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ANTISUBMARINE TACTICS

NAVY DEPARTMENT
OFFICE OF NAVAL INTELLIGENCE

OCTOBER, 1918

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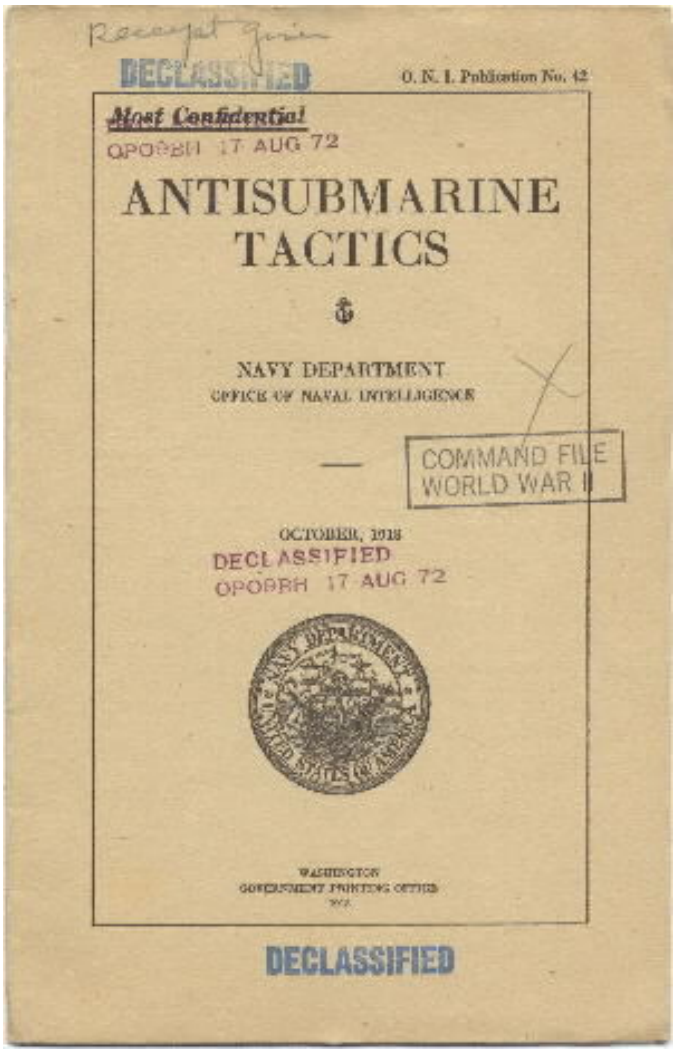

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OFFICE OF NAVAL INTELLIGENCE
Washington, October 1, 1918.

By direction of the Office of Naval Operations this discussion of "Anti-Submarine Tactics" is published for the information of the United States Naval Service.

This pamphlet is most confidential and is for the use of commissioned officers only.

ROGER WELLES,
Rear Admiral, U.S. Navy,
Director of Naval Intelligence.

PLANNING SECTION

MEMORANDUM.

SUBJECT: ANTISUBMARINE TACTICS.

GENERAL SITUATION.
War as at present (July, 1918).

ASSUME.
(1) That the final answer to the submarine will be tactical.
(2) A long war.

REQUIRED.
Estimate of the situation and decisions as to tactical weapons and tactical methods that should be employed in combating submarines.

MISSION.
To determine the best tactical weapons and tactical methods for combating enemy submarines.

ENEMY FORCES.
We need to consider the following concerning enemy submarines:
(1) *Tactical characteristics*.
(a) Ability to rest on the bottom for 72 hours.
(b) Ability to remain submerged under way –
60 hours at 1 to 2 knots.
36 hours at 3 knots.
12 hours at 5 knots.
3 hours at 7 knots.[1]
1 1/2 hours at 11 knots.
(c) Increasing ability to run nearly silent when submerged.
(d) Surface speed, 10 to 16 knots.
(e) Ability to submerge in 20 to 90 seconds.
(f) When submerged can hear pursuing vessels.
(g) With upper end of periscope showing, hull is too deep for torpedo running at 25 feet, the maximum depth setting.
(h) Torpedo range is limited to 3,000 yards. The most favorable range is about 300 yards.

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[1]Sterrett, 7 hours at 7 knots

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(2) *Operating areas.*

(a) English Channel and Irish Sea. Submarines can bottom.
(b) West coast of France and the Atlantic. Submarines can not bottom.
(c) North Sea. Can bottom in places, but not on the north-about route.
(d) Mediterranean Sea. Submarines can not bottom.
(e) U. S. Atlantic coast. Submarines can bottom, but as a rule U boats never bottom—only the smaller boats bