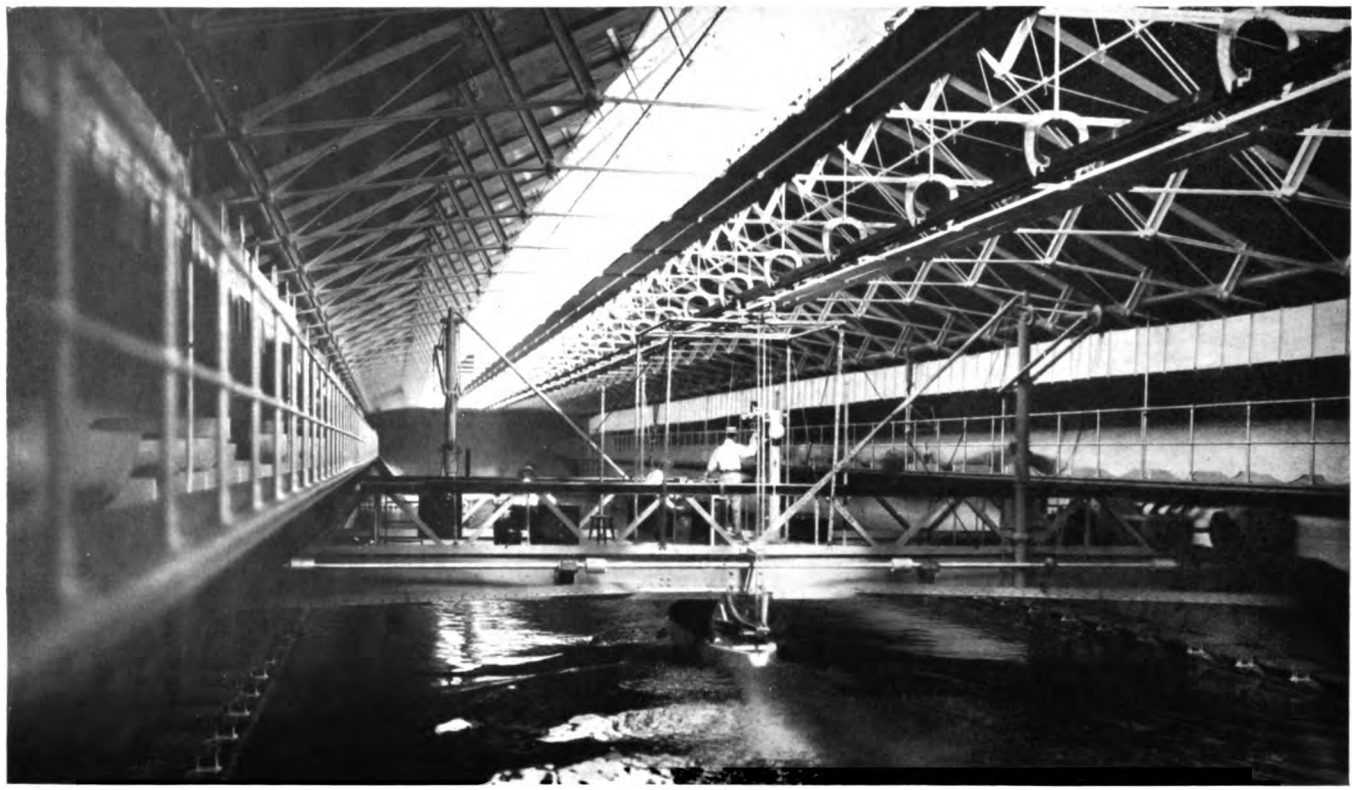
Chief—Submarine Depôt Kronstadt.

Torpedoes used in Russian Submarines.

18in. (1907 model) Whitehead torpedo. Effective range, 2,000 yards; speed, 25 knots; charge, 200 lbs. of gun-cotton.

Personnel.

The personnel of the Russian Submarine Flotilla is not very efficient; but manœuvres are constantly being carried out.



Models of the United States Naval Submarines being tested at Washington for the purpose of determining the best shaped hull, &c.

To face page 55.

UNITED STATES SUBMARINE FLOTILLA.

"If they had had two of these things in Manilla, I could never have held it with the squadron I had."—*Admiral Dewey, U.S.N.*

THE submarine flotilla of the United States Navy numbers 12 vessels built and 15 almost completed, all of which are of the "Holland," or improved Holland type.

The first submarine torpedo-boat acquired by the U.S. Government was (not taking into consideration the experimental boat Plunger) a vessel designated the "Holland."

This boat was by far the most efficient submarine built at that date; and it was the successful trials of the "Holland" that caused Great Britain to commence building her submarine flotilla.

This American submarine was the forerunner of a great number of vessels of the same type; for not only England, and America, but many other naval powers have adopted this pattern.

One of the most notable features of the first American submarine was a dynamite gun, placed in the bow at a fixed elevation. This weapon was intended for discharging small dynamite shells, both on the surface and when the vessel was submerged.

This ingenious weapon did not fulfil the high expectations of its designer, and has long since been removed. All the later types of American submarines, like those of most other nations, rely solely on torpedoes for their offensive power.

More exhaustive tests have been carried out with the "Holland," than with any other submarine-boat afloat; and, in most cases, she acquitted herself remarkably well.

Among the many expert naval officers who, from the first, strongly advocated the formation of a submarine flotilla for the United States Navy were Admiral Dewey and Rear-Admiral Philip Hichborn. The former made the following observations regarding the trials of the "Holland" before the House Committee on Naval Affairs, in April, 1900:—

"The boat did everything that the owners proposed to do. And I said then, and I have said it since, that if they had had two of those things

in Manilla, I never could have held it with the squadron I had. The moral effect—to my mind it is infinitely superior to mines or torpedoes, or anything of the kind. With those craft moving under-water, it would wear people out. With two of those in Galveston, all the navies of the world could not blockade that place."

The following is the log of the "Holland," during one of the most important official trials, which took place in Little Peconic Bay, Long Island, on November 6th, 1899:—

Log of Submarine Torpedo-boat "Holland," * November 6th, 1897.

2 hours 19 minutes 00 seconds.	Start for official run.
2 „ 26 „ 00 „	Amidship tanks filled and conning-tower closed and ran awash.
2 „ 28 „ 30 „	Dive. Revolutions of propeller 226 per minute.
2 „ 35 „ 00 „	Got ready to fire torpedo.
2 „ 41 „ 00 „	Rose to surface.
2 „ 42 „ 00 „	Fixed torpedo. Turned and headed for return, run.
2 „ 43 „ 12 „	The dive made. Vessel steered well in both vertical and horizontal planes.
2 „ 56 „ 10 „	Rose to surface.
2 „ 57 „ 00 „	Open turret. Stopped. Two air tanks down to pressure of 1,300 lbs.

Commander Emory and one of the crew left the boat. Their places were taken by Naval Constructor Capps and Lieutenant Commander Henderson.

3 hours 20 minutes 00 seconds.	Closed turret and went ahead awash.
3 „ 35 „ 00 „	Dive. Ahead full speed and fired torpedo at submergence of 5½ feet. Rose to surface, and the members of the Naval Trial Board left the boat.

Maximum inclinations during these runs—10 degrees by the head, 9 degrees by the stern.

Voltage at start, 125; at finish, after the surface run, at 3 hours 30 minutes P.M.—123.

The many very successful trials of the submarine torpedo-boat "Holland," and the favourable opinions expressed by most of the naval experts who watched closely the performances of the boat, caused an

* Reproduced by the courtesy of Messrs. Vickers, Sons, and Maxim.

order for six more submarines of the same (improved) type to appear in the Naval Estimates for the following year.

These vessels, which were launched during 1901 and 1902, were named the Adder, Porpoise, Shark, Grampus, Moccassin, Pike, and Plunger (No. 2). They have the following dimensions:—

Length, 63ft. 4in.
Beam, 11ft. 9in.
Depth, 12ft.
Displacement, 120 tons.

Although these seven boats were built almost exactly alike, for some unaccountable reason the Shark has proved slightly superior, as far as stability on the high seas is concerned.

These submarines are all fitted with four-cylinder vertical petrol engines, for propulsion on the surface; and electric motors for use when submerged. They have recently been fitted with an extra périscope, and they have now one "high" and one "low" instrument.

The Porpoise, Plunger, and Shark are also fitted with a special accident signal, and external communication apparatus.

This consists of a hollow copper globe, to which is attached one end of a telephone wire. The globe is fixed in a recess of the superstructure, or deck of the submarines; and 180 feet of telephone cable is coiled underneath.

In the event of an accident and the submarine sinking, the globe automatically releases itself, floats to the surface, and permits of communication with the submerged vessel. This apparatus has been practically tested on the submarines Porpoise, Plunger, and Shark, and has proved very reliable.

The seven boats of the "Adder" class are also fitted with external connections, so that air may be pumped down in the event of an accident. A crusher gauge is fitted to all United States naval submarines to prevent their submergence to excessive depths. The Porpoise, during her submerged speed trials, proved very erratic; and with the helm at zero she travelled in long, up and down hill, swoops. Even when the hydro-planes and horizontal rudders were used, this "porpoise" like motion would not be entirely stopped.

The trials of the Adder, Shark, Grampus, Moccassin, Pike, and Plunger, all proved very successful; except that their longitudinal stability when submerged, and their diving ability, left room for great improvement.

A maximum trial speed of 9 knots on the surface (light condition), and 6½ submerged, was attained; and their radii of action is as follows:—Surface, 400 miles at 9 knots; 600 miles at 7½ knots; Submerged, 20 miles at 6½ knots.

The contract price for these vessels was just over £38,000, and they are undoubtedly very efficient weapons of warfare for coast defence.

Among the latest additions to the United States submarine flotilla are the boats Cuttlefish and Octopus.

These submarines are far superior to any of the older boats; and much resemble the "B" class of the British flotillas.

They were built at the Fore River Shipbuilding Works, Quincy, Mass., and were launched in 1906. (For dimensions see table.)

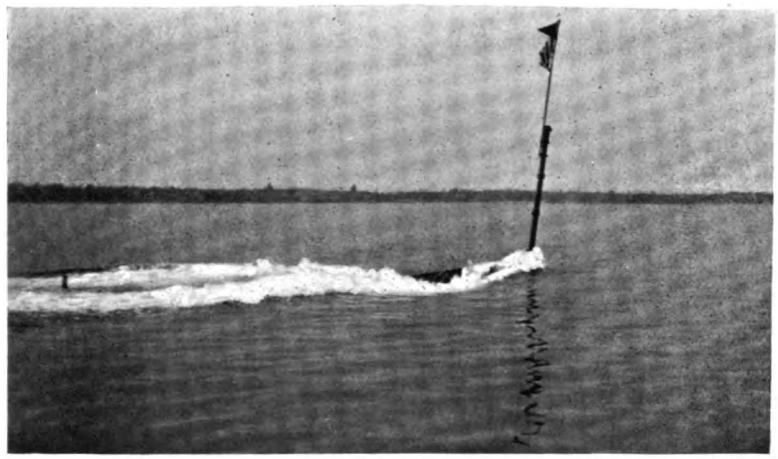
The vessels have two bow torpedo tubes—starboard and port. Five 18in. (short) Whiteheads are carried; two of which are placed in the tubes ready for firing, and two others are rested on "carriages," just abaft their respective tubes. These "carriages," or moveable racks, are operated by compressed air; and it is possible to fire two torpedoes in six minutes. The operation requires opening the cap at the mouth of the expulsion tube, discharging one torpedo (which was already in tube), closing the cap, blowing out the water, opening the breach, automatically moving second torpedo into tube, closing breach, re-opening cap, discharging second torpedo.

This automatic loading device not only saves time and labour, but regulates the water-ballast in the compensating tanks, and thus prevents any change in the longitudinal trim of the boat.

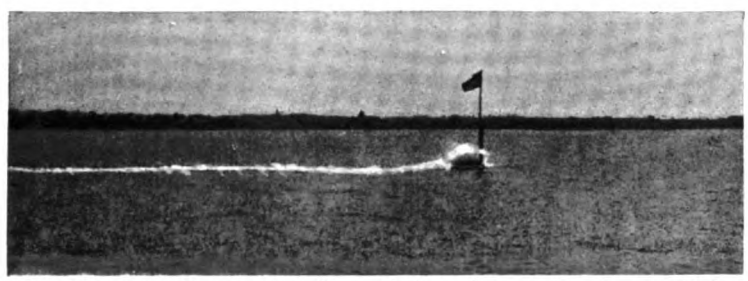
These vessels have two four-cylinder vertical petrol motors, for use when running on the surface; and two electric motors for propulsion when submerged. They are fitted with twin screws.

The propeller shafts of the Octopus are placed at a slight angle to the major-axis of the boat. (This is done with a view to producing a sufficient upward thrust to counteract the natural tendency of submarines to dive by the head.) She is built in five compartments, divided by watertight bulkheads, and doors. Each of these compartments is fitted with a hatch, which can be opened from the inside in case of emergency. These were made with the idea of acting in conjunction with safety jackets*; which are carried in the boat. If an accident happened, in which the hull of the submarine was pierced, the damaged section would be shut off, and the crew would then have time to don their escape dress, fill the compart-

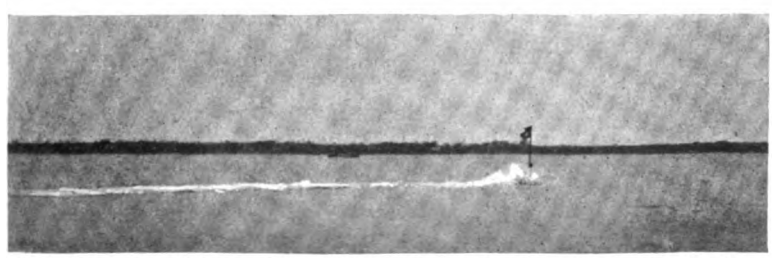
*See Article on Safety Appliances, p.p. 128-130.



U.S. Submarine "Octopus" "breaking surface."



U.S. Submarine "Octopus" travelling at full speed at a submergence of 10 feet.



U.S. Submarine "Octopus" travelling at full speed totally submerged. The flag and staff would be removed in action.

By special permission.

To face page 58.

ment with compressed air, emerge through the hatch, and float to the surface.

This method is undoubtedly one of the best forms of safety appliances yet invented. (A different, and more efficient pattern of escape dress is now installed in the British boats).

The Octopus carries several large flasks of oxylithe powder, so that the air in the boat may be constantly purified.

This powder, which is the invention of a Frenchman, absorbs the carbonic-acid gas of respired air, at the same time restoring the requisite amount of Oxygen.

The Octopus has been fitted with a special apparatus for submarine signalling. This appliance was not included in her original design; but has been added for the purpose of enabling the submarine, when submerged, to communicate with surface vessels, or with the shore.

The apparatus consists of a pneumatic bell weighing 450 lbs., fitted in the stern of the Octopus, and operated by compressed air, from a special air reservoir. Two transmitters, or sound receiving tanks, have also been fitted inside the hull of the Octopus, one on the port, and the other on the starboard, bow. These tanks may be termed the "ears" of the submarine, for they catch, and magnify, the sound of submarine signals, coming from the shore, or from a super-marine vessel. (Full description of apparatus, and a report, published by special permission of the British Admiralty, see pp. 143-5). The sound is then conveyed by telephone wires to the conning-towerof the Octopus; from which point the pneumatic bell is also operated.

By the use of a system of signals, messages were dispatched during her submerged speed trials to and from the submarine Octopus, and her tender, the yacht "Starling," which is also fitted with submarine signal apparatus, and on board which were the Naval Trial Board.

The yacht signalled by means of this device to the Octopus telling her when she had crossed the finish line, what manœuvres to execute, and when to come to the surface. In every case the submarine sound signal was understood by the operator in the submarine, who replied with the "understood" signal.

The sound of the pneumatic bell can be heard at a distance of five miles; and the Octopus, during her open sea trials, communicated with the Boston Lightship when over five miles distant.

The Octopus was the first vessel of its kind to be fitted with this apparatus; but so successful were the tests carried out before the Naval

Trial Board, that it is to be fitted to several of the older boats for further trial, and the boats now building will also be equipped with submarine signal apparatus.

The great utility of this new appliance will be felt during the trials, or manœuvres, of submarines. To use it in time of war would be to make known to any hostile ships in the vicinity the proximity and position of the submarine; and thus to destroy its chances of a successful attack.

Experiments have also been carried out, with wireless telegraphy, between the submarine Octopus and a shore station, during May of 1907.

It was conclusively demonstrated that wireless messages could be exchanged at a distance of 30 miles when the submarine was running on the surface—she being fitted with two telescopic masts 35 feet high.

The radii of action of the "Cuttlefish" and "Octopus"; and also of the other two vessels of the same class, the "Viper" and "Tarantula" are as follows:—Surface, 600 miles at 10 knots (full speed); Surface, 800 miles at 7 knots; Submerged, 35 miles at 8 knots; Submerged, *115 miles at 5½ knots. These vessels are built for offensive action, and are very valuable units of the United States' Torpedo-boat Flotilla. Fifteen larger boats with increased engine power are in various stages of construction.

The following is an account of the trials of the Octopus, which took place during July, 1907: of interest because the Octopus is, undoubtedly, one of the most efficient submarine torpedo-boats afloat.

Trials of the U.S. Submarine "Octopus" before Naval Trial Board.

President: Captain Marise, U.S.N.

SPEED TRIALS.

Newport, R.I., May, 1907.

The submarine torpedo-boat "Octopus" has now completed all her speed trials, and the following shows the result.

Maximum trial speed on the surface, over measured mile, 11 knots.

The boat had the benefit of the tide, which, however, was running weak.

Maximum trial speed awash, 9.98 knots.

Tide in favour.

*This allows for two ascents to the surface for refreshing air supply, not for re-charging Batteries.

Maximum trial speed at a submergence of 10 feet†, 8.90 knots.
Five feet of periscopic tube showing above water. Tide in favour.

MANŒUVRING TESTS.

Newport, R.I., May, 1907.

The Octopus made two "porpoise" dives. Went down at an angle of 8 degrees to a depth of 25 feet, in 40 seconds.

Returned to surface for observation of 5 seconds, then dived again to same depth in 43 seconds.

Proceeded for ten miles partly trimmed for diving, then fully trimmed; and went down to a depth of 20 feet, in 1 minute and 30 seconds.

ACCIDENT TESTS.

(Not Really Required by U.S. Government.)

These tests were carried out by the Contractors, with a view to proving that the Octopus is especially adapted for warfare; and to accentuate her worth.

1st Demonstration.—Both petrol engines coupled to one propeller shaft, and using only the one screw, the Octopus made 7.92 knots against wind blowing 15 miles an hour, and choppy sea.

2nd Demonstration.—One petrol engine broken down; accumulators run out; and one propeller damaged. Thus, with one engine, coupled to single propeller shaft, the Octopus made 7.25 knots.

SUBMERGENCE TEST.

(Narragansett Bay.)

Newport, R.I., May 16, 1906.

Octopus rose from sea-bed (28 feet of water), where she had remained for 24 hours, with 15 men on board.

The foul air had been pumped out twice during submergence; and it was estimated that about 40 per cent. of the stored air had been used (?)

Submarine signals were successfully used during these tests.*

TORPEDO-FIRING TRIALS.

Newport, R.I., May, 1907.

Targets.—Two small boats, moored 300 feet apart (average length of battleship).

Type of torpedoes used—(Old) Mark I. Whitehead.

* See p 143

†Conning-tower cap to surface.

1st Discharge, from Port tube.

Octopus travelling submerged at 8½ knots, proceeded towards target. Torpedo launched, at a range of 1,100 yards. The old, and unreliable, Mark I. pattern were used for these tests; and the first torpedo, discharged from the Octopus, headed straight for the target, for about 600 yards, and then broached—turning to the right at an angle of 90 degrees. The torpedo sank and was not recovered. It was pronounced a "crank" projectile.

2nd Discharge, Starboard tube.

Torpedo caught at muzzle of expulsion tube, and hung. Buoyancy chamber of torpedo badly broken; and projectile only released after much delay.

3rd Discharge.

Torpedo ran straight for target, but did not travel as far, coming to surface after running 600 yards.

Later.—Torpedo discharged from starboard tube successfully; but projectile again fell short of target.

DEEP SEA SUBMERGENCE TEST.

(Six miles off Boston Lightship.)

The water-inlet valves of the ballast tanks of the Octopus were opened.

Crew left the boat; and the conning-tower cap was screwed down.

The submarine was then lowered by cranes and steel hawsers to a depth of 200 feet, at which depth the pressure on the hull of the submarine was 86½ lbs. per square inch.

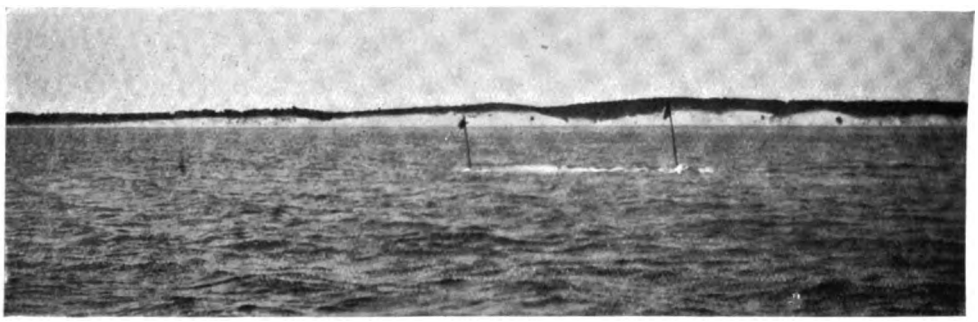
The Octopus stood the pressure well; and did not develop the smallest leak.

OPEN SEA TRIAL.

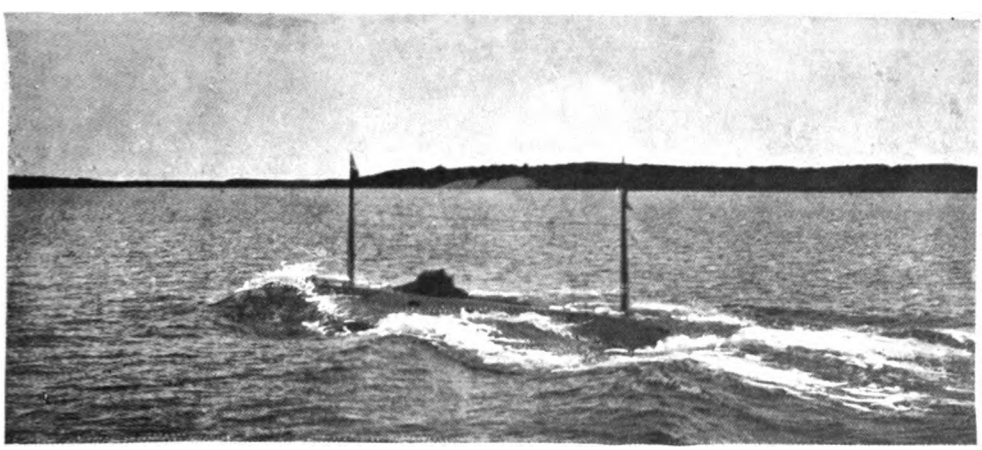
(Off Boston Lightship).

The submarine Octopus cruised for five hours off Boston Lightvessel, during rough weather; and proved her good qualities for surface cruising.

A submarine torpedo-boat, designed by Captain Simon Lake was put through the same trials as the Octopus; and although, as regards speed and one or two other features, she proved inferior, this "Lake" boat embodied many new and valuable improvements (same type as Lake boat "Protector," see Russian flotilla). At the time of writing the Lake submarine has not been purchased by the United States Government. (If



The U.S. Submarine "Holland" travelling submerged, the illustration showing the small wash made by Submarines when travelling in this manner.



The U.S. Submarine "Holland" running a-wash.

To face page 62

the United States do not acquire this boat, it is more than probable that the Russian Government will; as was the case with the "Lake" boat "Protector.")

"... I thoroughly believe in developing and building an adequate number of submarines ..."*—PRESIDENT ROOSEVELT.

United States Submarine Stations; Torpedo Depôts—Torpedoes, &c.

Chief Constructor: Washington Lee Capps.

U.S. Submarine Torpedo-boat Builders. Builders of Naval Submarines.

Fore River Company, Quincy, Mass.
Crescent Shipyard (Lewis Nixon), Elizabethford, N.J.
Union Ironworks, San Francisco.
Designers—Holland Torpedo Boat Co. (Electric Boat Co. Ltd.).

Chief Submarine and Naval Torpedo Stations

Submarine Depôt: Cutchoque Bay, Long Island, N.Y.
Submarine Depôt and Chief Torpedo Station: Newport, R.I.

Torpedoes used in U.S. Submarines 18in. Whiteheads (short); extreme effective range, 2,000 yards; speed, 26 knots, when set for 1,500 yards; charge, 200 lbs.

Personnel.

The personnel of the United States Submarine Flotilla is only fairly efficient, if compared with that of Great Britain or France.

* Army and Navy Register—26/1/07

ITALIAN SUBMARINE FLOTILLA.

". . . The knowledge that the enemy possesses submarines is likely to have a great moral influence over the mind of the commander of the vessel, although he may be aware that the hull of his ship may be able, in a certain degree, to withstand their attack . . ." *—COLONEL V. CUNIBERTI, Chief Constructor Royal Italian Navy.

THE Italian submarine flotilla is composed of two distinct types of vessels: submarines, and submersibles—the latter type being the most efficient. There are eleven submersibles and two submarines now building, or in commission.

Colonel Vittorio. E. Cuniberti, Chief Constructor Royal Italian Navy, has many times expressed the opinion that the submersible is the type of the future; and all the latest boats building for the Italian Navy are of this pattern.

SUBMARINES (ITALIAN).

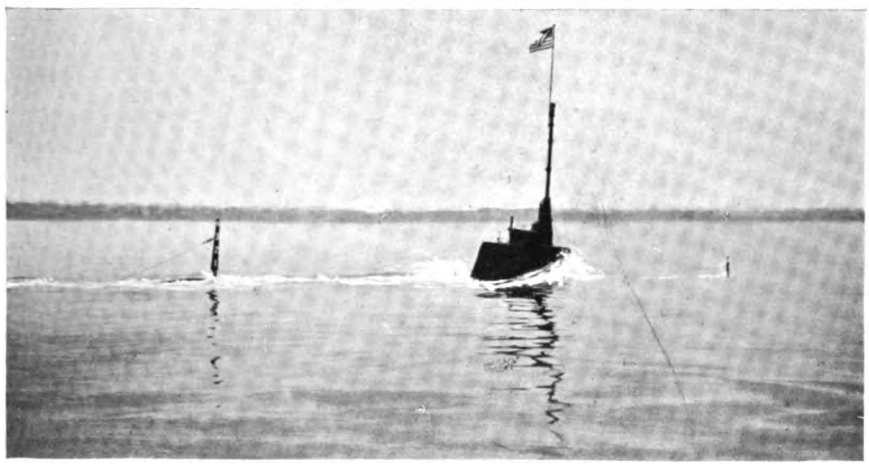
The first submarine torpedo-boat to be acquired by the Italian Government was a vessel named the "Delfino," which was launched at Spezia in 1894.

This boat was designed by Engineer Pullino, R.I.N. Her hull is constructed of steel; and is cylindro-conical in shape. She is propelled, both on the surface and when submerged, by an electric motor of 150 h.p., and attained a maximum trial speed of ten knots and 7.3 knots, above and below, respectively. She has lately been fitted with accumulators on the "Tudor" system, and her speed has, by this means, been slightly increased. The displacement of the "Delfino" is ninety-three tons when in the light condition, and one hundred and five when submerged.

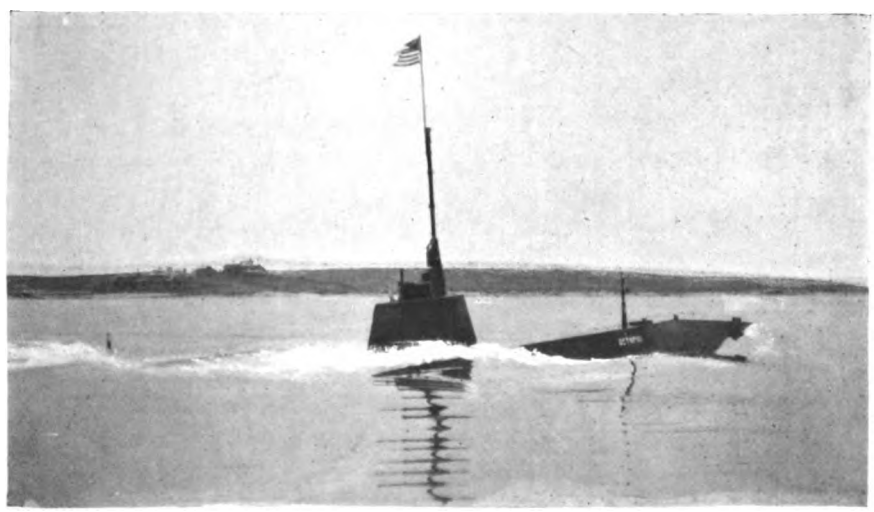
When the vessel is running on the surface, the auxiliary motors can, by a suitable arrangement of gearing, be coupled to small air compressors. By this means, while the vessel is travelling on the surface, air is being stored in steel flasks for use when submerged.

* Extract from an excellent Article by Colonel V. Cuniberti in Janes' "Fighting Ships."

The U.S. Submarine "Octopus" running on the surface at 11 knots, light condition.



The U.S. Submarine "Octopus" diving.



The U.S. Submarine "Octopus" rising by the action of her propellers, rudders and hydroplanes, to get a glimpse of her object of attack.

By special permission.

To face page 64.

Owing to the fact that the Delfino has no heat engine, her radius of action on the surface is very small; but she can remain submerged for over seven hours, with a crew of 12 on board. This feat she accomplished during her submergence test.

The Delfino is fitted with a cléptoscope for steering when under water, and it is stated that this instrument has proved remarkably successful.

The armament of this vessel consists of two torpedo tubes, situated side by side in the bow. Four 18 in. Whitehead torpedos are carried. During her trials she succeeded in approaching unobserved, and torpedoing a battleship lying at anchor.

All her trials proved successful.

It is interesting to note here, that, up to the time of writing, no serious accident has happened to any of the Italian submarines or submersibles; which fact certainly speaks well for the efficiency of both boats and crews.

The next submarine built for the Italian Navy was the "Tritone," designed by Captain Guiseppi Ferrarii. This boat, which was launched at Spezia in 1902, is intended solely for harbour defence at that port, and has the following small demensions:—Length 56 feet; Diameter 8 feet 6 inches.

Electricity is her only motive power; and she attained a speed of 8 knots above, and 5½ below, in her trial trips.

She is armed with one torpedo launching apparatus; fitted with an 18 inch Whitehead.

Although the trial of this vessel proved very successful, her slow speed, small radius of action, and insufficient armament, causes her to be of little fighting value; and it is therefore unnecessary to give any further particulars, than those contained in the table.

SUBMERSIBLES (ITALIAN).

The first Italian submersible was the "Glauco," which was launched at Venice Arsenal in 1905; and is undoubtedly the most efficient submarine torpedo-boat in the Italian Navy.

This vessel was designed by Engineer Laurenti; and is fitted with special petrol engines, from the designs of the Chief Constructor of the Italian Navy, Colonel Vittorio Cuniberti.

The hull of the Glauco is shaped like an ordinary torpedo boat, and is 100 feet long and 14 feet in diameter. Her displacement is 150 tons on the surface.

She is propelled, when above water, by a 12 cylinder petrol engine of 600 h.p., which gives her a speed of 11½ knots.

Two electric motors propel the "Glauco," when submerged. The current is supplied from accumulators, on the Tudor system, which, from numerous experiments carried out, appear to be the lightest and most efficient of the many patterns submitted for trial.

The Glauco is fitted with twin screws, and attained a submerged speed of 8½ knots on her trial trip. She has a surface radius of 1,000 knots, and is thus capable of taking part in actions fought at a distance from a base. Her endurance submerged at full speed is very small, being only 24 miles, but she can remain submerged for over seven hours, owing to the action of her horizontal fins. If she could manage, by "accident or design," to get in the track of the enemy's fleet, she could submerge and await her opportunity without using much of her stored electrical energy. She would then be in the most favourable position for a submarine attack.

The auxillary electric motors can be coupled to air compressors (as in the Delfino) when the vessel is travelling on the surface. The compressed air, which is carried in steel flasks, is sufficient to last the crew for eight hours.

The Glauco is armed with one torpedo tube, which, by an arrangement of watertight joints, can be trained over a large arc. The exact particulars of this moveable submerged tube are kept a strict secret.

The Glauco proved remarkably successful, and during the Italian submarine manœuvres at Taranto, which took place during the middle of October, 1906, she proved herself by far the most efficient submarine torpedo-boat in the Italian flotilla.

She succeeded in torpedoeing a Depôt ship travelling at 22 knots; and in remaining submerged for seven hours at a depth of 50 feet. On another occasion the Glauco attacked a flotilla of Italian torpedo-boat destroyers, and torpedo gunboats, which were lying at anchor surrounded by picket-boats.

The submarine approached the flotilla unobserved, and succeeded in diving under the picket-boats, without being seen until she was within a few hundred yards of a gunboat.

The Italian Government consider this submersible torpedo-boat a remarkable success. Two others of the same type have already been launched, and two more are nearly completed.*

* These four are now in commission.

These are named the Narvalo, Squalo, Otario, and Trichico. They were all built at Venice Arsenal, and are exact reproductions of the successful Glauco. It is therefore unnecessary to give any further particulars.

There are nearly completed at Muggino six more submersibles of an improved type. These vessels which were to be ready in the beginning of 1910, have the following dimensions:—

Length 138 feet.
Diameter 14 feet.
Surface displacement 175 tons.
Submerged displacement 220 tons

They will be fitted with a special type of petrol and electric engine, for use on the surface and when submerged; and they are expected to attain a surface speed of 15 knots. Their endurance under the petrol engine, at economical speed, will be 2,000 knots; and the armament will consist of two bow torpedo tubes. Six 18 inch Whiteheads will be carried.

These are the latest boats of this class ordered for the Italian Navy, and when they are launched the Italian torpedo-boat flotilla will be sensibly increased.

Italian Submarine Depots—Torpedoes, &c.

Minister of Marine: Rear-Admiral Carlo Mirabello.
Chief Constructor: Colonel V. Cuniberti.
Spezia: Chief Submarine Depôt (first 2 boats built here).
Venice: Chief Submarine Depôt (Glauco type built here).
Muggiano: (latest 4 boats building).

Type of Torpedo used in Italian Submarines.
Whitehead's (17·72 in.) type.

Personnel.

The personnel of the Italian Submarine Flotilla is fairly efficient; but the training up to the present is not systematic.

JAPANESE SUBMARINE FLOTILLA.

THE practical way in which Japan is rapidly building an effective flotilla of submarine torpedo-boats is shown by the fact that, although the first vessel of this kind was not launched until 1904, Japan already possesses nine submarines of the latest type; and has two more on order. These boats, which are all of the "Holland-Improved" type, were built by the American Company, and Messrs. Vickers of Barrow.

The first five have the following dimensions:—Length 65 feet; Diameter 12 feet; and a Displacement of 120 tons.

They are propelled, when on the surface, by a four cylinder vertical Petrol engine of 160 horse power, and, when submerged, by an electric motor of 70 h.p. These boats attained a maximum trial speed of nine knots on the surface, and seven knots when submerged. They have recently been fitted with two périscopes, one small and one large. Their armament consists of one bow torpedo expulsion tube, and three 18 inch (short) Whitehead torpedoes are carried.

The trials of these submarines proved fairly successful; but they are bad "divers," and their stability when submerged left much to be desired.

The "Toyohaschi," an old merchant vessel of 4,200 tons, is acting as a torpedo depôt ship*

Japan has four more submarines of the improved Holland type. These new vessels have an increased length of 35 feet, and 70 feet, making their length over all 100 feet, and 135 feet respectively; and their shape is longer and slimmer. The "buff nose" of the first boats has been considerably modified in the four new boats; and their speed has been considerably increased.

It is stated that these vessels will be equipped with a special life saving dress, for use in case of accident; and they will be fitted with two torpedo tubes, instead of one, as in the first boats. Three 18 inch (short) Whitehead torpedoes are carried.

The Japanese model of the Whitehead torpedoes (long) is much too heavy for use in submarine boats.

The new vessels building will also be fitted with 16 cylinder petrol engines of much greater power. When these vessels are built, the Japanese submarine torpedo-boat flotilla will number 11 vessels of the most efficient type.

* From "Jane's Fighting Ships," 1906, by Fred T. Jane.

GERMAN SUBMARINE FLOTILLA.

THE first submarine boats built for the German Navy, were two vessels of the Nordenfeldt type, launched at Kiel and Dantzig in 1890. These vessels proved fairly successful; but they are no longer of any fighting value, and I have, therefore, omitted to mention them in the table.

The first submarine which can now be reckoned as a fighting unit of the German torpedo-boat flotilla, was a vessel designated the "U1." This vessel was built at the Germania Shipyard, Kiel, and launched on August 30th, 1905.

This boat, the demensions of which can be seen in the accompanying table, is fitted with petrol engines of the Koerting type for propulsion on the surface, and an electric motor of 100 h.p., for use when submerged. She is fitted with a special automatic device for maintaining equilibrium when submerged. Her armament consists of one bow torpedo tube, and three (17.7) Schwartzkopf torpedoes are carried. These torpedoes are constructed of phosphor-bronze, and are fitted with Gyroscopes. Their range is 1,000 yards at 30 knots.

The trials of the "U1" extended over a period of a year and a half, and all proved remarkably satisfactory. During her submergence tests, which took place in Eckernforder Bay, she dived twice to a depth of 45 feet, and remained there for some minutes. She also succeeded in torpedoeing a moving target, while travelling submerged at full speed.

The "U2," which was launched at Kiel in 1906, underwent her trials in the Autumn of 1908; with the exception of a few minor improvements she is exactly like the "U1."

The "U3" and "U4" were laid down at the Germania shipyard in May, 1907; and took their place in the German Flotilla during November of 1908.

The "U5," "U6," and "U7," which have already been laid down, will also be completed in about eighteen months.

The two hundred thousand pounds voted for the construction of submarines, and the large dimensions of the first German submarine, U1, indicate that the uncertainty displayed for some years by the German Naval Authorities regarding the value of submarine boats, has given place to a thorough sense of the important part these "mighty atoms"

must play in future naval warfare; and to a strong determination that the German Navy shall include a submarine flotilla, equal to that of any other nation.

German Submarine and Torpedo Depots—Torpedoes, &c.

Torpedo and Submarine Depôts (or proposed):—

Kiel. Wilhelmshaven. Heligoland.

Torpedoes used in German Submarines.

17.7in. Schwartzkopf (phosphor-bronze); range, 1,000 yards at 30 knots, 1,500 at 26 knots; charge, 240 lbs.

Personnel.

The personnel of the German Submarine Flotilla is, up to the present time, very inexperienced; but taking into consideration the efficiency of the general torpedo service and the submarine exercises which are now constantly being carried out, it will not be long before German submarines are handled with the same adroitness that torpedo-boats are at present.

SWEDISH SUBMARINE.

SWEDEN commands one submarine of the Holland type. This vessel, which is named the Hajen, was launched in 1904. (For dimensions, see table, p. 84).

She is propelled, when on the surface, by a four cylinder vertical petrol engine of 200 I.H.P., and, when submerged, by an electric motor.

The manœuvring qualities of this vessel, both on the surface and when submerged, are excellent, and her trials proved very successful. In the summer of 1905, the Hajen succeeded in "hitting" twice in quick succession a torpedo-gunboat steaming at full speed.

The success of this vessel has induced the Swedish Naval Commission to consider the advisability of ordering two more of the same type.

A submersible, named after its inventor, Herr Enroth, a Swedish Engineer, has been experimented with, but not purchased. This vessel uses steam for its motive power and was designed for coast defence.

SPANISH SUBMARINE.

SPAIN possesses but one submarine torpedo-boat, the "Peral" which was launched at the Arsenal at Carraça in October, 1887.

This vessel was designed by Lieutenant Peral of the Spanish Navy.

The only trial of this vessel worthy of note took place during the summer of 1890, when the submarine succeeded in torpedoeing the armoured cruiser Christobal Colon; but this proved little, for the attack took place at night, and the Peral was allowed to submerge before the cruiser was permitted to use her search-lights.

The Peral is fitted with two vertical steering propellers, and has a searchlight intended for use under water. These are the only features of the Peral worth mentioning, as she is an old boat of no fighting value.

The designs for three other submarines have been offered to the Spanish Government, including the plans for a submersible torpedo-boat, by a well-known French inventor; but none of these have as yet been accepted.*

For particulars of the submarines of small Naval Powers see table page 84.

* The strengthening of the Royal Spanish Navy recently decided upon will, doubtless, cause a small submarine flotilla to be provided.

BRITISH SUBMARINE TORPEDO BOATS.

Name.	Where Built.	Launched.	Displacement on Surface.	Displacement Submerged.	Length.	Beam.	Depth.	Motive Power on Surface and Submerged	H.P. of Surface Engine.	No. of Propellers.	Speed. Knots.	Maximum Surface Endurance.	Endurance Submerged	Time to 1st Submerge	No. of Torpedo Tubes	No of Torpedoes carried.	Complement.	Colour of Paint	Notes on Trials, etc.
Nos. 1-5	Vickers, Barrow	1901-2	—	120 tons	63	ft. in. 11 9	ft. in. 11 9	Petrol and Electricity.	190	1	* ‡ 8·5	400 kts. at 8 kts.	3 hours fullspeed	—	1	3—18in.	7	pale colourless gray.	**Nos. 1—5.**—" Holland boats," only moderately successful, great trouble was experienced with the petrol engines. They were very erratic when submerged, and their surface cruising qualities were bad.
A 1-A 4	Vickers, Barrow	1903 ...	—	180 tons	100	10 0	10 0	,,	600	1	11·7	400 kts. at 10 kts.	3 hours fullspeed	—	1	4—18in.	varies from 10 to 15.		**A 1—A 4.** " Improved Holland," fitted with high conning-tower, and short periscopes. These four boats showed only a slight improvement on the original boats.
A 5-A 13	Vickers, Barrow	1904 ...	—	200 tons	100	10 0	10 0	,,	600	1	11·8	500 kts. at 10 kts.	3 hours fullspeed	—	2	4—18in.			**A 5—A 13.** An improvement on previous A's.
B 1-B 11	Vickers, Barrow	1905-7	—	300 tons	135	10 0	10 0	,,	600	1	12·8	1,800 kts. at 10 kts.	4½ hours fullspeed	—	2	4—18in.			**B 1—B 11.** These boats proved far superior to all preceeding ones, and are equal even now to any foreign submarines afloat.
C 1-C 9	Vickers, Barrow	1906 ...	—	320 tons	135	13 6	12 0	,,	600	2	13·9	2,000 economical	4½ hours fullspeed	—	2	4—18in.			**C's.** Sea-going submarines of great fighting value (improved B's.)
C 10 & C 11	Vickers, Barrow	1907 ...	—	320 tons	135	13 6	12 0	,,	600	2	13·9	,,	4½ hours fullspeed	—	2	4—18in.			
C 12-C16	Vickers, Barrow	1908 ...	—	320 tons	135	13 6	12 0	,,	600	2	—	,,	4½ hours fullspeed	—	2	4—18in.			
C 19-30	,,	1909 ...		320 tons	135	13 6	12 0									4—18in.			
D 1	Vickers, Barrow	1909 ...	—	150 tons	150	—	—	,,	830	2	15·9	—	—	—	—	—			**D 1.** This boat is a very marked improvement on all predecessors, and is undoubtedly the most efficient submarine afloat.
C 31-38	Vickers, Barrow								600	2	13.9				2	4—18in.			
C 17-C18	Chatham ...	,, ...	—	320 tons	135	13 6	12 0	,,	600	2	—	(expected)...	4½ hours fullspeed	—	2	4—18in.			
12	Projd. 1910				—	—	—	,,	—	2	—	2,000 economical	—	—	—	—			

	Name.	Where Built.	Launched.	Displacement on Surface in Tons.	Displacement Submerged in Tons.	Length. In feet and inches.	Beam.	Depth.	Motive Power on Surface and Submerged.	H.P. of Surface Engine	No. of Propellers.	Speed. knots.
						ft. in.	ft. in.	ft. in.				‖ ‡
*	Gymnôte	Mourillion	1888	30	...	56 6	6	6 0	§Electricity	55	1	6·4
*	Gustave Zédé	Toulon	1898	266	...	160	12 4	12 4	,,	220	1	8·5
†	Narval	Cherbourg	1899	106	200	111 6	12	12	Steam and Electricity	250	1	12·8
*	Morse	,,	1899	146	...	118	9	9	§ Electricity	360	1	,,
*	Francaise	,,	1901	,,	...	,,	,,	,,	,,	350	1	,,
*	Algerian	,,	1901	,,	...	,,	,,	,,	,,	,,	1	,,
†	Sirene	,,	1901	106	200	111 6	12 4	,,	Steam and Electricity	217	1	,,
†	Triton	,,	1901	,,	,,	,,	,,	,,	,,	,,	1	,,
†	Espadon	,,	1901	,,	,,	,,	,,	,,	,,	,,	1	,,
†	Silure	,,	1901	,,	,,	,,	,,	,,	,,	,,	1	,,
*	Farfadet	Rochefort	1901	185	...	185	9 5	9 5	§ Electricity	...	1	,,
*	Lutin	,,	1901	,,	...	,,	,,	,,	,,	...	1	,,
*	Korrigan	,,	1902	,,	...	,,	,,	,,	,,	...	1	,,
*	Gnome	,,	1902	,,	...	,,	,,	,,	,,	...	1	,,
*	Naiade	Cherbourg	1902	67	...	76	7 6	8	Petrol and Electricity	60	1	8·5
*	Protée	,,	1902	,,	...	,,	,,	,,	,,	,,	1	,,
*	Perle	,,	1903	,,	...	,,	,,	,,	,,	,,	1	,,
*	Castor	Rochefort	1903	,,	...	,,	,,	,,	,,	,,	1	,,
*	Loutre	,,	1903	,,	...	,,	,,	,,	,,	,,	1	,,
*	Lynx	Cherbourg	1903	,,	...	,,	,,	,,	,,	,,	1	,,
*	Truite	Toulon	1903	...	...	...	...	...	...	...	...	...
*	Oursin	Rochefort	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Meduse	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Otarie	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Phoque	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Ludion	Cherbourg	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Alose	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Anguille	Toulon		...	...	,,	,,	,,	,,	,,	1	,,
*	Grondin	,,	1904	67	...	,,	,,	,,	,,	,,	1	,,
*	Dorade	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,

* Submarine. † Submersible. ‖ Surface. ‡ Submerged. § On Surface or Submerged.

TORPEDO - BOATS.

Maximum Endurance. Surface.	Maximum Endurance. Submerged. See Note below.	Time to 1st Submerge.	No. of Torpedo Tubes.	No. of Torpedoes carried.	Complement.	Colour of Paint.	Depot of Flotilla.	Notes on Trials, etc.
		Min					=	
180 miles at 6 kts.	6 miles ($1\frac{3}{4}$)	20	2 Holders	2 14in.	4		D	**Gymnôte.**
80 „ 8 „	...	10	1 Tube	3 18in.	9		D	Fairly successful for Frst Naval Submarine, now mostly used as a Training Ship for officers and men of French Submarine Flotilla. Little fighting value.
600 „ 8 „	32 miles at 8 kts.	20	4 Holders	4 18in.	9		A	
120 „ 6 „	30 „ 6 „	5	1 Tube	3 18in.	„		A	**Gustave Zédé.**
80 „ 10 „	30 „ 7 „	3	1 Tube 2 Holders	4 18in.	„		A	Very unsuccessful at first, but fairly successful later, after alterations. Many important and successful trials. On two occasions has torpedoed warships travelling at half-speed, and in French Naval Manœvures, 1901, succeeded in entering Ajaccio harbour while in possession of hostile fleet and torpedoed battleship, then, owing to bad maneouvring, was adjudged destroyed.
„	„	3	„	„	..		A	
600 „ 8 „	30 „ 8 „	9	4 Holders	„	10		A	
„	„	„	„	„	„		A	
„	„	„	„	„	„		A	
„	„	..	„	„	„		A	
200 „ 7 „	30 „ 8 „	3	1 Tube 2 Holders	„	9		E	**Narval.**
„	„	„	„	„	„		C	The French Government consider this type very successful. Good qualities for surface cruising, and all trials fairly successful. Stability when submerged, moderate. Great fault, time taken to submerge.
„	„	„	„	„	„		E	
„	„	„	„	„	„		C	
Small	Very Small	„	1 Tube 2 Holders	...	5		B	**Morse, Francaise and Algerian.**
„	„	„	„	...	„		F	Improved Gustave Zede. Trials fairly successful; increased surface buoyancy, and therefore better qualities for cruising.
„	„	„	„	...	„		F	
„	„	„	„	...	„		C	**Sirene, Triton, Silure, and Espadon.**
„	„	„	„	...	„		C	Improved 'Narvals'; can submerge in half time taken by prototype. Good sea boats; fairly invisible when submerged, but rather erratic. Very small radius for submersible type.
„	„	„	„	...	„		F	
„	„	„	„	...	„		...	**Farfadet, Lutin, Korrigan, and Gnôme.**
„	„	„	„	...	„		C	Fairly good sea boats, but bad divers. Accident to first two (see p 139).
„	„	„	„	...	„		C	
„	„	„	„	...	„		C	**Perle Class.**
„	„	„	„	...	„		B	Very successful for size, but strictly limited to coast defence. Proved on trials good surface manœuvring powers but erratic when submerged.
„	„	„	„	...	„		B	
„	„	„	„	...	„		D	
„	„	„	„	...	„		D	**Souffleur, Thon, Bonité, and Esturgeon.**
„	„	„	„	...	„		D	See table, pp 76-7.
„	„	„	„	...	„		D	

Pale Sea Green, with a tendency to Grey.

Note.—Endurance under Electric Engines. In some cases a rise to the surface is necessary to replenish air supply.

|| See under French Submarine Flotillas pp 44-5.

FRENCH SUBMARINE

	Name.	Where Built.	Launched.	Displacement on Surface.	Displacement Submerged.	Length.	Beam.	Depth.	Motive Power on Surface and Submerged.	H.P. of Surface Engine.	No. of Propellers.	Speed.
				Tons.	Tons.	ft.	ft. in.	ft. in.				‖ ‡
*	Souffleur	Toulon	1904	67	...	76	7·5	8	Petrol and Electricity	60	1	8-5
*	Thon	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Bonité	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
*	Esturgeon	,,	1904	,,	...	,,	,,	,,	,,	,,	1	,,
†	Aigrette	,,	1904	172	...	118	12.6	8.6	Steam and Electricity	200	1	10-5
†	Cicogne	,,	1904	,,	...	,,	,,	,,	,,	200	1	,,
*	"X"	Cherbourg	1904	168	...	122	10	10	Benzoline and Electricity	220	2	,,
*	"Z"	Rochefort	1904	202	...	136	10	10	...	190	1	11-8
*	"Y"	Toulon	1905	213	...	148	10	10	§Compressed Air and Alcohol	250(?)	1	11-8
†	Omega	,,	1905	300	375	140	18	9	Steam and Electricity	330	1	11-9
*	Emeraude	Cherbourg	1906	390	450	146	18	12	Petrol and Electricity	600	2	12-8½
*	Opale	,,	1906	,,	,,	,,	,,	,,	,,	,,	,,	,,
*	Rubis	,,	1907	,,	,,	,,	,,	,,	,,	,,	,,	,,
*	Saphir	Toulon	1908	,,	,,	,,	,,	,,	,,	,,	,,	,,
*	Topaz	,,	1908	,,	,,	,,	,,	,,	,,	,,	,,	,,
*	Turquoise	,,	1908	,,	,,	,,	,,	,,	,,	,,	,,	,,
*	"No, 61"	——?	...	20	...	...	...	...	...	...	,,	...
*	Guêpe 1 and 2	Cherbourg	1908	44	...	...	...	...	...	50	1	9-5
†	Circé	Toulon	1907	344	...	...	...	...	...	440	...	...
†	Cylapso	,,	1907	344	...	...	...	...	...	,,	...	...
†	Nos. 51—60	Cherbourg										
†	,, 62—69	Rochefort*	Bld.	398	...	160	16	...	...	700	2	12-9
†	,, 70—86	Toulon										
†	,, 87—89	...	Pro.	560	800	...	...	...	...	...	...	15-10
†	,, 90—99	...	Pro.	...	...	...	...	...	...	...	...	...

† Submersible. * Submarine. ‖ Surface. ‡ Submerged. § On Surface or Submerged.

* Three or more are already in commission. They are named the Pluviose, Ventose, and Germinal; fifteen more are nearly completed and will join the flotillas during 1910-1911.

TORPEDO-BOATS.

Maximum Endurance.		Time to first Submerge.	No. of Torpedo Tubes.	No. of Torpedoes carried.	Complement.	Colour of Paint.	Depot or Flotilla.	Notes on Trials, etc.
Surface.	Submerged. See note below.							
		Min					=	
Small	Very Small	3	1 Tube	...	5		D	**Aigrette and Cicogne.** There are 29 of the most efficient French submersibles in commission. In comparitive trials with submarine "Z" Aigrette superior in nearly every way. Surface cruising qualities good. Submerged very fair. Radius of action good. Cicogne has this year (1907) successfully accomplished a dive of over 100 feet at Toulon.
,,	,,	,,	,,	...	5		D	
,,	,,	,,	,,	...	5		D	
,,	,,	,,	,,	...	5		F	
700 at 8 kts.	60 at 6 kts.	4	,,	...	20		A	
,,	,,	4	,,	...	20		D	
500 economic speed	,,	3	2 Tubes	6, 18 in.	15		A	**"X"** Fairly successful. Improvement regarding stability, both surface and when submerged; also in powers for quick submersion. During first trials she succeeded in torpedoing a Battleship at full speed.
,,	,,	3	,,	,,	20		A	
400 economic speed	20 hours (?)	...	,,	,,	15		D	
650 economic speed	...	...	2 Tubes 2 Holders	,,	20		...	**"Z."** Not very successful. Comparative trials proved Aigrette superior. Doubtful results regarding stability on the high seas.
1100 economic speed	4 hours	2	2 Tubes 4 Holders	,,	22		...	
,,	,,	,,	,,	,,	,,		...	**"Y."** During first trials this submarine proved a distinct failure, but after drastic charges had been made she was able to take her place in the "D" Flotilla.
,,	,,	,,	,,	,,	,,		...	
,,	,,	,,	,,	,,	,,		...	
,,	,,	,,	,,	,,	,,		...	**No. 61.** Very little is known about this vessel, and some doubt exists if this vessel is really built.
,,	,,	,,	,,	,,	,,		...	**Omega.** No further particulars.
...	...	...	...	...	...	Pale sea-green, with tendency to grey.	...	**Emerauda Opale, Rubis, Saphir, Turquoise, and Topaze.** These submarines are designed for offensive action, and will undoubtedly prove far superior to any previous vessels.
...	...	2 *exptd*	2 Holders	...	...		...	
...	...	...	2 Tubes 4 Holders	...	...		...	
...	...	...	,,	...	...		...	**Guepe 1 and 2.** Small Submarine, intended solely for harbour defence.
2500 at 12 kts, expected	6 hours	...	...	...	...		...	**Circe & Caylapso.** Improved type of submersible, heavily armed and have large radius of action
,,	,,	...	...	...	...		...	**Nos. 87-89.** The largest submersibles on order by any Naval power, and will be valuable additions to the French Navy.
...	...	...	...	...	...		...	

Note.—Endurance under electric engines. In some cases a rise to the surface is necessary to replenish air supply.

|| See under French Submarine Flotilla, pp 44-5.

	Name.	Where Built.	Date of Launch.	Surface Displacement.	Submerged Displacement.	Length.	Beam.	Depth.	Motive Power on Surface and Submerged.	H.P. of Surface Engine.	No. of Screws.	Speed. knots.
						Feet.	Feet.	Feet.				§ ‡
*	Petr Kochka‖	Kronstadt	1902	20	...	50	14	10	Electricity	...	2	8·6
*	Delphin	,,	1902	...	...	...	...	...	...	...	...	...
*	Graf Cheremetiev	Holland Type	1904	175	...	77	14	14	Petrol and Electricity	...	1	9·7
*	Nalim	Kronstadt	1904	...	...	80	14	10	Electricity	...	2	9·5
See Description p 49-50	Ostr	Lake Boat (Protector)	1904	115	170	65	11	...	Petrol and Electricity	250	2	12·7
	Skat	,,	1904–5	,,	,,	,,	,,	...	,,	,,	,,	,,
	Lom	,,	1904–5	,,	,,	,,	,,	...	,,	,,	,,	,,
	Kasatka	,,	1904–5	,,	,,	,,	,,	...	,,	,,	,,	,,
	Forel	,,	1904–5	,,	,,	,,	,,	...	,,	,,	,,	,,
*	Peskar	Holland Type	1905–6	175	...	77	14	14	,,	...	1	...
See Description of Lake Boats, p 49-50	Schuka	Lake Type	1905–6	115	170	65	11	...	,,	250	2	12·7
	Byeluga	,,	1905–6	,,	,,	,,	,,	...	,,	,,	,,	,,
	Losos	,,	1905–6	,,	,,	,,	,,	...	,,	,,	,,	,,
	Sterylad	,,	1905–6	,,	,,	,,	,,	...	,,	,,	,,	,,
†	Kefal	Holland, Biriliff	1906–7	175	...	77	14	14	,,	200	1	10·8
†	Sig	,,	1906–7	,,	...	,,	,,	...	,,	,,	,,	,,
†	Platus	St. Petersburg	1906	...	...	80	,,	14	Steam	...	...	12·7
†	Plotva	Holland, Biriliff	1906	175	...	77	,,	14	Petrol and Electricity	...	...	...
*	Buichok	Kronstadt	1906	,,	...	50	,,	...	Electricity	...	2	10·8
†	Okun	Holland, Biriliff	1906	140	...	...	,,	...	...	...	2	...
†	Makrel	,,	1906	,,	...	...	,,	...	...	...	,,	...

6 other Boats on order (American Lake design). * Submarine. † Submersible. § Surface. ‡ Submerged.

‖ It is generally believed that this vessel was captured at Port Arthur.

TORPEDO - BOATS.

Maximum Endurance.		Minutes in Submerging	No. of Torpedo Tubes.	No. of Torpedoes carried.	Complement.	Colour of Paint.	Depot of Flotilla.	Notes on Trials.
Surface.	Submerged.							
18 miles full speed	2 hours	...	2 Holders	Whitehead 2 18 short	...		...	**Petr Kockha.** This small Submarine proved very successful, but owing to small radius, slow speed, and erratic motion when submerged, she is of no fighting value. The torpedo launching apperati at the submarine manœuvres in 1908 twice failed to work.
...	...	...	...	...	...		...	
...	...	...	...	...	...		...	
...	...	...	...	...	...		...	
450 knots at full speed	4 hours	...	3 (2 Bow 1 Stern)	3 or 5 18in. (long)	7		Kronstadt	**Delphin.** Very successful. Has made some remarkable surface cruises from Kronstadt to Bjoerkoe.
,,	,,	...	,,	,,	...		...	
,,	,,	...	,,	,,	...		...	
,,	,,	...	,,	,,	...		...	**Lake Type.** The Protector, re-named the Ostr, was refused by the American Government before being sold to Russia, but she certainly embodies many new and valuable features.
,,	,,	...	,,	,,	...		...	
...	3½ hours	...	1 Tube (Bow)	2 18in. (short)	...		...	
...	...	...	...	...	...		...	**Holland Biriliff Type.** As far as can be ascertained, these boats proved very successful.
...	...	...	...	...	...		...	
...	...	...	...	...	...		...	
...	...	...	...	...	...		...	
...	...	...	4 Holders	4 18in. (long)	...		...	
...	...	...	,,	,,	...		...	
600 at 12 kts.	(Semi Submersible)	...	,,	,,	...		...	
...	...	...	...	...	...		...	
...	...	...	2 Holders (1 Ahead, 1 Astern)	2 18in. (short) ...	...		...	
...	...	...	...	...	...		...	

NOTE.—The dates and figures in this table are only approximate. Owing to the strict secrecy which surrounds the Russian Submarine Flotilla, it is impossible to get any exact information as to the dates of launch, etc.

ADDENDA.—Three new boats named "Kambala," "Karas," and "Karp having the following approximate dimensions:—Displacement 240 tons, surfaced, H.P. 250, have been added to the Russian flotillas.

Name.	Where Built.	Date of Launch.	Submerged Displacement.	Length.	Beam.	Depth.	Motive Power on Surface and Submerged.	H.P. of Surface Engine.	No. of Screws.	Speed.	Maximum Endurance.		No. of Torpedo Tubes.	No. of Torpedoes carried.	Complement.	Depot of Flotilla.	Notes on Trials.
											Surface.	Submerged.					
*"Holland"	Elizabethport, N.J.	1897	75	ft. in. 54	ft. in. 10	ft. in. 10 6	Petrol and Electricity	45	1	§ ‡ 8·5	150 miles at 6 kts.	3 hours	1	3 18in. (short)	...	Mostly at Cutchoque Bay, Long Island, N.Y.	**Holland.** First U.S. submarine. Designed by Mr. J. P. Holland. This vessel is really a submersible (see definition under France). The "Holland" was the forerunner of many submarines of the same type. Trials proved fairly successful, but she is now of little value.
*Adder	,,	1901	120	63 4	11 9	12	,,	160	1	9·6½	400 miles at 9 kts.	3 hours	1	,,	...		**Adder, Porpoise, Shark, Grampus, Moccasin, Pike, and Plunger.** Improved Hollands. Trials fairly successful, but these vessels lack stability when submerged. Good qualities for surface cruising, and have proved very reliable.
*Porpoise	,,	1901	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Shark	,,	1901	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Grampus	San Francisco	1902	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Mocassin	Elizabethport, N.J.	1902	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Pike	San Francisco	1902	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Plunger (—)	Elizabethport, N.J.	1902	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	...		
*Cuttlefish	Quincy, Mass.	1906	170	106	10	10 0	,,	,,	2	9½·8	(Slightly inferior to Octopus)			...	...		**Octopus and Cuttlefish.** The "Octopus" is undoubtedly the most efficient submarine in the U.S. Flotilla. For account of trials see p 60.
*Viper	,,	1906		,,	,,	,,	,,	...	...	...	...	...	...	...	...		
*Tarantala	,,	1906		,,	,,	,,	,,	...	...	...	...	...	...	...	...		
*Octopus	,,	1906	170	,,	,,	,,	,,	...	...	10·8½	600 at 10 kts.	115 miles, 5½ 85 at 8 kts.	2	5 18in. (short)	15		
15 larger vessels of the same type built or building.†																	

NOTE. — The first U.S. Naval Submarine was a vessel named the "Plunger," designed by Mr. J. P. Holland, but this vessel was never completed, and the money paid for it by the U.S. Government was refunded by the Holland Torpedo Boat Company on condition that the Government contracted with them for an entirely new and improved vessel. This the Government wisely did, and the "Holland" was built. The "Plunger" (—) mentioned above is one of the later boats named after the first and original boat.

* Submarines. § Surface. ‡ Submerged.

† It is understood that some of these vessels are named Salmon, Sturgeon, Skate, Tarpon, Stingray, Carp, Grayling, Skipjack, Snapper and Thrasher.

ITALIAN SUBMARINE TORPEDO-BOATS.

Name.	Where Built.	Date of Launch.	Surface. Displace	Submerged ment.	Length.	Beam.	Depth.	Motive Power.	H.P. of Surface Engine.	No. of Screws.	Speed.	Maximum Endurance. Surface.	Maximum Endurance. Submerged	No. of Torpedo Tubes.	No. of Torpedoes carried.	Complement	Depot or Flotilla.
† Delfino	Spezia	1894	Tons. 95	Tons. 111	ft. in. 78 6	ft. in. 10	ft. in. 10	§ Electricity	150	1	‡ ‖ 10-7	Knots. Small	Small	2 Tubes	Whitehead 4-18 in.	12	...
† Tritone	„	1902	...	...	56	8 6	8 6	„	...	1	8-5½	(For Harbour defence		1 Holder	1-18 in.	5	Spezia
* Glauco	Venice (Arsenal)	1905	...	150	100	14	14	Petrol and Electricity	500	2	11½-8½	1000 at economical	... (7 hours) working horizontal emersion propeller (?)	1 Tube	...	...	...
* Squalo	„	1906	...	„	„	„	„	„	„	„	„	„	„	„	...	...	...
* Narvalo	„	1906	...	„	„	„	„	„	„	„	„	„	„	„	...	...	...
* Otario	„	1907	...	„	„	„	„	„	„	„	„	„	„	„	...	...	...
* Trichico	„	1908	...	„	„	„	„	„	„	„	„	„	„	„	...	...	...
* 6(Building)	Muggiano	1909	175	220	188	14	14	Special Petrol (engine)	...	...	15-10 (expctd)	2000 econnomical	(?)	2 Tubes	6-18 in.	...	...

Delfino.—The first Italian Submarine was the outcome of the trials of a small vessel, named after its designer, Engineer Pullino. This vessel turned out so very successful, that a larger boat of the same type was ordered by the Italian Government. The Delfino also proved remarkably successful; but owing to the small radius of action she is limited to coast defence.

Tritone.—A small Harbour defence boat. Rather erratic when submerged, insufficiently armed, and of little fightiug value.

Glauco, Squalo, Narvalo, Otario, and Trichico.—Submersible Topedoboats, shaped like ordinary torpedoboats. Fitted with horizontal emersion screws (like in Nordenfeldt boats). Proved very successful. Good "divers" sea-boats, and have a very wide sphere of activity.

NEW BOATS.—Expected to be completed by first part of 1910. They embody many new and improved features that does not exist in other boats. Should prove valuable additions to Submarine Flotilla.

JAPANESE SUBMARINE TORPEDO-BOATS.

Name.	Where Built.	Date of Launch.	Surface Displacement.	Submerged Displacement.	Length.	Beam.	Depth.	Motive Power.	H.P. of Surface Engine.	No. of Screws.	Speed.	Maximum Endurance.		No. of Torpedo Tubes.	No. of Torpedoes carried.	Notes on Trials.
												Surface.	Submerged.			
			tons.								§ ‡					
5 Boats	Holland type	1904	120		65	12	12	Petrol and Electricity	160	1	9·7	400 miles at 9 kts.	21 miles at 7 kts.	1 bow tube	3 18in. (short)	**1st. 5 Boats.** These submarines proved fairly successful during official trials, but are bad divers, and their stability when submerged left room for much improvement.
2 Boats	Japan	1907	180		100	10	10	„	300	1	10	400 miles at 10 kts.	„	„	„	
2 Boats	Vicker's Maxim	1909	300		185	18-6	18-6	„	600	2	18	2,000 at economical speed.	„	2	3	
2 New Boats building (same, but improved type)																**2 New Boats.** Improved "Holland" type. Will be equal to the submarines of any other nation (latest English, French, United States, and German excepted).

§ Surface. ‡ Submerged. Torpedoes used in Japanese Submarines, 18in. (short) Whitehead torpedoes.

SUBMARINE TORPEDO-BOATS (BUILDING) FOR SMALL NAVAL POWERS.

Number of Boats already in commission.	Naval Power.	No. of Boats and Type.	Where Building.	Date of Launch.	Dimensions.	Motive Power.	NOTES.
0	Austria	2 Holland Type	Barrow	1908	...	Petrol and Electricity	All these Submarines
1	Brazil	8 ,, ,,	...	1908	...	Do.	will be comparatively
0	Chili	1 (Small Electric)	...	...	...	Electricity	small Boats, for Coast
0	Norway	1 (Projected)	...	...	...	...	and Harbour defence.

PART II

Contents of Part II.

SUBMARINE WARFARE.

The Tactical Value of the "Day-light Torpedo Boat."

To arrive at a definite decision as to the value of submarine torpedo-boats, or the part they will play in future naval war, it is necessary to consider not only the submarines themselves, but also the methods of attack and defence, and to weigh carefully the evidence offered by naval officers who have had practical experience in commanding, or operating against them.

Submarines are known in the naval service 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-boat can do under cover of darkness or fog—that of creeping up close to an enemy, and launching a "Whitehead" unobserved.

Submarines have two great advantages, 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. Of course, there are many minor features, which I shall deal with later.

A clever naval tactician once described the submarine as a "handicapped torpedo-boat."

The two points on which he based this opinion, were the slow speed of these vessels, compared with that of the surface warship; and its almost total blindness when submerged.

These two defects are undoubtedly the principal drawbacks of all the submarines afloat at the present time; but since that naval expert pronounced submarines to be "handicapped torpedo-boats,"—great changes, great improvements have taken place.

The speed of the submarine has increased; and will go on increasing.

They have been given a longer and wider range of vision, by the introduction of two périscopes instead of one.

There is, however, great room for improvement in this field; and inventors would do well to turn their attention to discovering a new

method of seeing when submerged; for it is "eyes" that submarines require to make them perfect weapons.

INVISIBILITY.

There are many different types of submarines, each of which has its advantages, and disadvantages. I do not intend to deal here with the "pros and cons" of the different patterns,—my humble opinion on that point may be seen in the "comparative table" at the end of the book; but, as I have said before, one of the greatest points in favour of a submarine is its invisibility in each of the three positions in which it is designed to manœuvre, *i.e.*, on the surface, awash, and submerged.

Some types are much more easily detected when approaching than others.

A large white wave, thrown off by the conning-tower, was the excellent target which one type of French submarine made, while attacking in a semi-submerged, or awash condition, on her trial trip. Most of the vessels, however, used in the different navies, glide through the water with but little disturbance.

The submarines of the British Navy are specially painted a colourless, grey, so that, when travelling in an awash condition, they blend with the water around, and thus cannot be easily detected.

The best colour to paint the hulls of submarines, to cause them to be invisible from a distance, has been the object of years of experimenting. Some of the results of these paint-trials are very interesting.

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, the French Naval Officers in charge of the tests arrived at the conclusion that a pale, sea-green, non-luminous paint caused the submarines to be as invisible as is possible, considering the ever changing light and shade of the sea.

The British Admiralty have also carried out a few minor experiments in this direction; and they have come to the conclusion that a dull grey is the most serviceable, and invisible shade. Not only have they adopted it for submarines, but for all classes of warships.

DIVING ABILITY.

Another important factor in the value of the submarine is its ability to dive quickly. The time taken to perform this operation varies greatly. Some of the latest British submarines take scarcely three seconds to sink from the "awash" to the totally-submerged-condition; whereas many of the older foreign types took as long as ten minutes to perform this operation.

In time of war, every minute that an attacking submarine remained on the surface after the time had come to sink, would be adding a hundredfold to the risk of being seen by the enemy; and thus the vessel that takes the least time to submerge would stand the least risk of being hit by the hail of shot which would sweep the surface the moment a submarine was sighted above water.

DIVISION INTO CLASSES.

The tactical value of the different types of submarines varies considerably; for whereas some of the older patterns, owing to their small radius of action and armament are restricted to coast and harbour defence, others, like the latest British boats, are quite capable of taking part in actions fought at long distances from a naval base or depôt ship.

For convenience in estimating their tactical value, and the part they will play in future naval war, the submarines of all nations may be divided into three distinct classes.

These classes are as follows:—

(1) Sea-going submarines.
(2) Coast-defence submarines.
(3) Harbour-defence submarines.

The "comparative table" page 121 shows exactly to which class the vessels of the different Naval Powers belong.

TACTICAL VALUE OF SEA-GOING SUBMARINES.

This is the latest and most efficient type of boat. They have a comparatively wide sphere of activity, and more surface buoyancy in the "light condition" than vessels of the other two classes. They are, in fact, the newest, largest, fastest, and most heavily armed submarines of all nations.

They have speeds varying from 12 to 15 knots; radii of action of from 1,000 to 1,500 miles; and their average endurance when submerged is about 3½ hours at a speed of 8½ knots.

These submarines are intended, in the event of war, to accompany a coast defence fleet, and thus add enormously to its strength; for by so doing they set free a great many larger ships to take their place in the Battle Fleets.

It may be remembered that during the war between America and Spain, the inhabitants of the ports on the Atlantic coast of the United States insisted upon having some protection against mythical Spanish torpedo-boats. Several old and practically useless "monitors," were taken down to the different ports, and the population was satisfied. This is exactly what would happen in any country during a naval war; and submarines would be used to patrol the coast. This would have a moral effect, not only on an enemy who meditated an attack, but also on the inhabitants of coast towns.

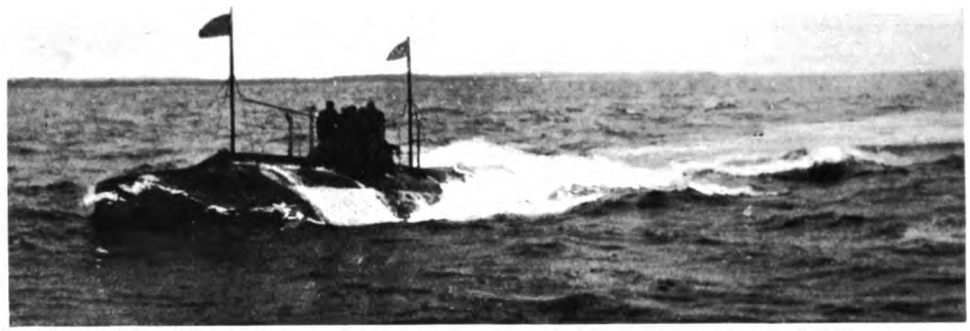
Therefore, these inexpensive, ideal coast defenders would set free a large number of vessels which would otherwise be required for the defence of unimportant ports, and coast towns.

Protection, of some sort, would be demanded by the inhabitants of coast-towns, whether it was absolutely necessary or not, during a Naval war in home waters.

In an action between a coast defence fleet and an investing squadron, sea-going submarines would certainly lend very valuable aid to the former, not only by the demoralizing effect that the knowledge of their presence would produce on the enemy, but also by reason of the great fighting value, due to their ability to operate within the zone of fire between engaging ships, when immersed to a depth at which the shot and shell of friend or foe would in no way affect them. Their value, when acting in conjunction with a coast defence fleet, cannot be over-estimated.

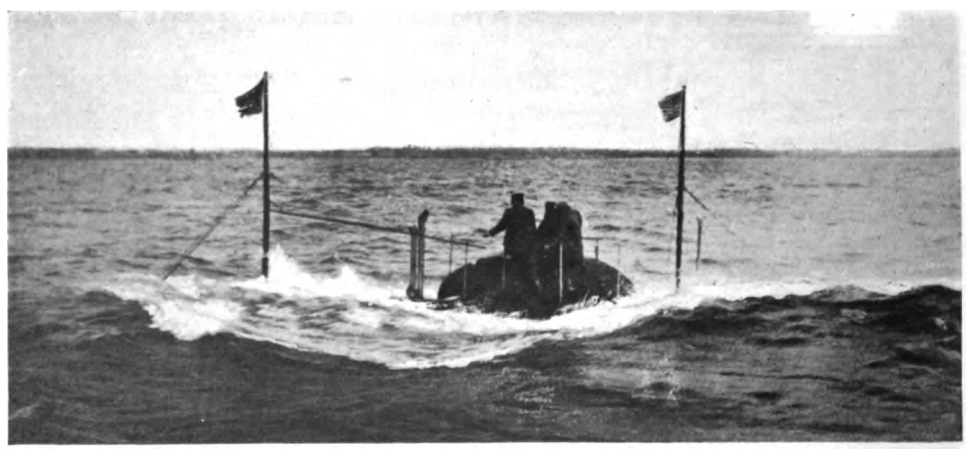
The sea-going submarines would also be used to harass the mercantile marine of the enemy, and for guerilla attacks upon the hostile fleets. They could also be used as dispatch boats, when it was necessary to go through the enemy's lines. Their ability to run submerged for 4 hours at a speed of 8½ knots, would enable them easily to pass completely under a hostile fleet.

The stern trial of war would bring out many other spheres of usefulness for these small inexpensive, but deadly craft.



The U.S. Submarine "Porpoise" running on the surface—light condition.

By special permission.



The U.S. Submarine "Porpoise" travelling a-wash with the conning-tower hatch open.
The illustration shows the danger of the a-wash run.

By special permission.

To face page 93.

COAST DEFENCE SUBMARINES.

The submarine torpedo-boats of this class would be used for holding the first line of coast defence, *i.e.* a line just outside the five mile limit, deemed effective in blockading or bombarding.

Many naval officers confidently assert that a fleet attempting to blockade or bombard a port defended by submarines would be forced to steam well out to sea the moment darkness gave place to light.

The blockading of Russian ports by the Japanese fleet was, in all probability, the last instance in which the harbours of a nation will be closed by a hostile fleet, or a close blockade or bombardment be carried out so successfully.

The strain on the personnel of a fleet, attempting to blockade a post defended by a powerful submarine flotilla, would affect the aim of the artillerist and would completely wear out the officers and crew.

M. Lockroy, ex-Minister of Marine of France, while watching an attack by submarines, made the remark that the excitement and strain on both officers and crew when expecting an attack by these unseen foes, would be terrible.

Admiral George Dewey, U.S.N., in a statement before the House Committee on Naval Affairs, once stated that with two submarines in Galveston, all the navies in the world could not blockade that place. With submarines moving under water the moral effect upon a hostile fleet would be tremendous, and would completely wear out the personnel.

Although "picketing" is considered to be a good defence against submarines, there is always the likelihood that a submarine might dive completely under the picket boats unobserved; and it is this chance, which would have such a demoralizing effect on an investing squadron, that makes it perfectly safe to say that the advent of the submarine torpedo-boat has made a close blockade impossible.

HARBOUR DEFENCE SUBMARINES.

These are the old vessels, or the very small ones—such as the two Guêpe boats, building for the French Navy. They would be used in time of war for defending the mouths of rivers, holding narrow waterways; and for defending unimportant harbours.

These vessels, owing to their very small radii of action, which in some cases does not extend 15 miles, and to their consequent inability to operate at even the smallest distance from a base, or depôt ship, would be strictly limited to the defensive; and as the policy of the British

Fleet is not defence but attack, none of these small vessels have been, or are likely to be, built for this country.

Submarine Warfare Tactics.

As to the tactics which would be employed by a submarine flotilla in attacking a hostile fleet, it would be 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; but the accompanying plan "D" shows a method of defence against an approaching bombarding or blockading fleet. Chart "A" roughly illustrates the general method of a submarine attack, viz: 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 2½ to 5 miles, as might be deemed expedient. She would then submerge, and steer by her périscopes, each of which have a range of vision of 50* degrees.

He would be a very keen look-out who would be able to detect the few square inches of périscopic-tube at a distance of 3 miles. As this distance lessened, it would be advisable—if the object of attack was stationary—for the submarine to slacken speed, so as to prevent any spray being thrown off by the périscopic-tube—as shown in the illustration of American submarines manœuvring.

Assuming, however, that the optical tube was seen by the enemy, it would be almost impossible to hit it either with gun-fire, or torpedoes; or to damage the boat, which would probably be immersed to a depth of 12 feet. At a distance of about 1,100 yards the submarine would discharge her first torpedo. Should this miss another could be discharged at shorter range from the second bow tube.

The submarine would then either dive completely under the "enemy," or else sink much deeper and turn tail.

Chart "B" represents the most favourable position for an attack.

The submarine has succeeded, by "accident or design," in placing herself in the track in which the enemy is steaming. She simply lies low while the hostile warship come forward to destruction.

* In some cases 60 degrees.

For methods of defence against submarines see pp. 100-108, 104-5.

SUBMARINE ATTACK AND DEFENCE

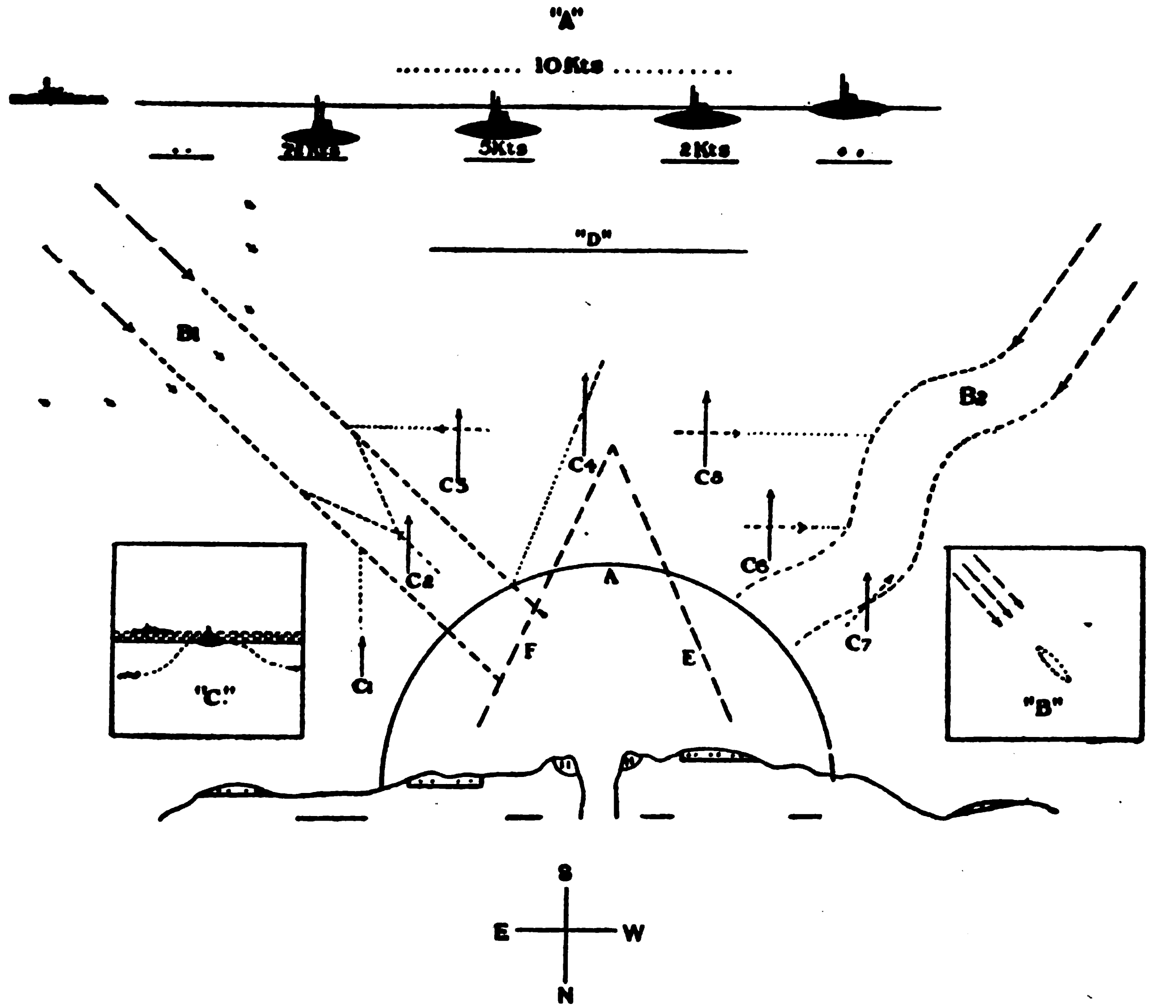


Chart "C" illustrates the manœuvre known as the "porpoise-dive." The submarine on approaching the object of attack, rises quickly to the surface by the action of her horizontal rudders and hydroplanes, then dives again, only remaining above water for a few seconds to enable her commander to get a glimpse of the enemy, and to take bearings. The submarine can then get within torpedo-range, with simply the tiny périscope projecting from the surface.

ATTACKING AT RIGHT ANGLES.

THE SPEED DIFFICULTY.

When it is taken into consideration that the speed of a submarine is frequently only half, or even a third, of that of her enemy, the difficulty of an attack at right-angles can be readily seen.

Chart "E," 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 eleven miles on her port-bow. "B" shows the hostile vessel's course; which is ten miles to point marked "C"; and each division beyond equals one mile.

Directly the submarine, which is represented as lying in an awash condition, sights the object of attack, (warship silhouetted), she totally submerges and steers forward at a speed of ten 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, which it would not be wise to state here, this is not the best point of attack.

This chart shows approximately the limit at which a submarine could sight and attack an enemy steaming at right-angles.

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 awash condition.
(5) Owing to (1) (2) and (3) (above) the submarine travels from point "D" on all courses in a submerged condition.

* 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 practise need only reach the torpedo firing line.

CHART "E"

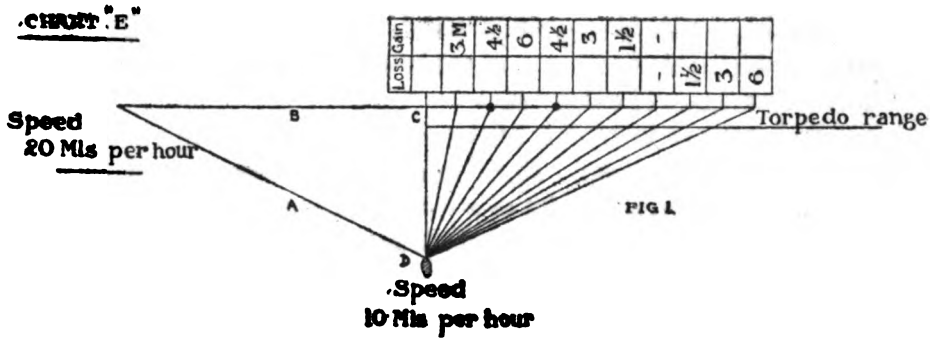


FIG 1.

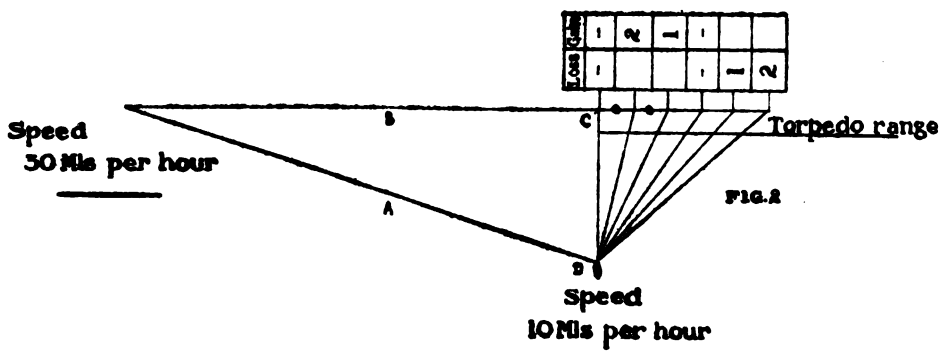


FIG.2

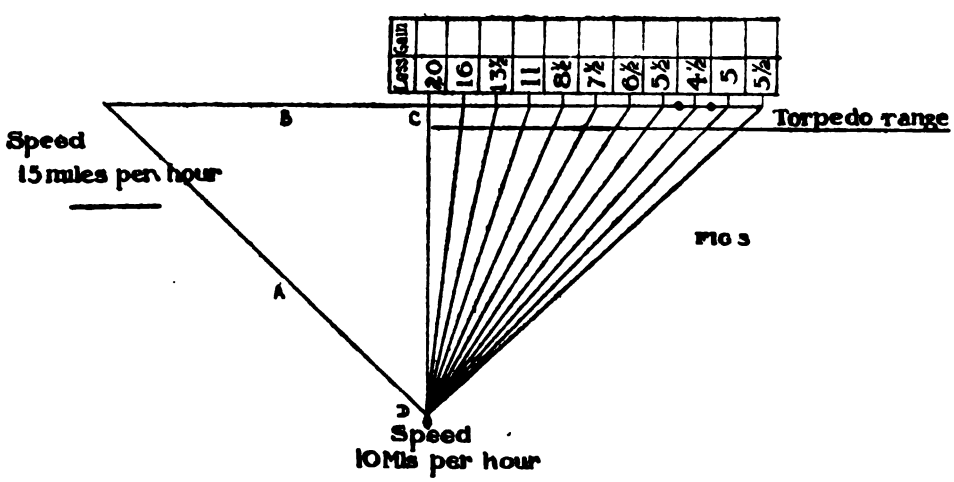


FIG 3

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

The distance to "C" is fifteen miles for the surface vessel, and five 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.

These show the limits at which an attack would be possible with a chance of success.

Chart "E," 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 fifteen miles an hour. (Ocean tramps, or cargo vessels, on which, in time of war, the people of England would rely for the main bulk of their food supply.)

In this case the surface vessel accomplishes the ten mile journey along course "B"—arriving at point "C," twenty 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.

These charts show approximately the extreme limits of the right-angle attack.

A submarine could, of course, proceed for some distance in the "light-condition" 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 almost certainly be detected, and thus destroy her chances of a successful attack.

Considering, also, the time that would be wasted in sinking from the "light" to the totally-submerged condition, on coming to close quarters, the submarine would in all probability fall short of her prey.

SUBMARINES DEFENDING A HARBOUR.
HOLDING THE FIRST LINE OF COAST DEFENCE.

METHOD I.

Plan "D," shows two methods of attack, by bombarding or blockading fleets, on a fortified base defended by submarines. The circle "A" shows the five mile limit, deemed effective in blockading or

bombarding. B1, and B2, are the hostile fleets approaching—B1 keeping a straight course, and B2 a zigzag course; which is considered to be one of the best defences against attacks by submarines.

Captain Bacon, D.S.O., in a paper before the London Institution of Naval Architects, pointed out that the true defences of a ship, or ships, when submarines were supposed to be in the vicinity, was speed, with a frequent change of course.

"C1—C7" are the submarines in "A" formation, waiting, in the awash condition for the approaching enemy, which has been sighted at a distance of just over seven miles.

"C1" submerges, and keeps a straight course, S.S.E., and attacks the starboard vessels of the hostile fleet; as shown on Chart "B."

"C2" travels slowly forward, on a S.E. course; and attacks any of the enemy's ships which succeed in evading "C1" and "C3."

"C4" is what might be termed the "goalkeeper," for she steams back in a N.E. direction; and attacks any hostile ship which gets within bombarding range (having eluded C1, C2, and C3).

It must be remembered that it is 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 the defending flotilla attacking one or two of the hostile ships, and allowing the others to pass through unmolested, but also of collision and of torpedoing each other by accident.

Another point which has to be taken into consideration is that the armament of British and many foreign submarines, is confined to bow-tubes; therefore, these subaqueous vessels must in some way "meet" their antagonists; and considering that the enemy would, in all probability, be steaming at least twice as fast as the submarines, and that the submarines to keep "sub-marine" must always be steaming forward, the chances of a second shot at the same object would be very remote. Thus it is necessary to have a second line of defence.

Another problem that would confront the commander of a defending submarine flotilla is that it would be imperative for the vessels, previous to the attack, to be placed in some formation which would protect the entire front of the port to be defended; as a bombarding fleet would—if submarines were known to be part of the defence—steam in constantly

changing their course, and so possibly, by some adroit manœuvre, evade the defending flotilla; unless the entire first line of coast defence was properly guarded.

METHOD II.

Attacking fleet, "B2," is steaming in on a zigzag course (or frequent change of course). This would, undoubtedly, be the best method for the attacking fleet, as it would make it much more difficult for the submarines to get within striking distance, in a suitable position to launch their torpedoes.

"C5" would attack first: about one mile ahead of "C6." If she failed, "C6" would then launch a projectile.

"C7" would attack the hostile vessels on the port-side—if possible, in position, as shown on "Chart B."

The submarines, C1, C2, and C3. or *vice versa*, would then "run" back and take up positions along line "E," so as to form a second line of defence (or subs. C5, C6, and C7, to line "F," as the case might be).

Between C1 and C7 and the shore would be well looked after by the land batteries.

This method of submarine defence is of course one in many—as also are the plans of attack; and, no doubt, in this as in all schemes, there is a "hole." I do not put it forward as the best, or the worst; but simply as a method to be criticised—with a plea for leniency.

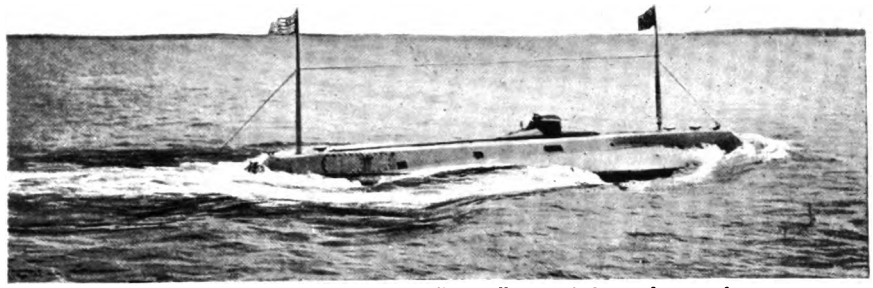
DEFENCE AGAINST SUBMARINES.

In all warfare, new weapons of attack are met by new methods of defence.

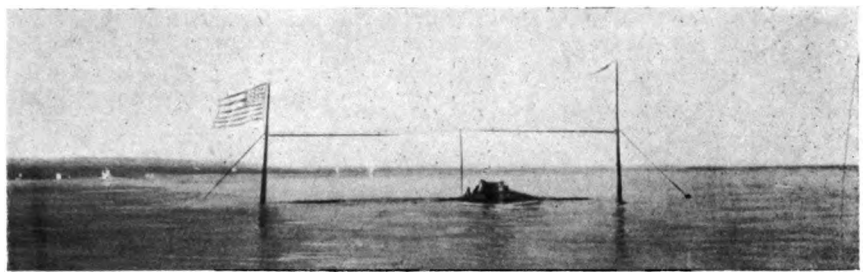
The heavy breech-loading guns, with which modern warships are armed, do not hurl their terrible projectiles against "wooden-walls," but against many inches of hardened steel; and, in comparison, these heavy guns against armour-plate are no more effective than the muzzle-loaders were against "British oak."

The torpedo-boat has met its "destroyer"; but the true defence against the submarine has yet to be devised.

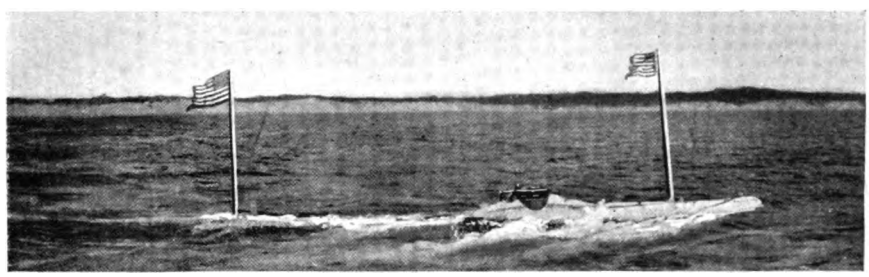
Many means of attack on submarines have been proposed; and no doubt some of these, in certain cases, would prove effective; but none can be relied upon. Therefore, one of the chief points in favour of the submarine still remains without its antidote. This is the moral effect; for if there is no absolutely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



The U.S. Submarine "Holland" travelling at full speed on surface.

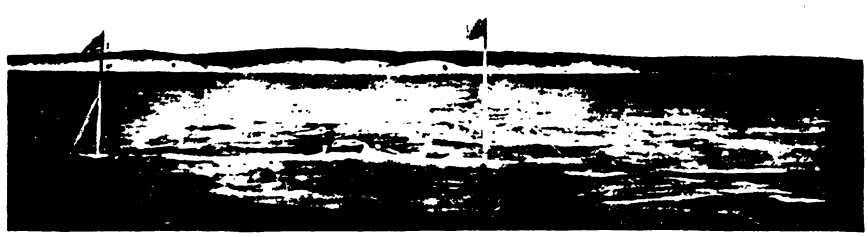


The U.S. Submarine "Holland" trimming to dive.



The U.S. Submarine "Holland" running a-wash.

The U.S. Submarine "Holland" diving.



The U.S. Submarine "Holland" rising to the surface after discharging torpedo.

To face page 100.

war we should rely for food—when anywhere within the danger-zone of the submarine.

The submarine torpedo-boat is at present the only weapon against which there is no true means of defence. This state of affairs, however, will not last long; a true and effective means of defence will shortly be devised.

In the last chapter, I said it was "eyes" that submarines required to make them perfect weapons. This, however, is hardly correct. To enable the submarine to see when submerged would be giving to the surface warship—(it cannot for a minute be supposed that one class of vessel would be fitted with the instrument and not the other)—the means of also seeing under water. This would in all probability render the submarine useless, for it would nullify its greatest power—invisibility.

Many of the different proposed methods of attack on submarines are based on the assumption that the boats have been recently seen.

In this lies their weak point, for it is more than probable that nothing would be seen by the crew of the surface ship until a "Whitehead" betrayed its presence by that terrible "shoot" of water accompanied by a vibrating roar.

Let us now see what practical defence a modern warship has against submarine attacks.

Great speed is undoubtedly a ship's most reliable defence; and when combined with a frequent change of course, would greatly reduce the chances af a successful under-water attack. Should the attacking submarines be "waiting" in the most favourable position, as described on page 94 and chart, their commander would, even then not know what to do—whether to wait and chance the enemy approaching within torpedo-range, or 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.

Quick-firing guns of the 12 or 14 pounder 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 warships.

Directly the submarines rose to the surface to get a glimpse of their object of attack, previous to discharging torpedoes, the quick-firers, placed in convenient positions for repelling torpedo attacks, would have to pour a hail of shot in the close vicinity of the white wave, which would be thrown off by the submarine as she rose from the deep.

The chance of the gunner would be but short lived, for the subaqueous vessels would remain but a few seconds on the surface before they plunged again.

It is very doubtful whether the tense excitement of waiting for the submarines to rise would not affect the aim of the man-at-the-gun. Even should this not be the case, the short time between the appearance and disappearance of the submarine foes would not permit of many shots being fired.

The périscopic-tube of the submarine would also prove a target for gun-fire; but a grey steel tube, three inches in diameter, at a distance of 1,000 yards, would require "excellent" marksmanship to hit.

Of course, if the submarine, or submarines, were caught napping on the surface, the quick-firing guns would be the best weapons of attack; but another incident, similar to that which opened the naval engagements of the War in the East, cannot be looked for in the naval wars 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 in the old-fashioned way, close round each vessel, which method no doubt will shortly be discarded, owing to its many drawbacks—but suspended from "picket-boats" at a distance from the bombarding or blockading fleet. "Picketing" is also considered to be a good defence during daylight, but neither of these methods is reliable. A submarine might be able to dive unobserved under the "destroyers" acting as "pickets," or under the suspended torpedo-nets; and it is this chance that would cause these under-water craft to be a source of constant anxiety; and would, most likely, cause a bombarding or blockading fleet to steam well out to sea as darkness closed over.*

The torpedo-boat destroyer would, of course, prove a nasty enemy to the submarine. In war time, it would be 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 war-ships below the water-line, which would render the hulls able to withstand mine or torpedo explosions.

* For fear of a Submarine attack at dawn.

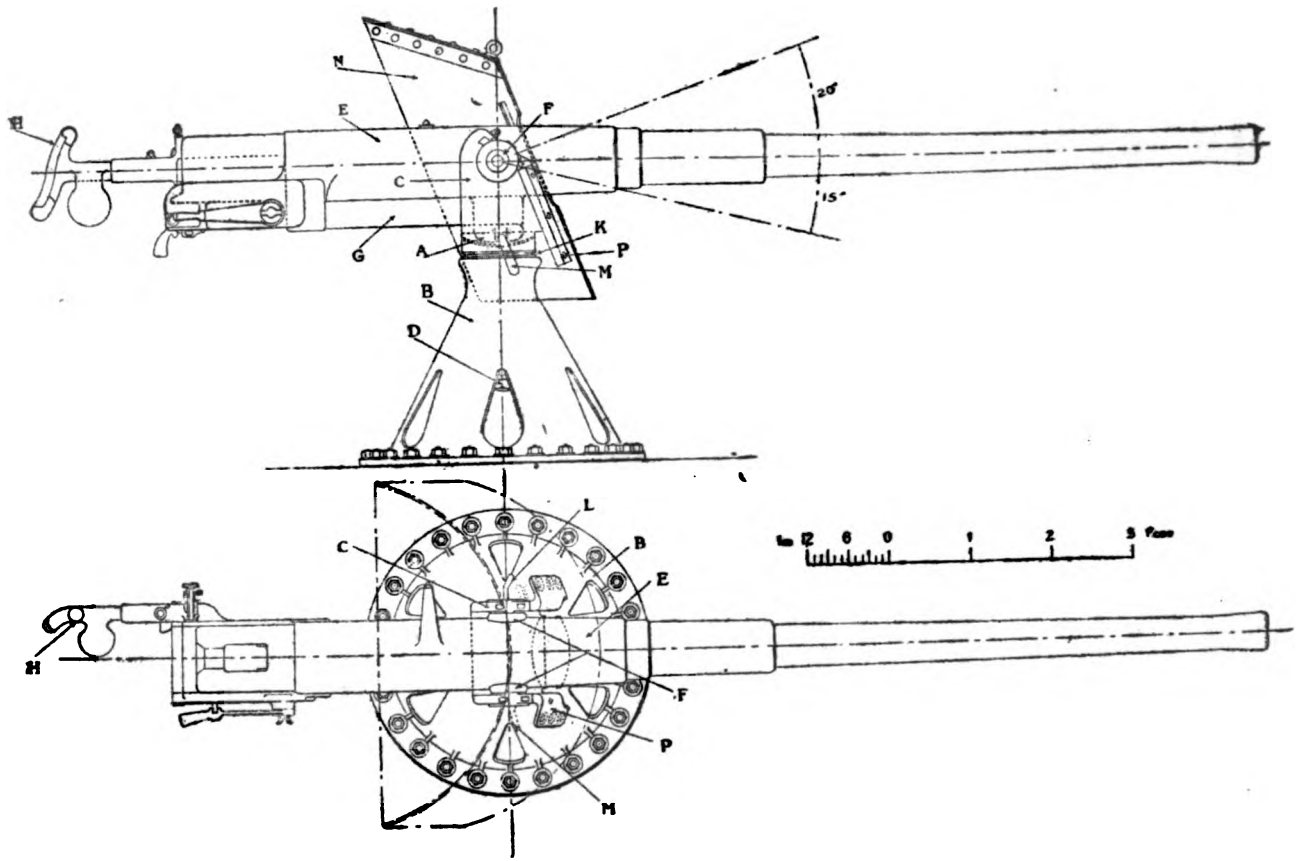
At present, this is practically impossible, as the great weight of this additional armour, combined with the ever increasing size of guns, and weight of the above-water protection, would necessitate a vessel of such enormous displacement as to be quite impossible, if the important factor—high speed—has 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, can be closed by means of a boom-defence, which is stretched across the mouth of the harbour from "East Battery" to "Block House Fort" (in which living-quarters are provided for officers and men of the Submarine Flotilla).

A slight addition to this defence, such as contact-mines connected by wires, or chain-netting suspended along the entire length, would effectively block the harbour to submarines, as well as to surface vessels.

There are many reliable means of defending a harbour against submarines; it is therefore, unnecessary to say anything further. But to protect moving ships at sea, under all conditions, certainly presents a most profound puzzle for inventors or tacticians to solve.



9-inch (14 Pounder) semi-Automatic Q.F. Gun. On Cone Mounting.

GUNS TO REPEL SUBMARINE BOAT ATTACK.

By Lieut. Sir A. TREVOR DAWSON, late R.N.

Of the type of naval ordnance specially used for repelling submarine and torpedo attacks, including weapons firing three-pounder, six-pounder, 12-pounder, or 14-pounder shot, the 14-pounder now adopted by the United States Government is a typical example. Torpedo or submarine boats attacking ships or fleets at anchor would do so at very long range, and would probably commence to fire their torpedoes from a range of nearly 2,000 yards. The guns for repelling such attack would have to be of power sufficient to stop the boats before they came within striking distance of their quarry. The United States Navy have therefore done the right thing in utilising a shell of at least 14 lbs. weight. Such a shell is certainly superior for dealing with high ballistics at long ranges, and is about the weight generally adopted by most countries as a minimum for their land service artillery.

The 14 pounder semi-automatic gun mentioned above by Sir Trevor Dawson, of Messrs. Vickers Sons and Maxim, as being one of the best weapons for repelling submarine boat attacks, is illustrated in detail below.

The mounting consists of a pivot A, which works in a steel cone, or naval stand B. and has its upper part formed into a crosshead C. The cone is provided with gun-metal liners, and the pivot is secured to it by means of a pivot nut D. The cylindrical cradle E, in which the gun is free to slide in recoiling, is supported by trunnions F, in bearings formed in the crosshead; and it is provided with two hydraulic buffers G, in which work pistons attached to a lug on the underside of the breech end of the gun. The elevating and training are effected by means of a shoulder-piece H, attached to the cradle. The crosshead is fitted with a clamping screw, and a traversing clamping segment which fits into a groove K in the liner. When tightened by means of the handle L this segment secures the gun in any required position of training. A similar handle at M clamps the gun at the desired degree of elevation. Protection is afforded the gunner by a shield N, which is bolted to flanges P, forged on the crosshead jaws. The cylinders of the hydraulic buffers are provided with

tapered grooves, which allow the oil to escape round the piston heads, and so regulate the flow that a constant pressure is maintained during recoil. Inside the cylinders are strong spiral springs surrounding the piston-rods, which, being compressed by the rear motion of the piston heads, cause the gun to return to its former position after firing.

United States Submarine "Octopus," the latest acquisition to the American Navy's Flotilla.

To face page 107.

SUBMARINE CONSTRUCTION.

ALTHOUGH submarine navigation dates back to 1620—when Cornelius Van Drebel,* a Dutchman, designed a submarine which proved so successful that a larger boat of the same type was built, in which James I. is said to have taken a trip—it was not until the launch of the "Gymnôte" for the French Navy that submarine construction received its first real impetus.

Inventors, engineers, and scientists have been wrestling with the problem of submarine navigation for centuries. Legions have bravely died on the road; but the fascination of ultimately producing a boat which would revolutionize naval warfare has held them tightly to their posts until the last. Few indeed have given their lives to this branch of naval science in vain; most have added some small portion, in some way, to the realisation of the fictitious "Nautilus," that marvellous creation of Jules Verne.

Even a brief account of the difficulties which have been met and overcome, would fill many volumes the size of this one; but a short account of the chief characteristics of a submarine, showing where, even now, the fight rages fiercest—is necessary to enable us to gain a full understanding of the difficulties that surround the successful designing and construction of these modern ships of war.

PROBLEM OF SUBMERGENCE.

Captain Bacon, D.S.O., C.V.O., R.N., in a paper read before the London Institution of Naval Architects, pointed out clearly that the first aim in the construction of a submarine must be its tactical and fighting efficiency considered from the point of view of safety under the exercise of reasonable care.

It sounds ridiculous in face of the many accidents to say that one of the greatest difficulties is to make a submarine sink quickly,—and yet this is the case. Many of the older types of French submersibles took some 15—20 minutes to disappear beneath the surface.

This delay, when it was necessary to sink, would be a great danger to a submarine in action.

* Van Drebel's submarine was really more like a diving bell.

As explained in the chapter on the tactical value of the "daylight torpedo-boat," one of the greatest points in favour of this class of boat is its ability to dive quickly.

The main reason why the early types took so long to accomplish this manœuvre is because they were designed with too much surface buoyancy, 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 salt water, at a slow rate, before they settled down sufficiently to enable total submergence to be accomplished by the use of the horizontal fins and rudders.

The difficulty of increasing the surface cruising qualities of submarines without materially increasing the time occupied in submerging, is a problem which is even now occupying the attention of submarine designers.

It is true that great strides have been made in this direction with the latest types of submarines, and their sea-going qualities are now excellent; but, as the displacement and radius of action of these boats increase —and they will undoubtedly increase—so must the surface buoyancy; only it must do so more than doubly, in proportion to their size, to enable submarines of the future to become independent units of a fleet, able to go anywhere, and to take part in ocean warfare.

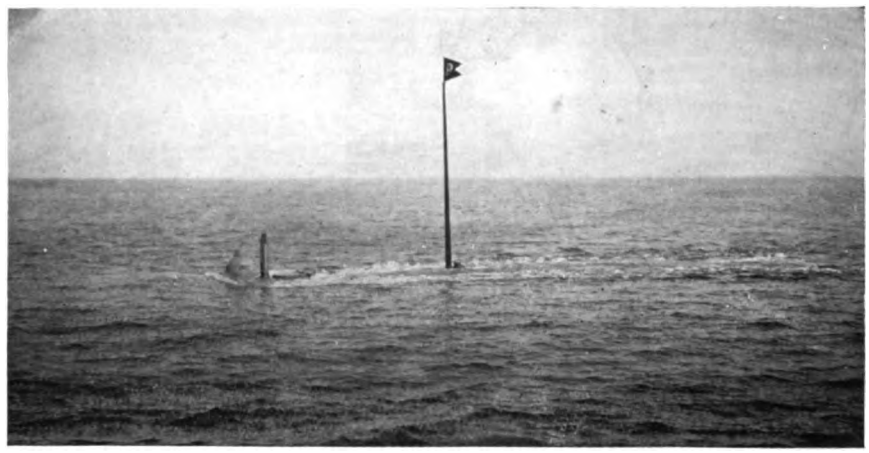
EQUILIBRIUM.

The reserve buoyancy of a submarine in the "diving-trim" is necessarily very small, amounting to only two pounds in a thousand, which in a three hundred ton craft means a difference of just under a hundred gallons of sea water between the ability to float and the inevitability of sinking.

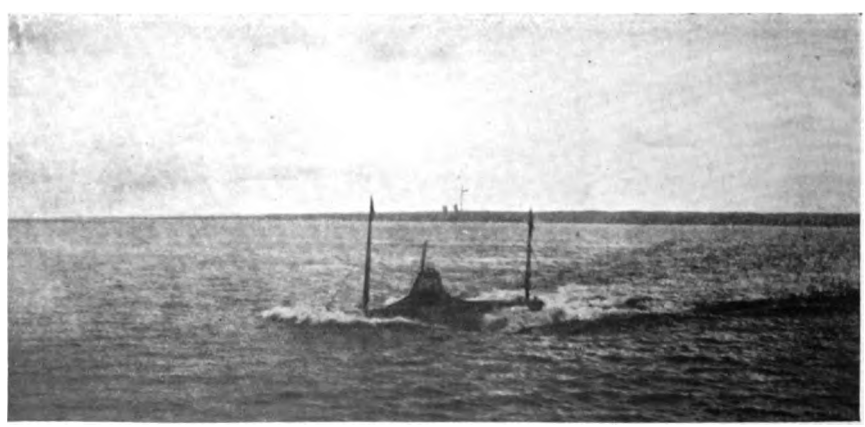
The result of this small margin of positive buoyancy is that when a submarine is forced under by the action of her propellers, horizontal rudders and hydroplanes, she is in a delicate state of equipoise.

It has been said that a man walking from one end of the submarine to the other would cause her to plunge dangerously. This certainly was more or less the case in the early types, but is certainly not the case now.

The latest and most efficient submarine cannot, however, up to the present steer an absolutely straight course when submerged. They make long "up and down hill glides;" but this motion, which used to amount in some cases, to "yaws" of 20 to 30 feet, has now been reduced to a few feet, which is really of little consequence—in fact it cannot be noticed when on board, except when the submarine is turned at a sharp angle.



Ostr running semi-submerged. Observation Hood and Periscope above the surface. The mast is not part of Service equipment.



A Russian Submersible—the Holland—Biriliff Type.

To face page 109

This "up and down" motion is not now sufficient to effect the discharging of torpedoes.

The minimum tactical angles and areas have also to be considered in submarines, as in all warship construction. In this the British boats undoubtedly lead the way.

PROPULSION.

The engine problem is perhaps the most profound puzzle of all.

Of the many "prime movers" tried on the different submarines, all have some failing.

At present petrol and electricity are undoubtedly the two best motive powers, but even these are very far from being perfect means of propulsion. The carrying of large quantities of petrol is under all circumstances attended with a certain amount of risk, but in a submarine many tons have to be carried in a confined space, and the slightest leakage when the vessel is submerged, would mean that a powerful explosive mixture of petrol and air, would be made. Also, it is absolutely impossible to use a petrol engine when running under water, which means that a second motive power—an engine, with its additional room and weight—has to be carried. From the foregoing it will be easy to realise that petrol is not the ideal motive power for submarines.

Electricity, again, has many drawbacks. It costs in weight thirty times more than other prime movers. It is dangerous, for should salt water in any way gain access to the storage batteries, chlorine gas would be given off in large quantities. On account of weight it is impossible to fit a very powerful electric engine into a submarine-boat, and thus the speed is curtailed, as well as the submerged radius.

Steam, which is the motive power used on many of the French submersibles for surface propulsion has even more faults than petrol.

The heat given off by a steam-engine, even when on the surface, makes the interior of the submarine, no matter how well ventilated, more like a stoke-hold. A steam-engine also retains the heat for a long time after the fires are out, and therefore when a submarine or submersible has been using a steam-engine for running on the surface and it suddenly becomes necessary to dive, time must be allowed for the steam-engine to cool before it is possible to hermetically close the boat.

It is for this reason that some of the French submersibles, notably those of the "Narval" type, take as long as twenty minutes to sink from the light to the submerged condition.

With steam, as with petrol, a second motive power is necessary for submerged use; and as only a certain amount of weight, and space can be allowed in a submarine for propelling machinery, the power has to be divided.

There is also the difficulty of the motive-power for the auxiliary engines, such as air-compressors, motors for operating the périscopes, steering mechanism and pump. In the British and French boats these small engines are all driven by electricity.

VISION WHEN SUBMERGED.

Of all the difficulties which have beset submarine navigation, the puzzle of how to see when submerged is perhaps the most unsolvable.

Even now, with the perfect périscope the range of vision is very small, and during anything like a rough sea it is almost impossible to see any distance ahead, owing to the waves and spray constantly wetting the glass of the périscope and causing the picture to become blurred.

A great deal has been said about the vibration of the périscope caused by the propelling machinery and the water friction of the périscopic-tube; this, however, is not the case in the latest boats. The picture from the périscope, on a clear and bright day, is quite as good as if your eyes were at the upper extremity of the tube.

The range of vision is of course short owing to the périscopic-tube only projecting from the surface a few feet, but on a moderately smooth and clear day, steering by périscope can be accomplished with as much ease as steering in the open.

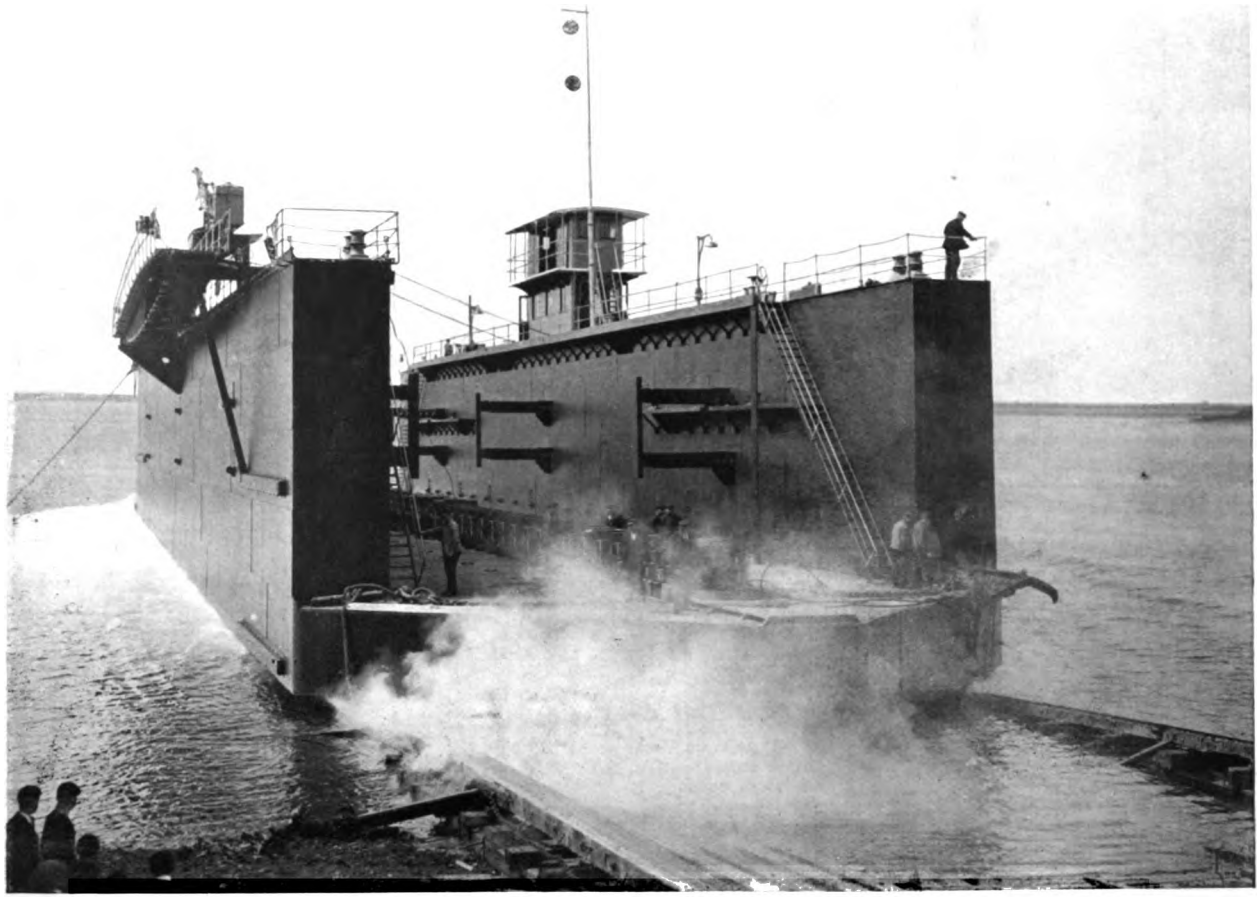
At night, or in fog, this instrument is useless, and for this, as well as many other reasons, it would be impossible for a submarine to travel submerged when the light gives place to darkness.

The latest panoramic périscope has a field of vision of 60 degrees, and gives natural and very distinct images.

HABITABILITY.

Habitability, is another important factor in the construction of a submarine. At the present time it is practically impossible for the crew to live on board for very many days, owing to the small free space in the interior, and to the cramped deck, but as the radius of action of these boats increases, so must the habitability.

The air-supply for submerged use is in most boats amply sufficient.



Launch of a Submarine Floating Dock, built by Messrs Vickers, Sons & Maxim, Ltd. Length, 250ft. Beam, 30ft. Lifting capacity 500 tons.

To face page 111.

ARMAMENT.

The armament of all Naval submarines is now confined to torpedoes, mostly of the "Whitehead" pattern. The particulars of this weapon are too generally known to need further description. The plan of a "Whitehead" and a brief description of its chief characteristics may be seen on page 119.

A gyroscope has now been fitted to all torpedoes. This wonderful little instrument corrects any deviation of the torpedo from the line of fire.

There are of course many other characteristics of a submarine, and other difficulties which have to be met in construction, but space for the present prevents any further description.

The following plans and descriptions of some of the most successful, and best known submarines will show the general disposition of some of the mechanism, and give an idea of their construction.

BRITISH ADMIRALTY—POLICY

Owing to the wise policy of the British Admiralty, "strict secrecy," the Author considers that it would be impolitic to give any plans whatsoever of British Submarine Torpedo Boats.

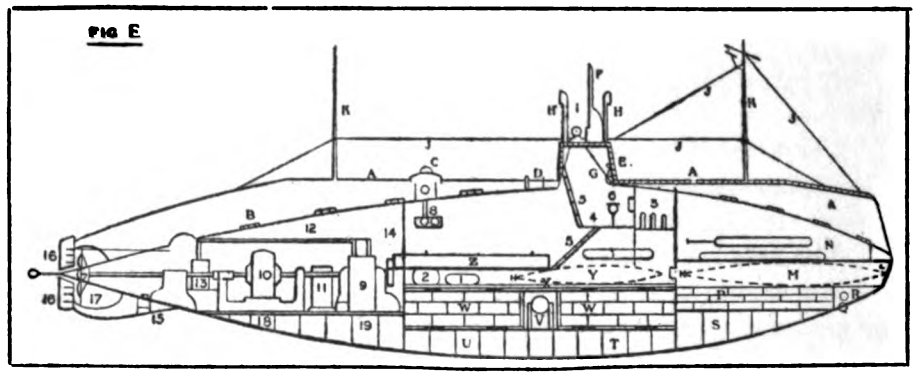
The plan and description of the latest U.S. Submarine of the Improved Holland Type is in many ways similar to many of the British Improved Holland Boats.

UNITED STATES.

IMPROVED "HOLLAND" TYPE.

U.S.S.'s OCTOPUS AND VIPER TYPE.

FIG E



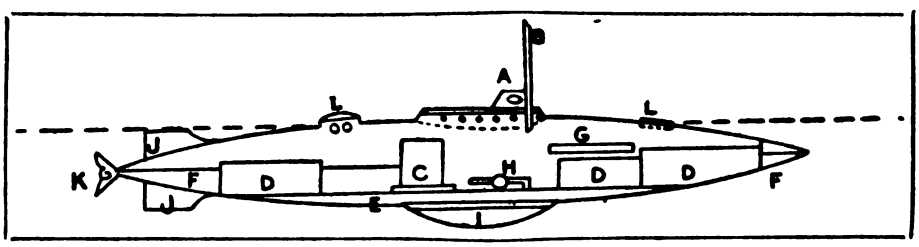
A	Deck super-structure.	X	Double casing, with special vesn for accumulators.
B	Scuppers for filling super-structure.	Y	Spare torpedoes.
C	Safety globe (described under p. 57).	Z	Petrol storage tanks (2).
D	External connections.	Nos. 1	Air flasks.
E	Conning-tower (4 in. armour)	2	Centrifugal pumps.
F	Périscope.	3	Air lock, with submarine escape dresses.
G	Périscope motor (for turning, etc.)	4	Commander's platform.
H	Air cowls.	5	Ladders.
I	Conning-tower cap (opening sideways).	6	Depth and deflection indicator, registering submarines' deflection from horizontal.
J	Mast stays.	7	Speed dials.
K	Mast (not part of service equipment).	8	External globe telephone.
L	Torpedo-tube cap.	9	Petrol engines.
M	Torpedo-tubes (twin), torpedoes in.	10	Electric engines.
N	Air-flask (for expelling torpedoes)	11	Dynamo, for re-charging batteries.
O	Hydroplane engines.	12	Petrol engines—exhaust.

P	Torpedo compensating tanks.	13	Vertical and horizontal rudder mechanism.
Q	Submarine signal transmitter.	14	Air compressor.
R	Bow trimming tank.	15	Submarine bell.
S	Fore ballast tank.	16	Rudders.
T	Fore-main ballast tank.	17	Propeller.
U	Aft-main ballast tank.	18	Stern trimming tank.
V	Circulating pump, for compensation and equilibrium.	19	Aft ballast tank.
W	Storage batteries.		

FRANCE.

GYMNÔTE.

Launched 1880. Displacement 30 tons (surface).



REFERENCE TABLE.

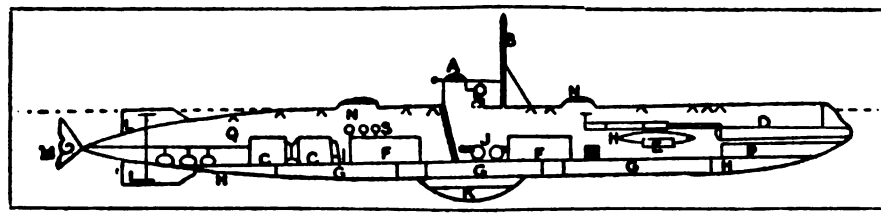
A	Conning-tower 50 ins dia.	G	Compressed air cylinder.
B	Twin-mirror optical tube.	H	Centrifugal pump.
C	Electric motor, 55 H.P.	I	Drop-keel.
D	Accumulators.	J	Vertical rudders.
E	Main ballast tank.	K	Propeller.
F	Trimming tanks.	L	Manholes.

FRANCE.

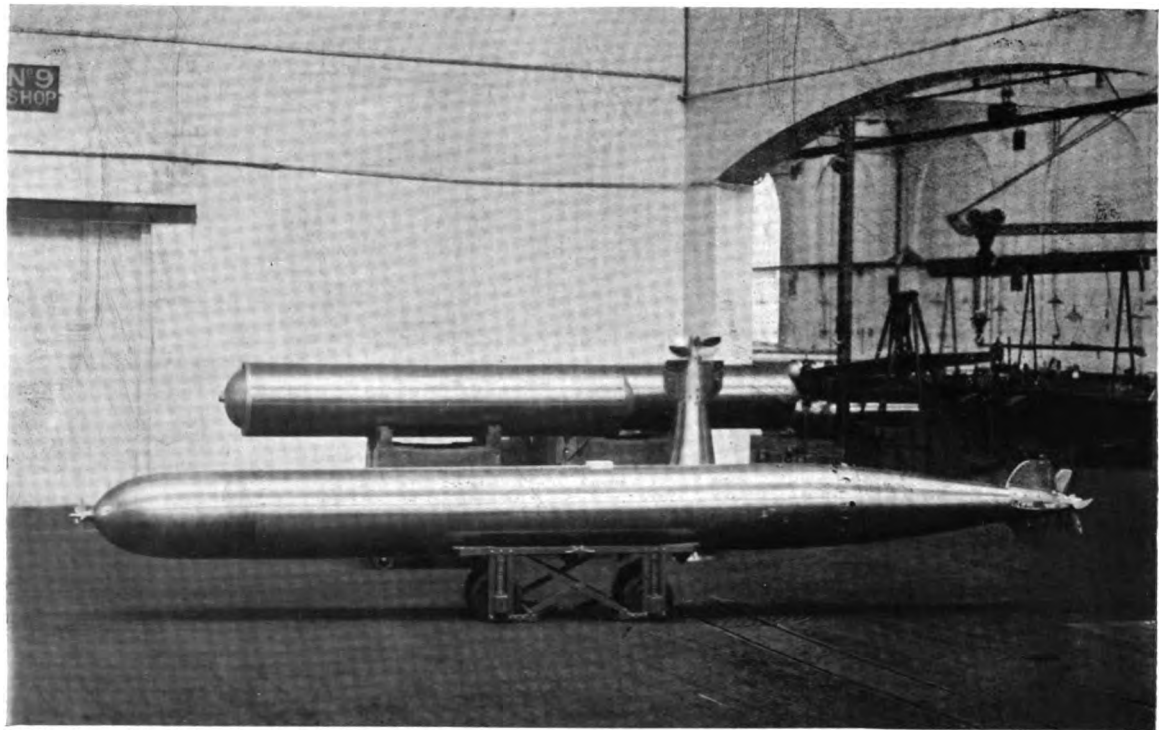
GUSTAVE ZÉDÉ.

Launched 1893. Displacement 266 tons (surface).

Designed by Engineer RAMOZOTTI.



A	Conning-tower.	K	Safety drop-keel.
B	Périscope.	L	Vertical rudders.
C	Electric motors.	M	Propeller.
D	18in. Torpedo-tube.	N	Manholes.
E	Spare torpedo.	O	Look-outs.
F	Accumulators.	P	Torpedo compensating tanks.
G	Main ballast tanks.	Q	Electric lights.
H	Trimming tanks.	R	Air compressor.
I	Compressed air cylinder.	S	Indicators.
J	Pumps.		



'The Arm of the Submarine."—The latest Whitehead Torpedo. This exclusive illustration shows the identical Torpedo which maintained the extraordinary speed of 42 knots for 1000 yards, and 38 knots for 2000 yards, being fitted with a special heating device.

By permission of the Whitehead Torpedo Co.

To face page 114

FRANCE.

NARVAL (SUBMERSIBLE).

Launched 1899. **Displacement 106 tons (surface).**

Designed by M. Laubeuf.

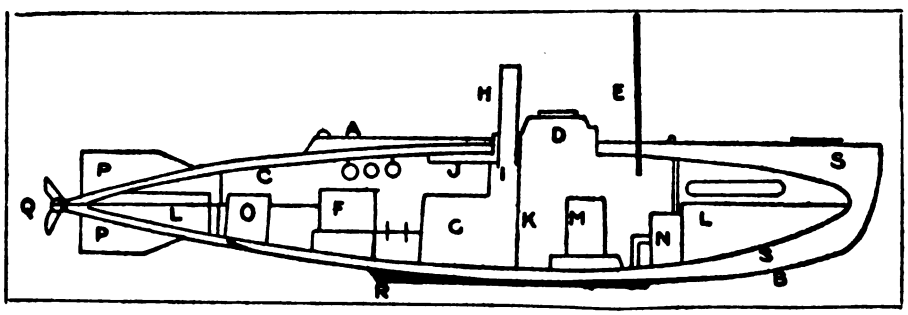


Fig. i.

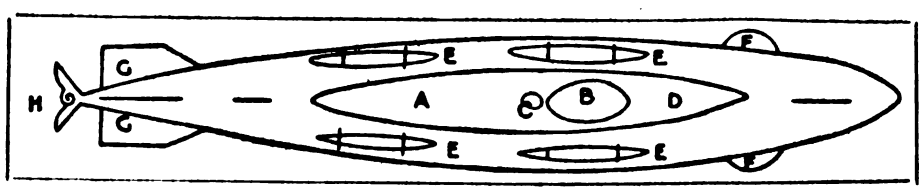


Fig ii.

Reference Table on next page.

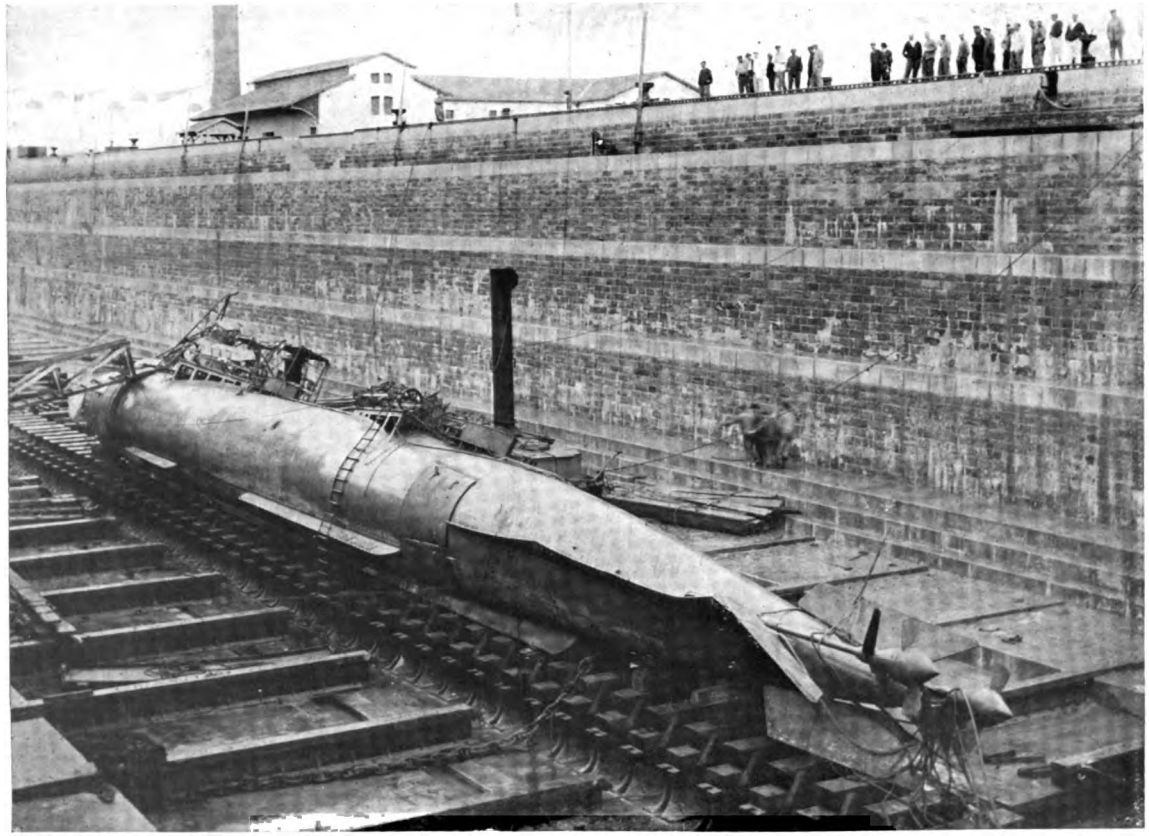
FRANCE.

NARVAL (SUBMERSIBLE).

Launched 1899. Displacement 106 tons (surface).

	Fig. I.		
A	Deck superstructure.	J	Water-tight hatch to cover funnel opening.
B	Outer shell (boat shape).	K	Water-tight bulkhead.
C	Inner shell (cylindro-conical).	L	Accumulators.
D	Armoured conning-tower.	M	Centrifugal pumps.
E	Périscope.	N	Air compressor.
F	Electric motors.	O	Steering mechanism.
G	Steam-engine flash, boiler, and dynamo.	P	Vertical rudders.
H	Funnel.	Q	Propeller.
I	Cylinder for housing funnel.	R	Detachable keel.
		S	Space for water ballast.

	Fig. II.		
A	Deck superstructure.	D	Périscope.
B	Conning-tower.	E	Torpedoes in "holders."
C	Funnel.	F	Hydro-planes.
		G	Horizontal rudders.
		H	Propeller.



The ill-fated Farfadet lying in dock at Bizerta, after the accident.

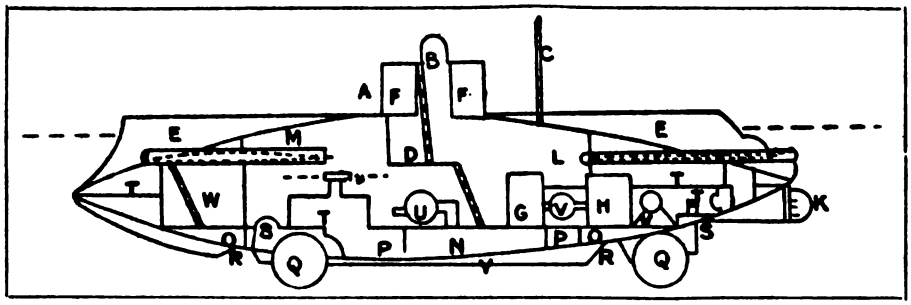
By special permission

To face page 116.

RUSSIA.

"OSTR" late "PROTECTOR" (lake type Submersible).

Launched 1904. Displacement 115 tons (surface).



REFERENCE TABLE.

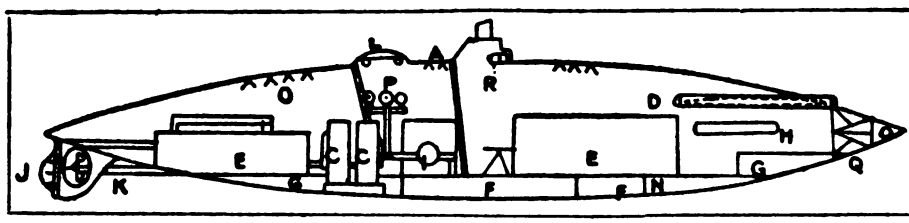
A	Armoured conning-tower.	N	Main ballast tank.
B	Look-out cowl.	O	Torpedo compensating tanks.
C	Optical tube.	P	Trimming tanks.
D	Navigating platform.	Q	Wheels.
E	Superstructure.	R	Drop-weights.
F	Petrol tank.	S	Power reels.
G	Petrol motors (2).	T	Hydro-planes and mechanism for operating same and steering engines
H	Electric motors (2).	U	Centrifugal pump.
I	Storage batteries.	V	Dynamo.
J	Propeller shaft.	W	Diving chamber.
K	Vertical rudder.	Y	Keel, which may also be released.
L	Stern torpedo tube.		
M	Pair bow tubes.		

SPAIN.

"PERAL."

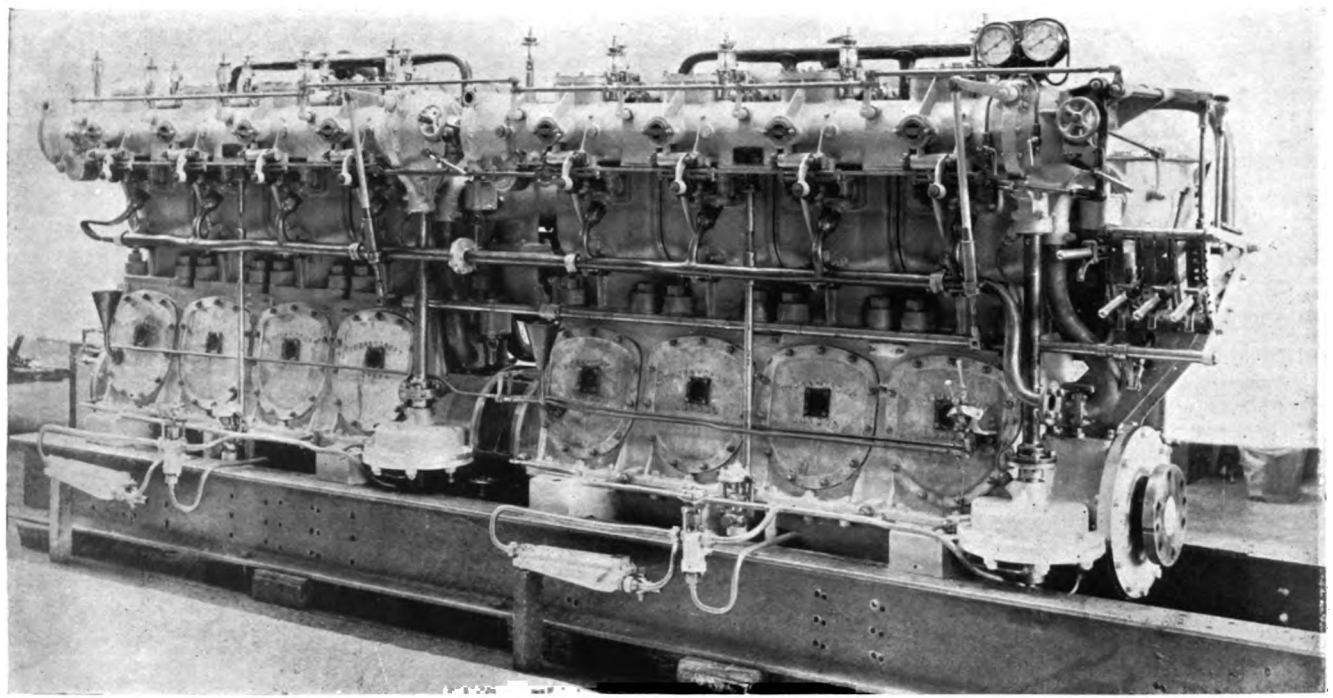
Launched, 1887. Displacement, 87 tons (surface).

Designed by LIEUT. PERAL, Spanish Navy.



REFERENCE TABLE.

A	Conning-tower.	J	Vertical Rudders.
B	Look-out cowl.	K	Propeller.
C	Electric motor.	L	Manhole.
D	Torpedo tube.	N	Torpedo compensating tanks.
E	Accumulators.	O	Electric lights.
F	Main ballast tanks.	P	Indicators.
G	Trimming tanks.	Q	Supports for bow intended as a ram.
H	Compressed air cylinder.	R	Searchlight.
I	Centrifugal pump.		



Type of engine used in Submarine Torpedo Boats.

By permission of Messrs. J. I. Thornecroft.

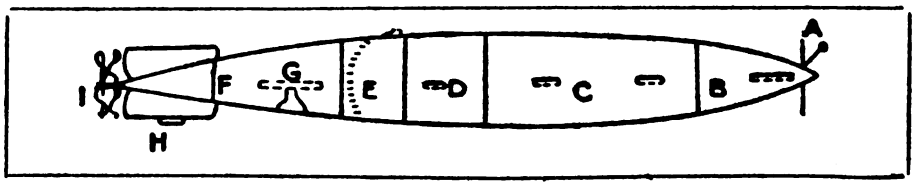
The illustration shows two 4-cylinder sets coupled together as they would be installed on each side of the Submarine. The cylinders are 8 in. stroke by 12 in. dia., and one four-cylinder set is capable of developing 175-B.H.P on paraffin, or 150° flash point, or 350-B.H.P. for the combined set; which would be coupled to each propeller.

To face page 118.

THE "WHITEHEAD" TORPEDO

(18in. Long).

(The Type mostly used in Submarines).



REFERENCE TABLE.

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 weighted dummy during practice).

C. Air chamber filled with compressed-air, at a pressure of approx. 1350 lbs. per square inch, for action. The chamber is tested to stand a pressure of 1,700 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. 56 in latest 18in. 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 "clock-wise" and "anti-clock-wise."

COMPARATIVE TABLE.

This table shows the submarines of the world's navies arranged in classes and points, according to their efficiency and fighting value in the spheres in which they are intended to operate.

Owing to the great variation in the displacement, power, radius of action, and efficiency of the various types, it has been necessary to divide the classes into points of value.

These indicate some small superiority which, however, is sufficient to cause vessels placed in higher parallels of fighting value to be more efficient and consequently of greater fighting value than vessels of the same class —in a lower line.

In estimating the relative value of different boats, special attention has been paid to the following all-important points:—

1st.—surface radius of action, combined with cruising qualities, manœuvring ability, and submerged radius.

2nd.—Speed, above and below.

3rd.—Time taken to "trim"—to dive after trimming. Angles of diving and rising.

4th.—Armament—time taken to discharge torpedoes (not counting those already in tubes) effect of discharge on longitudinal stability.

5th.—Stability when submerged. Invisibility when running awash, or submerged.

6th.—General efficiency—result of trials. Modernity of design, and habitability.

The classes are composed of vessels having the following qualifications :—

Class 1. Sea-going submarines (or submersibles) with the maximum radius of action, and possessing the largest number of points in the above important qualities.

Class 2. Sea-going submarines, short of some of the most important qualities possessed by boats in class 1 (but nevertheless of considerable fighting value).

Class 3. Coast Defence Submarines. In this class, armament, ability to dive quickly, with a moderate radius of action, are the principal points considered.

Class 4. Coast Defence Submarines. This class is composed of vessels of earlier date, which are consequently not nearly so efficient, and the fighting value of which is doubtful.

Class 5. Harbour Defence Submarines. Composed of boats having only a very small sphere of activity, and intended solely for the defence of harbours, canals, or narrow waterways. Vessels of little fighting value.

Class 6. Harbour Defence Submarines of practically no value.

SUBMARINES OF THE BRITISH AND FOREIGN NAVIES

COMPARATIVE TABLE.

	BRITISH.	FRENCH.	RUSSIAN.	U.S.A.	ITALIAN.	JAPANESE.	GERMANY.
CLASS I.	1. D1. (and latest British Boats)	Nos. 51–66				New Vessels	U4 U5 U6 U7 U8
	2. C12, C13, C14, C15, C16, C17, C18-C88			New Vessels			
	3. C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11	Circé Calypso, Emeraude, Opale, Rubis, Saphir, Topaz Turquoise	Kambala, Karas, Karp				
	POINTS.						
CLASS II.	1. B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11			Octopus Viper Tarantulla	Trichico, Otario		U3
	2.	Aigrette, Cigogne	Makrel, Okun	Cuttlefish	Narvalo, Squalo, Glauco		U2
	3.	"Y" "Z"					
	POINTS.						
CLASS III.	1. A5, A6, A7, A8, A9, A10, A11, A12, A13	Omega "X"	Plotva, Kefal, Sig, Peska, Ostr				
	2.		Schuka, Byeluga, Losos, Skat, Sterylad, Lom, Kasatka, Forel	Porpoise Shark Grampus Moccassin Pike Plunger (2)		5 Holland type	U1
	3. A1, A2, A3, A4	Sirene, Triton, Silure, Espadon, Morse, Francaise, Algerian					
	POINTS.						
CLASS IV.	1.	Narval, Lutin, Korrigan, Gnome, Gustave-Zédé	Platus, Graf Cheremetieve	Adder			
	2. Nos. 1, 2, 3, 4, 5				Delfino		
	3.			Holland			
	POINTS.						
CLASS V.	1.	Guépé 1 & 2 (20 small Submarines, Naiade & Perle type)	Buichok Nalim Delphin		Tritone		
	2.						
	3.						
	POINTS.						
CLASS VI.	1.	No. 61	Petr Kochka				
	2.						
	3.	Gymnóte					
	POINTS.						

PART III

Contents of Part III

Escaped from a Submarine Disaster. This photograph shows the buoyancy of a person equipped in the new Submarine Escape Dress on reaching the surface.

To face page 125

SUBMARINES IN OPEN SEA WARFARE

By Admiral Sir J. O. HOPKINS, G.C.B.

THE Admiralties of the different Powers catering for naval strength in all the various branches which constitute a powerful navy, could not possibly afford to neglect the acquisition, and development of submarine torpedo-boats.

The British Admiralty, very wisely, took up the question of submarine navigation at an early, yet practical stage and consequently the Navy of England now includes a powerful submarine flotilla.

The Admiralty, also, has had ample time in which to form a good estimate of the war-value of these new adjuncts to a fleet. Whether torpedo craft of such comparatively small dimensions, sphere of activity, and limited powers of action, can ever be expected to take important parts in sea-going contests in blue-water is problematical, but, undoubtedly, for harbour, waterway, and coast defence the utility of submarine torpedo-boats can scarcely be questioned.

My own view is decidedly in favour of a small type of submarine torpedo-boat, for ocean purposes, carried by a special auxiliary, and launched at the psychological moment, to take part in an open-sea combat.

These "carriers," or mother-ships, could be built with an open stern; and the small submarines launched down an inclined plane, with ease, and rapidity.

I can see no difficulty, whatever, in launching these submarines from a tunnel constructed in the mother-ship, as the earlier pattern of Italian ironclads did, or proposed to do, with their small torpedo-craft. Neither battleships, or cruisers, would, in my opinion make the best carriers.

A specially constructed vessel, which could accompany battle-fleets, would enable submarine torpedo-boats to take part in actions fought long distances from a naval base.

SUBMARINES v. TORPEDO-BOATS

Their Relative Tactical Value Considered.

By Admiral Sir CYPRIAN BRIDGE, G.C.B.

THE value of the submarine torpedo-boat in future naval war, in special circumstances will be great; but these circumstances will only be of rare occurrence.

Whatever important additions to the engine-power may be possible, the surface speed of the submarine will continue to fall very short of that of the ordinary man-of-war.

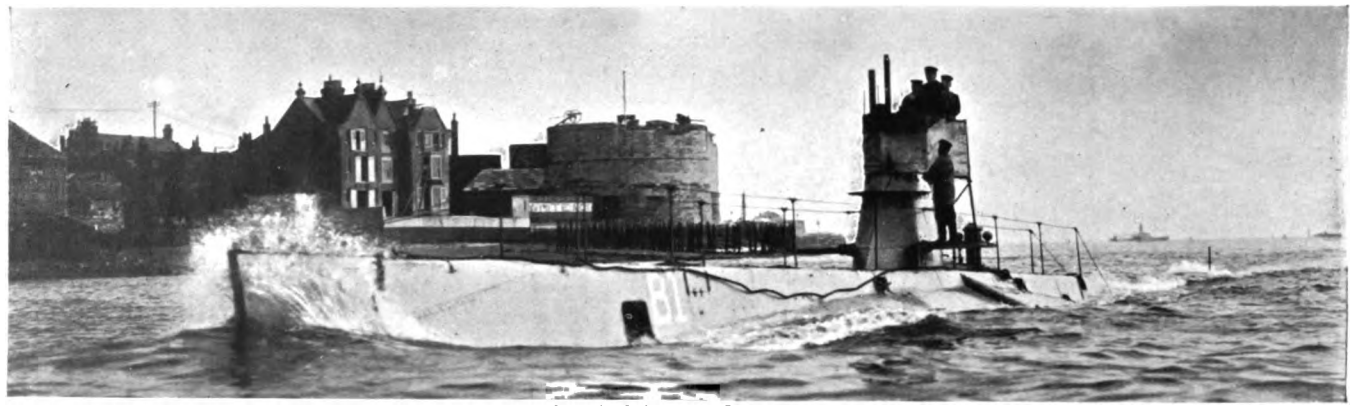
Additions to her fuel endurance, that is, her independent radius of action, will undoubtedly be accompanied by a considerable increase in size which, in all probability, will restrict numbers. Any considerable increase in size will prevent submarines from manœuvring in waters that are not of greater depth than those of many men-of-war anchorages.

A submarine torpedo-boat must, as it were, be prepared to encounter shoals above her, and shoals beneath her. She must have a certain stratum of free water, between her and the sea-bed; and she must also, when submerged, have a certain stratum of free water between the highest point of her conning-tower and the surface. The second stratum must be rather more in depth than the extreme draft of the ships of the surface force, which the submarine assails.

If a submarine has not got this amount of free water above her, she will be in imminent danger of striking against some ship's keel.

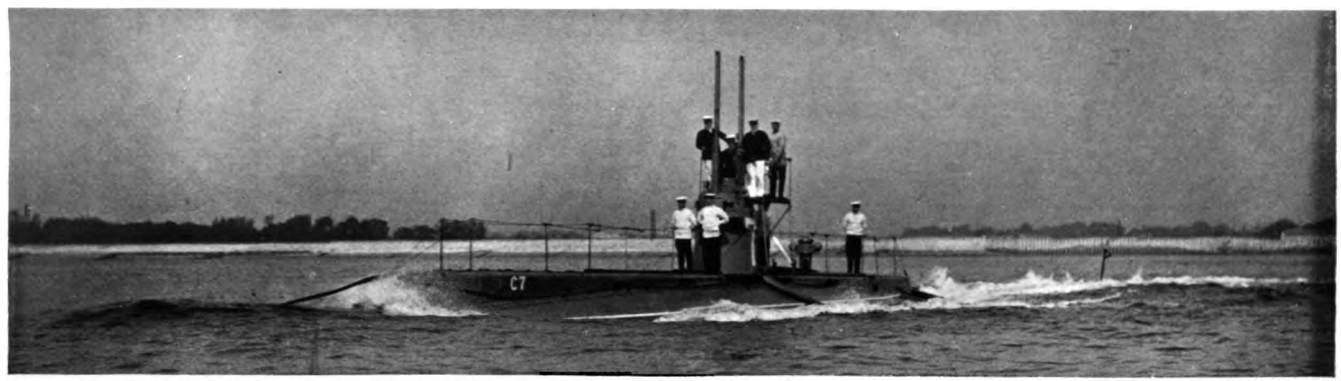
The torpedo discharged at an enemy by a submarine will have no greater effect than one discharged by an ordinary torpedo-boat manœuvring on the surface of the water. Consequently, a submarine's tactical value in actual combat will not be superior to that of an ordinary torpedo-boat. It therefore becomes a question as to the extent to which her preliminary tactical efficiency—that is, her important faculty of carrying out a surprise attack—is superior to that of the ordinary surface torpedo-boat which navigates only on the surface of the water.

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



British Submarine B 1.

Photographed by Symonds & Co., Southsea.



British Submarine C 7.

Photographed by Symonds & Co., Southsea.

To face page 127.

attack. In this the submarine is unquestionably superior to the above-water torpedo-boat, or destroyer.

The submarine, however, has a defect from which surface torpedo-boats are free, viz., the difficulty of seeing her object of attack. If she can get fairly close to, and almost directly abeam of a surface ship, this will not make much difference; but frequently this manœuvre will not be easy to accomplish; and sometimes, of course, it will be impossible for the submarine to reach a point so extremely favourable to her. Submarine torpedo-boats will, undoubtedly, be of great value in future naval war, when many of the conditions are in their favour. This, however, cannot reasonably be expected to always occur.

LIFE-SAVING APPLIANCES IN SUBMARINES.

It is absolutely necessary, in considering the question of Life Saving appliances in Submarines, to keep clearly in mind the entirely different conditions affecting Submarine navigation and the natural difficulties which have to be overcome, as compared with those obtaining in surface vessels. First of all, Submarines have, when submerged, a small margin of positive buoyancy, so that any accident to the propelling machinery, rudders, hydroplanes, etc., does not in practice involve any danger to a Submarine; it results merely in an involuntary ascent to the surface, and, in war time, probably, capture but not loss of life.

Secondly, all Submarines are equipped with methods of expelling water, such as compressed air, electric and hand pumps, quite capable of dealing with any form of small leakage involving loss of buoyancy. So, it follows that the only conditions under which one can imagine a Submarine unable to rise must be such as have involved a large and sudden loss of buoyancy, due to an inrush of water into the hull from some cause or another. And this conclusion is borne out in history, no case being known of a Submarine failing to be brought to the surface by her crew except when an inrush of water into the hull has taken place exceeding the capacity of her water expelling appliances.

The fact that there will in all human probability be a large quantity of water in the hull, must therefore be kept clearly before one in considering life saving appliances for use in case of disaster. It only remains to picture the conditions in a Submarine that has foundered with water in the hull, before turning to a consideration of life saving appliances in detail.

Reports of examination of Submarine Vessels made after their salvage, both in this country and abroad, have proved that unless the vessel is rapidly filled with water the air left in her will be so rapidly fouled by the formation of poisonous gases that not only can no work be done, but life cannot be maintained. This in itself is a practical condemnation of all appliances which aim at saving the lives of the crew by bringing the vessel to

the surface either by their own or outside means; for, as these gases accumulate, the chances of explosion from various causes become great. It is now agreed by all authorities that these two operations cannot run hand in hand—the practical difficulties of tide, weather, getting a salvage vessel to the spot, attaching lifting appliances, etc., being too great to leave any hope of success.

From the above considerations it must be recognised, therefore, that any form of life saving device must be such as to fulfil the three following conditions, and to do this promptly:—

(a) Save the crew from the effects of poisonous gases which will rapidly accumulate.
(b) Save the crew from drowning in the Submarine.
(c) Enable the crew to escape from the boat and ascend to the surface.

There remains also the facts, which are sometimes lost sight of, that space and weight are limited, and that no form of appliance is advisable which seriously hampers the fighting efficiency of the vessel.

There has been a great number of life saving appliances designed, but few, if any of them, will comply with the foregoing requirements, and the majority of them also suffer from the unreasonableness of expecting the crew of a submarine to undertake, in a moment of considerable excitement, an entirely novel and somwhat complicated operation which there has been no satisfactory means of testing beforehand. As experience shows that even plain drop weights will fail on these occasions, such apparatus is, in my judgment, foredoomed to failure.

The dress consists of a plain thin helmet provided with a front glass to which is attached a loose open jacket reaching to the waist and fitted with sleeves. As stowed in the Submarine the helmet has the dress tucked away inside it, so that the whole occupies about a cubic foot.*

The operation of putting on the dress occupies some 20 seconds, and when on, life can be supported in the dress for two hours, by means of a special form of purifier containing a substance called "oxylithe"; the moisture of the breath acting upon the latter having the effect of causing Oxygen to be liberated, whilst the Carbonic acid gas given off on respiration is absorbed at the same time.

*The Author was present at a special trial of this apparatus, which has been adopted for use in the British Navy.

The life-saving dress adopted by the Admiralty is being manufactured by Messrs. Siebe, Gorman and Co.. the Submarine Engineers to the British Admiralty.

Thus the first and second essentials of a life saving device are fulfilled, for, when once the dress is on, the wearer cannot be affected by poisonous fumes, neither can he drown.

The third factor, namely escape from the Submarine and ascent to the surface, entails the fitting to the Submarine of an air trap, so that when the boat is filling with water the crew can stand in it when the pressure of air in the helmet will be automatically adjusted to that in the air trap, which will vary according to the depth at which the Submarine happens to be. These air traps are so arranged that the water inside the dress cannot rise higher than the wearer's chin; when this is so, the occupants will possess a small positive buoyancy and on coming out of the air trap and opening a balanced hatch in the top, they will rise to the surface with a gradually increasing amount of buoyancy.

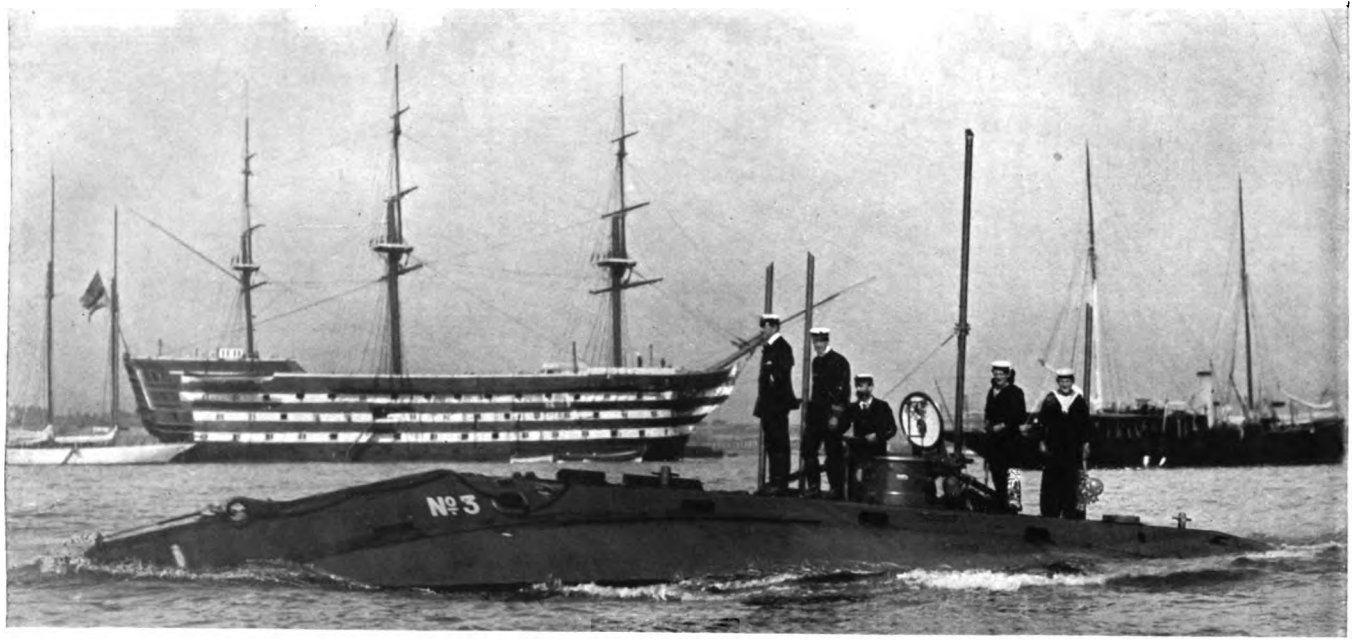
If the Submarine is taking in water with rapidity, the only steps to be taken by the crew will be to release the clips of the balanced hatch; if, however, the boat is filling slowly, steps can be taken to hasten this, if necessary by opening the torpedo tubes into the boat. There are two other points which will occur to everybody, viz., the limit of depth and recovery of the crew when they get to the surface.

From the results of a long series of experiments it is found that no harm will be done if the escape can be limited to 10 minutes from a depth of not more than 150 feet. If the depth is less than 150 feet the time taken can be proportionately longer.

The question of recovery of the crew after they have escaped must depend upon the presence of other vessels in the vicinity; and since collision is generally recognised as the chief danger to submarines there is more likely than not to be some succour at hand for the refugees.

"THE OLD AND THE NEW."

Submarine Torpedo-boat No. 3 passing H.M.S. "Victory."



Submarine No. 3.

Photographed by Symonds & Co., Southsea.

M. Bar, Photo.

French Submersible Torpedo-boat "Narval."

To face page 130.

SUBMARINES IN FUTURE NAVAL WAR.

By Monsieur I. BERTIN.

(Late Chief Constructor French Navy.)

I AM much honoured by your desire to know my opinion on Submarines; but I must ask you to pardon me if I can give you only an incomplete answer.

The first trial trips of the "Gymnôte" and the "Gustave Zédé," led me in 1895 to consider submarine torpedo-boats as destined to play an important part in naval warfare; but only on the condition of their having a great radius of action, that is to say, of becoming submersibles. That is how I came to take up the question of submarine navigation, and to prepare the French Naval Programme of 1895.

Perhaps, however, I may not have been the first to have that idea of the submarine. All the boats designed in America by Monsieur Holland are propelled by petrol motors. This motor is a distinguishing characteristic of the submersible type; since up to the present one can make only electric-motors, fed by accumulators, work properly under water.

The previsions of 1895 have been fully justified by the accomplishments of these boats. The problems unsolved at that date have now been solved, or nearly so. Submarines, thanks to the périscope, are no longer "blind"; their compasses work properly; they can be easily manœuvred, at a great depth, even at a speed which was unforeseen in 1895.

I am not familiar with the successive steps which have been made in the general progress. Thus it is not for me to describe them. Besides, my present occupation would not leave me sufficient leisure for a full account.

SUBMARINES.

"A New Field for the Torpedo."

By Lieut. Sir A. TREVOR DAWSON, late R.N.

(Messrs Vickers, Sons and Maxim.)

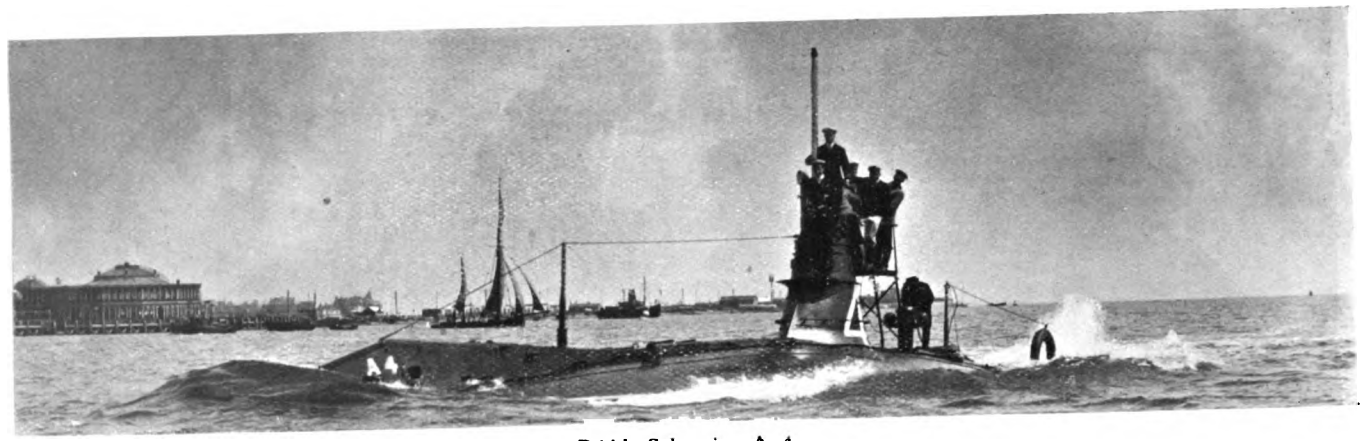
THE torpedo-arm undoubtedly constitutes a most serious factor in connection with our future naval history. Up to the present time the torpedo has been carried by most of our ships of war, but the maximum serviceability of the weapon must be obtained from such specially designed ships as the torpedo-boat or torpedo-boat destroyer. Now, however, a new field for the torpedo is opened out by the introduction of flotillas of submarine or semi-submerged boats. Torpedoes are inoperative at a greater range than 3,000 yards, and must be discharged within closer distance, so that in the case of two vessels, even, otherwise unequal, but armed with torpedoes, the chances of success would be equal, and thus it would be impolitic, under most circumstances, for the superior vessel to take the risk of being torpedoed. For this and other reasons mechanical torpedoes should be utilised by specially constructed vessels, and particularly by boats capable of remaining unseen except for momentary re-appearances to take observation. This is a condition fulfilled by a submarine boat much more effectively than by torpedo-boats of the ordinary type. Attack by daylight would make the latter almost certain victims of any ship armed with a moderately heavy quick-firing gun, escape being impossible; whereas the submarine boat, if discovered when porpoise-like she comes to the surface, can immediately dive, cruise under water for a few miles and make her escape to fight another day.

At the present time France has in commission a large flotilla of these boats, and many more in various stages of manufacture. Germany is also carrying out important trials and spending large sums of money in their development.

Before many years have passed, Germany, and other naval powers, will also possess powerful submarine flotillas, with which they will not only be able to protect their ports, but to make attacks on an enemy's

M. Bar, Photo.

Truite, Torpilleur sous-marin.



British Submarine A. 4.

Photograph by Symonds & Co., Southsea.

To face page 132.

fleet in much the same way as the bands of Boers made guerilla attacks on our regular army in the Transvaal. Of the continuous stream of ships passing up and down the English Channel—the busiest steamship track on the globe—quite 90 per cent. are British vessels, and upon them our mercantile greatness depends.

Let us suppose that in time of war one hundred of the enemy's submarines were let loose in the Channel at night. These boats have sufficient speed and radius of action to place themselves in the trade routes before the darkness gives place to day, and they would be capable of doing almost incalculable destruction among unsuspecting and defenceless victims. The same applies to the Mediterranean and other ocean highways within the danger-zone of the submarine.

The submarine boat has thus increased the value of the mechanical torpedo tenfold.

To some extent the Marconi system of telegraphy affects the range of utility of the submarine, as the operation of blockading no longer entails the use of so many vessels, because the distance through which a message can be signalled at sea has so much increased that one of our ships off a foreign coast may communicate direct with its base in Britain.

The speed of the submarine has greatly increased, and further progress is certain. When the Whitehead torpedo was first introduced it had a low speed, and generally speaking was very uncertain as to its direction, depth, and applied utility. Now, however, it is capable of running within a few inches of the required depth at a speed of over 37 miles an hour for a range up to 3,000 yards, and of hitting the point aimed at with almost the same precision as a gun.

In the same manner there is no doubt the submarine boat will follow the line of progress until it attains the same high point of efficiency.

THE ARM OF THE SUBMARINE.

Latest "Whitehead" Torpedo.

By Captain EDGAR LEES, R.N.

(Whitehead Torpedo Works, Ltd., Weymouth.)

THE Whitehead torpedo is now so well known as to require no explanation in its ordinary form: *i.e.*, propelled by compressed air which is stored in that part of the torpedo known as the air vessel, and expanded in a 3 or 4 cylinder engine of the usual Whitehead pattern. But what has for long exercised the makers of these torpedoes has been the inevitable loss of heat due to the expansion of the air.

To overcome this loss of heat the Firm of Sir W. G. Armstrong, Whitworth and Co. has devised and patented what is known as the "Elswick separate vessel heater for torpedoes," and this device has now been adopted by Messrs. Whitehead and Co. and is being fitted with astonishingly successful results to their torpedoes at the Whitehead Torpedo Factory at Weymouth and at Fiume.

Taking the latest pattern 18 in. Whitehead torpedo as an example, —this torpedo, when using the ordinary cold air, maintains a speed of 28 knots for 2,000 yards,—or 34½ knots for 1,000 yards: for longer distances such as 3,000 and 4,000 yards the speed, of course, is proportionately less, falling to about 20 knots for the 4,000 yards range.

When using the heater the same torpedo maintains a speed of 42 knots for 1,000 yards, 38 knots for 2,000, 32 knots for 3,000 yards, and 28 knots for 4,000 yards.

These speeds are quite extraordinary, as they represent exactly 100 per cent. more power from the engine; and when it is further pointed out that the heater is extremely small, and simple, that it burns any ordinary lamp oil, and is capable of being fitted to practically any existing type of torpedo, the effects of it are seen to be such as cannot fail to command the serious attention of all Countries using the Whitehead torpedo.

The general principles of the heater are that the air is warmed by burning oil fuel with it after it has passed the usual reducing valve. The reducing valve is consequently a measure of the pressures produced by combustion, and automatically controls the air and fuel supply, thus making no difference in the evenness of the speed obtained when running cold, or hot, and producing—what has hitherto been lacking in all other forms of heating devices—a constant temperature, irrespective of the quantity of air or fuel used.

The whole apparatus adds only a few pounds weight to the torpedo, and is absolutely safe and simple to manipulate.

The torpedo here illustrated represents one of the latest 18 in. torpedoes manufactured by the Whitehead firm. It has a total length of 5.2 metres, and carries a charge of 200 lbs. of wet guncotton, and it is from this torpedo that the speeds already quoted have been obtained. Although the maximum diameter of 18 in. has been practically adhered to by all Countries for a period now of some years, there has been a tendency gradually to increase the power by adding to its length, with the result that, at the present time, the total weight has risen to 1300 lbs., and the cubic capacity of the air vessel to just under 12 cubic feet.

With torpedoes,—like other things—there appears to be no finality, and it is highly probable that at the time of the next issue of this work the "Whitehead" will have, again, been so vastly improved; as to render the present speeds, and ranges, extraordinary as they are, interesting only as a matter of history.

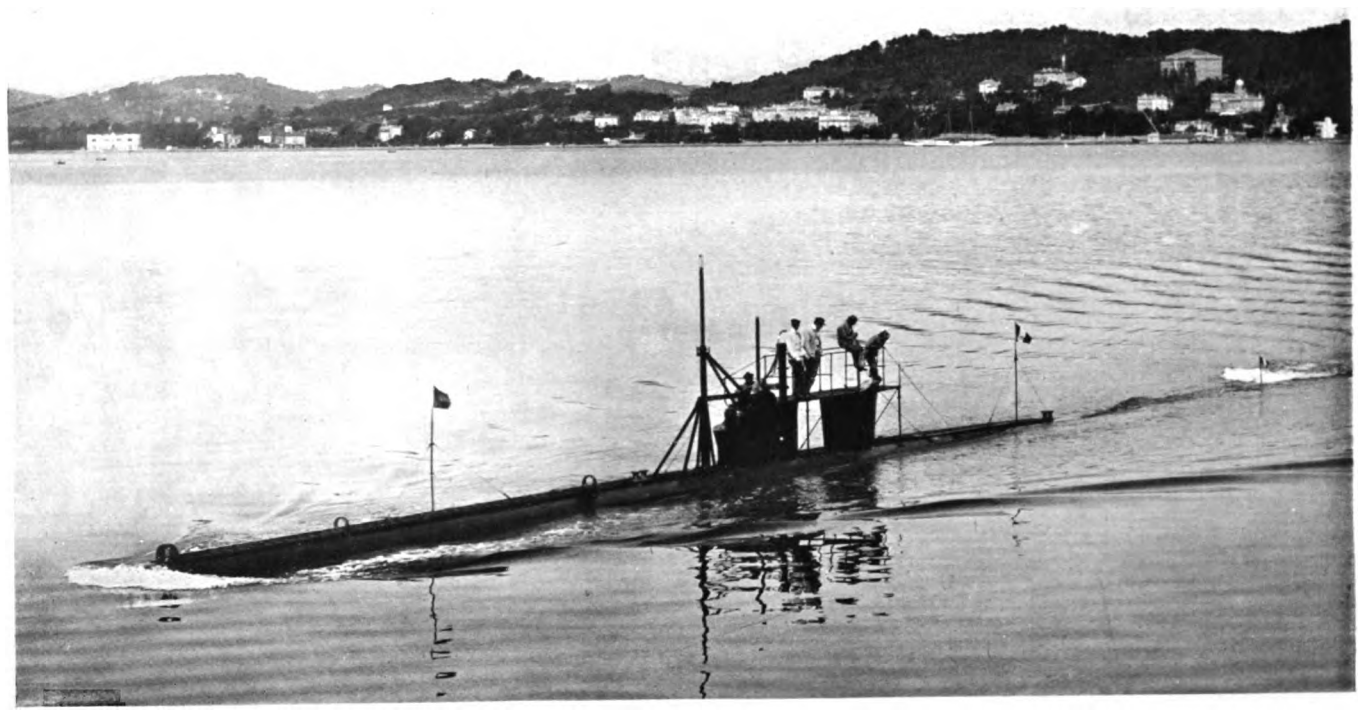
THE DANGERS OF THE SUBMARINE: Real and Imaginary.

By LAWRENCE Y. SPEAR* (Late) Naval Constructor, U.S.N.

MAN, being a land animal, cannot, without much mental readjustment, bring himself to consider dispassionately the dangers which may surround human life and activity under the sea. To the average man the dramatic quality of submarine navigation is its most striking feature, and it follows inevitably that he should exaggerate its dangers and have a more than usually keen feeling of horror when fatal accidents do occur.

Some dispassionate and non-technical discussion of this phase of the subject would therefore appear to be worth while, which, owing to limitations of space must here be confined entirely to the dangers peculiar to under-water work, neglecting those, such as explosions, which a submarine shares equally with ordinary types of ships.

All modern submarines when under way submerged are lighter than the water they displace; and their tendency always is to return to the surface, so that, in case of a failure of the diving apparatus, the mere stopping of the propellors will bring them up. Under normal conditions, then, with the hull intact, they cannot sink, except by expenditure of power through the propeller. This buoyancy, however, is very small, being only about 800 pounds in a vessel of 200-tons displacement. Therefore, if the weight is in any way increased, sinking can only be prevented by rapidly adding additional buoyancy. The principal method of securing this additional buoyancy is the rapid ejection of the water from the ballast tanks, for which purpose three systems are fitted: air, power-pumps, and hand-pumps. Of these, the air system is not only the quickest but the most reliable and the least likely of disarrangement by the inflowing water. Therefore, the pumps are regarded as accessories, and the main reliance is placed on the air system, which, in the best practice, is so arranged as to be efficient at a depth of over 200 feet. Another method sometimes used consists of fitting a drop weight, generally in the form of a loose keel, which may be released at will. Its



M Bar.

Gustave-Zédé-Torpilleur sous-marin.

To face page 137.

advantages are that the buoyancy so obtained can be secured very quickly, and that it is entirely independent of depth. Its disadvantages are as follows: First; it is impracticable to test it every day, since if it be dropped it is lost, unless buoyed, and in any case the vessel must go on dock to have it refitted. In the absence of frequent tests, failure of operation in emergencies is possible. Second; if sufficient weight is allowed to be of any material importance, the vessel ceases to be a submarine as soon as it is dropped, as it cannot again submerge after remedying the difficulty. Third; the weight cannot be very great without detracting from other vital features. These disadvantages have prevented its universal use. These means have under some circumstances proven adequate and under others inadequate. In any case, it may be safely said that the admission of water into the interior constitutes the only real and serious danger to a submarine, with one possible exception. It is conceivable that the whole crew through some abnormal cause might simultaneously be rendered unconscious or otherwise incapable of action. If this should occur at a time when the diving apparatus was set to dive, the vessel would of course proceed on a downward course until arrested by the bottom. Fortunately, this contingency can be and has been met, at least in the latest United States types, by an entirely reliable automatic device, simple in its character, which may be tested without submerging the boat. So that this danger, even if remote in the first instance, is adequately provided for.

All of the real dangers under consideration are included in the above summary, and space here forbids any long discussion of imaginary dangers. It is sufficient to state here that years of practical experience and thousands upon thousands of submerged runs made all over the world under all conditions of weather and sea, have conclusively demonstrated that all the problems in connection with the normal control of the boat have been generally solved. The danger, therefore, of uncontrolled dives reaching enormous or fatal depths is in fact imaginary. This becomes further apparent when it is remembered that a depth of 50 or 60 feet is the greatest for which there is any ordinary tactical use, while the boats themselves are able to withstand a depth of 300 feet. There is thus a large margin of safety. Fears have sometimes been expressed that operation in shallow water is dangerous on account of the likelihood of grounding and knocking a hole in the bottom of a submarine; but since she weighs less than nothing when submerged, no great crushing effect can be produced by striking the bottom. This has been demonstrated in

practice a great many times and is not open to dispute. However, the case does not rest there, for, assuming that the bottom could be ruptured, it is unlikely that any serious results would occur since tanks already filled with water extend the greater part of the length, and a rupture of the outer skin would merely serve to transfer pressure to the inner skin. No water would be admitted to the interior of the boat, nor would the weight of the boat change at all.

Having thus outlined the general conditions, let us now examine briefly the unfortunate accidents of recent years; for if we find that the cause of these is inherent in submarine boats and without remedy, then there is indeed justification for looking askance at the whole system; but if we find this not to be the case, there can be no excuse for the timid proposals sometimes heard for the abandonment of this valuable weapon. The list covers the English boats "A-1" and "A-8," the French boats "Farfadet" and "Lutin," and the Russian boat "Delphin," all of which have been sunk in recent years with serious loss of life.

In the case of the "Delphin," an unusual number of men were in the boat and the ballast-tanks were flooded with the hatch open. Very naturally the boat filled through the hatch and sank. Comment on such gross and almost unbelievable incompetence and folly is unnecessary. No provision of design can ever forestall such an accident, and as the cause was obviously not inherent in the boat, it may be dismissed without further discussion.

The case of the "Farfadet" was somewhat similar. The boat was apparently prepared to dive, or diving, when it was discovered that a hatch had been improperly shut and was leaking. In some unexplained manner, the crew, while attempting to close it, fully opened it instead, and the vessel partially filled and sank. This was a very distressing case, as it appears that the crew lived for many hours after the occurrence, having succeeded in limiting the flow of water. The amount taken in, however, was sufficient to overcome the buoyancy due to the drop weights and of the ballast tanks, which in this particular vessel were of smaller capacity than is now considered good practice. This particular instance, then, was primarily due to a combination of possible carelessness with a badly designed hatch, and as a proper hatch design is a simple matter, there would appear to be no reason to fear the repetition of such an accident.

In the case of the English "A-8," the boat, while running at a high speed under abnormal conditions, was driven under with an open hatch, which the crew did not succeed in closing in time to prevent the

The Author reading newspaper under water.

To face page 130

catastrophe. The evidence before the Court of Inquiry shows clearly that the boat was in an abnormal condition with regard to her buoyancy, and indicates, moreover, that this was even less than the commanding officer thought. Under the circumstances, with this particular design of hatch, prudence should have suggested the closing of the hatch which need not necessarily have been open, in which case the catastrophe would not have happened. Remembering this, and remembering also that the condition was an abnormal and unnecessary one and not contemplated in the design, it is certain that this case does not reveal any usual and necessary danger, and the accident must therefore be classed with the preceding ones.

In the case of the English "A-1," the top of the conning tower was struck by a steamer, the collision resulting in leakage through the hatch, which was sprung open, but otherwise in no serious damage to the structure. However, after the collision, the boat travelled the whole length under the ship, during which time sufficient water had leaked in to sink her, though it is by no means certain that the leak was of sufficient dimension to sink the vessel had all her water ballast been immediately ejected. This apparently was not done, and the cause still remains a mystery. The generally accepted theory that the whole crew were rendered momentarily unconscious by the shock of collision hardly seems tenable. At any rate, this sad accident clearly indicated the necessity for the automatic appliances previously referred to. It also pointed out the desirability of a second modification now generally carried out, viz.: the fitting of a watertight hatch between the tower and the body of the boat. So far as it is possible to tell now, "A-1" would not have been sunk had she been provided with these two features. Therefore, it is legitimate to say that, as things now stand, this particular case does not reveal any inherent and unavoidable danger. Nevertheless, the broad cause of this disaster, viz.: collision involving the upper part of the submarine is the most serious danger to be avoided in practice, and will consequently be reverted to below.

In the last case, the "Lutin," detailed information is lacking to enable any mature opinion to be expressed. Press dispatches indicate that the vessel, having previously made two successful dives, plunged for the third time, after which no sight of her was had, except a momentary glimpse of her bow. The divers' reports show that she sank in about 118 feet of water, and further that the conning tower hatch was open and the interior full of water, and all of the drop weights in place except one, which had been detached. It is stated that the official commission reports

the disaster as being due to a large leak in the stern. This explanation is hardly tenable, as there is no evidence of collision, and no adequate cause can be imagined which would produce a leak of such dimensions as to overcome the ability of the air system and pumps. At present little more can be said about this sad case than that it illustrates very well one of the objections to drop weights, that is their unreliability, and that the fact that the conning tower was found open is very significant.

Summing up, then, we may legitimately say that one of the accidents occurred from causes as yet not clearly understood, and that the other four were due to causes in no way inherent in submarine boats. And further, that three out of these four accidents never should have happened at all to the boats in question, and that, while the fourth accident arose from a real danger to which all submarines are subject, the fatal results might have been avoided with two comparatively slight changes in construction now clearly understood. From all of the foregoing it should be plain that the principal source of danger to a submarine lies in collision with other craft. It would, however, be far from the truth to assume that such a collision inevitably involves grave results to the submarine, for there are at least eight authentic cases known to the writer where a submarine has been in collision without any material damage, and these cases should be set against the one case of the "A-1." Nevertheless, it is the duty of the commanding officer to exercise the greatest caution in this one respect, and if he be determined to avoid collision, as he ought to be, the chances of doing so should be excellent, as he can move his craft, not only horizontally but vertically. The particular accident to be avoided is a breach in the upper part of the hull of the submarine, which would be dangerous; but, if the breach occurs lower down, the water may be kept at the level of the hole by admitting compressed air to the body of the boat, and with the freedom of action thus given to the crew their chances would be much improved.

This naturally brings us to the much-discussed question of the advisability of providing means of escape for the crews of sunken and disabled submarines. It must be apparent from the foregoing that a sunken and disabled submarine inevitably means one with more or less water in its interior, and generally more rather than less. This fact is of vital importance in connection with the question of escape, and is the prime reason why a diver's compartment in the bottom has not been generally adopted as a solution of this problem. Owing to the interior water the vessel may, in the first place, lie at such an inclination as to make egress

from such a compartment impossible, and in any case it is almost certain that the water would prevent access to or use of the compartment. Again, assuming that, by a lucky chance, neither of these conditions obtain, the utility of the arrangement is strictly limited by the depth of the vessel. Too great depth means that the man leaving the boat would probably drown before reaching the surface, or if he escaped this, he would most certainly be incapacitated by the diver's disease known as the "bends," and so would drown helplessly on the surface. The solution, therefore, does not lie in that direction. A method of escape from the top of the boat exists, and this is less likely to be rendered useless by the internal water and is therefore preferable. It still remains subject to the limitations of depth, but there can be little doubt that this problem will be solved in time.

In addition to the escape of the crew from such a disabled boat, much thought has been given to rescue work along other lines, that is by external aid. This has been worked out to the extent of providing external connections on the submarines, so that air may be supplied from the surface in case the supply on board has been used up or unavoidably lost during the accident. The presence of a disabled boat can be revealed by a detachable buoy connected to a reel of wire to the vessel. This also serves to establish telephone connection with the interior. This apparatus has been practically tested and found satisfactory, and is now being fitted on the United States Submarine "Plunger" at the Navy Yard. The difficulties inherent in raising from the bottom by external means a disabled submarine, full or partially full of water, and to do so quickly enough to save life, are very great. The weight to be lifted is very large, and it is excedingly difficult to attach sufficiently strong lines to the hull, particularly when the vessel is at a considerable depth and the surface is disturbed by waves.

Captain R. H. Bacon, R.N., D.S.O., formerly in charge of the English submarines, and now in command of the much-talked-of battleship "Dreadnought," has covered this ground thoroughly in a paper read before the Institution of Naval Architects in London, last year. Owing to his very great experience with submarine boats, this article can have no better conclusion than his opinion:—

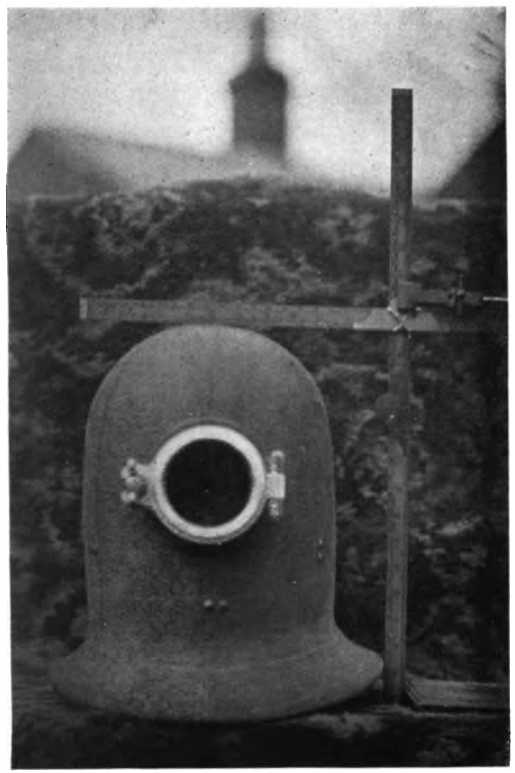
"In conclusion, I hope that I have been able to put impartially before you the relative safety of submarine vessels compared with that of surface craft. That the danger of the work is apt to be exaggerated you will all concede. That it requires constant care goes without saying, but with the

exercise of such care no apprehension need exist of a larger percentage of accidents than in other branches of the service. That with the increase in numbers of the boats accidents will occasionally occur is undoubted, for wherever large quantities of energy are stored in an easily available state, danger must exist, but that this is present to an exaggerated extent in the case of submarine boats is not a fact. Nowhere is the extent of possible danger known better than among those who man the boats, and nowhere would the idea of excessive liability to accident be more scouted.

There is, however, another class of danger that may exist, though at present it does not do so, and that is, that, in the desire to avoid all risks, the efficiency of the boats may be reduced both by constructional limitations, and also by curtailing their practical manœuvring by subjecting them to work less stringent than that which simulates war conditions. Much better have no boats at all than allow such limitations to creep in. At present we can safely say that all the work the boats do is up to the full requirements of war training, and that neither of the two lamentable accidents to the boats have in any way detracted from the severity of the tactical work. The sympathy of the whole country with the sad fate of those splendid men who, being volunteers, were the pick of the service, is apt to lead to exaggeration of the real danger of the work. It is rather outside the navy than in it that apprehension as to the safe use of the boats arises."

SUBMARINE ESCAPE DRESS.
(British.)

Wading ashore after a Submarine Accident. This dress can also be used for diving purposes.
By permission.



"One cubic foot per man"—showing the small space required in a Submarine for each dress.

Dress being used amidst poisonous gases. The illustration shows the wearer's immunity from the effects of poisonous fumes which rapidly accumulate in a Submarine after a disaster.

To face page 142.

SUBMARINE SIGNALLING

Applied to Submarine Torpedo-Boats.

THIS system of signalling by sound under water enables a battleship, by code signals, to communicate with her deployed submarine boats; or two submarine boats can signal each other.

The system comprises two parts:

The signalling-bell adapted to produce sounds in water, and operated by compressed air, or electricity. It is fitted inside the hull of both the surface ship and the submarine. In the case of the United States submarine "Octopus," the signalling-bell weighed 450 lbs., and is fitted in the stern of the vessel.

Secondly, the electric sound receivers, which catch the signals and transmit them to the conning-tower.

This apparatus takes different forms according to the requirements of service. For communication between submarines, or ships in motion, it is desirable to employ a sound of different character from the stationary submarine fog-signals for the use of surface vessels, in order that there may be no possible confusion. For this purpose either specially designed submerged bells, or a continuous sound, which, for signalling purposes, may be broken into long and short impulses, on the principle of the Morse, or Naval Code, may be used.

The sound-receiving apparatus, as applied to submarine, or surface vessels, comprises the transmitters—or, as they may be called, the "ears" of the boat—located inside the hull below the water-line; the receiving-telephones, and the direction-indicator, which are placed in the conning-tower of a submarine, or in the pilot-house of a surface vessel.

The transmitters are arranged as follows:—In the fore-part of the vessel are placed a pair of small tanks, each about as large as a good-sized iron kettle. They are fastened, one on the port side and one on the starboard side, below the "natural" water-line, with the open mouth of the tank against the outer plating, which, in the case of a submarine, is, of course, comparatively very thin, so that the side of the ship makes one

side of the tank. The joint between the tank and the side is made tight by means of a gasket, and a small opening at the top of the tank allows it to be filled with a dense liquid. Through the cover which closes this opening is hung the microphone, or electric telephone-receiver, having a round brass case about the size of a watch, which is suspended in the liquid of the tank.

This method of applying the sound-receivers requires nothing projecting from the outside of the vessel; the apparatus is wholly inside the hull, there being no cutting through or any connection between the outer water and the liquid in the tanks.

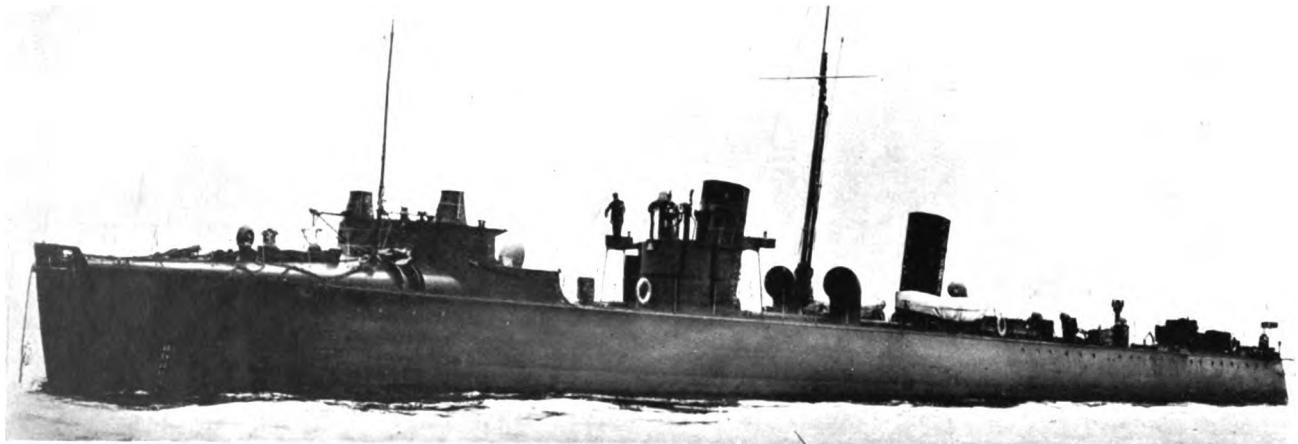
The sound of the submarine bell passes from the outer water, through the wall of the ship, into the liquid in the tank, where it affects the microphone in the same way as an ordinary telephone-transmitter is affected by the sound of the voice. The microphones in the port and starboard tanks respectively are connected by wires, through a battery, to the direction-indicator.

The direction-indicator is a round metallic case, about seven inches in diameter, shaped like a ship's clock, and fastened in the same way to the wall of the conning-tower. On its face is a switch, by means of which either the port or starboard microphone can be connected with the receiving-telephones. It has also a dial, which shows to which side the telephones are connected; and inside is an electric lamp which in a submarine enables the commander to see clearly the dial.

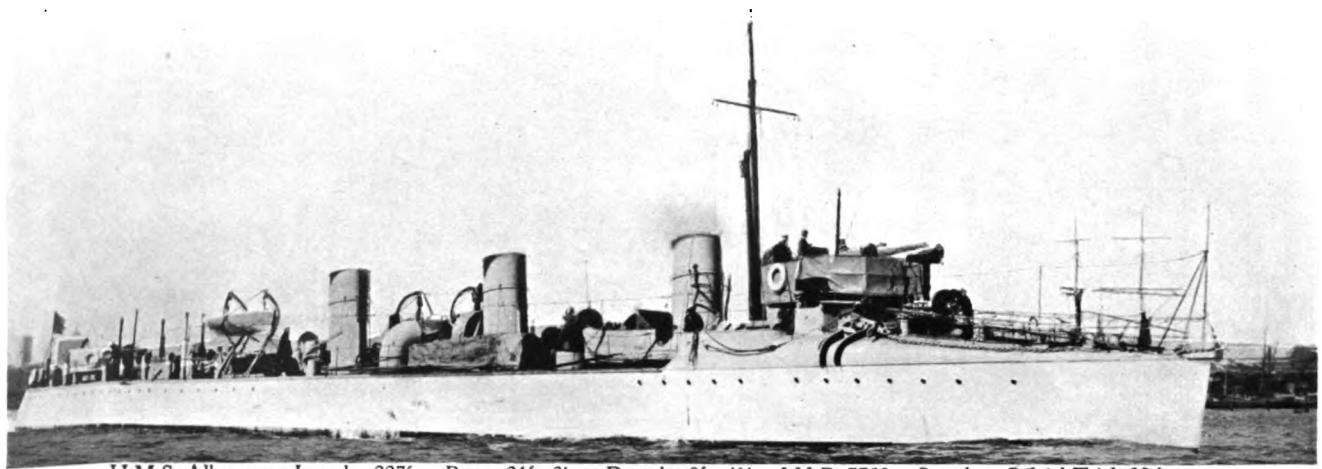
The receiving-telephones are similar to the common telephone ear-piece, and are hung on hooks, one on either side of the direction-indicator. They are always connected together, either to the port or the starboard transmitter, according to the position of the switch. Either of the telephones may be used alone to listen to the submarine bell; or, when the sound is faint and it is desired to shut out other noises, both may be used.

By holding the telephone to his ear and turning the indicator-switch to connect with either the port or starboard microphone, the commander could hear the sound of a submarine bell on either a "mother ship," or another submarine, as received either on the port or starboard side of the boat. The sound is always heard louder on the side of the vessel towards the signal-bell.

To point the submarine exactly at the bell, the commander swings her "nose" around towards the side on which the sound is louder, until a sudden falling off in the intensity of the sound indicates that the bow is passing across the line of direction. When the bell is directly ahead,



German Torpedo Boat Destroyer, "D. 10." This vessel which was built by Messrs. J. I. Thorneycroft, is similar in construction to the English "Desperate" Class. Length 211ft. 6in. Beam, 19ft. 6in. Draught, 7ft. I.H.P., 5,543. Displacement 338 tons. Speed 27¾ knots.



H.M.S. Albatross. Length, 227ft. Beam, 21ft. 3in. Draught, 8ft. 4½in., I.H.P. 7750. Speed on Official Trial, 32 knots.

To face page 144

the sounds are equal on both sides. The bearing of the bell can be taken accurately by the compass, and the submarine's course laid accordingly. The great drawback to the use of sound signals on submarines is that in time of war, the sound, which could be heard by friend and foe, would make known to any of the enemy's ships, within a radius of 10 miles, the proximity and position of the attacking submarines; and thus completely destroy their chances of a successful attack.

This, of course, does not detract from the utility of submarine sound-signals on surface warships, or merchantmen—to whom this most reliable means of fog signalling would be of extreme utility—nor from their utility during the manœuvres, or trials, of submarines, except for the disadvantage of extra weight, with no compensating additional fighting value.

The following is an extract from the report on the trials of this apparatus, made by order of the British Admiralty.

TRIALS OF SUBMARINE SIGNAL APPARATUS.

(Published by the permission of the Admiralty.)

"We have come to the following conclusions as to the utility of the Submarine Sound Signals:—

"If the light-vessels round the coast were fitted with submarine bells it would be possible for ships fitted with receiving apparatus to navigate in fog with almost as great certainty as in clear weather.

"The saving of time and money brought about by ships being enabled to reach port, instead of being delayed by fog and losing tides, etc., would be very considerable; and shipwreck and loss of life would be rendered less frequent.

"Ships not fitted with receiving apparatus would hear the submarine bell much farther and with greater certainty than the present ærial fog signals used by light-vessels, although they would be unable to get direction from them.

"Men-of-war would be as much benefitted by the submarine bell as merchant vessels, as it is of the greatest importance that they should be able to navigate the coasts with speed and certainty in thick weather.

"The bell could also be used to enable them, when collecting at a rendezvous in thick weather, to determine the direction of the Flagship from a distance of about ten miles; but this would necessitate fitting selected ships in the fleets with bells."

ALPHABETICAL INDEX

This alphabetical index has been compiled with the object of, not only acting as a brief summary of the contents of the book, but of showing by the letters after the name of each vessel to which of the "World's Navies" she belongs without further reference.

Abbreviations.

B.S.—Britisth Submarine; F.S.—French Submarine; R.S.—Russian Submarine; U.S.N.A.—United States Naval Submarine; I.S.—Italian Submarine; G.S.—German Submarine; J.S.—Japanese Submarine; S.S.—Spanish Submarine; I.R.N.—Imperial Russian Navy; I.G.N.—Imperial German Navy; I.J.N.—Imperial Japanese Navy; R.I.N.—Royal Italian Navy.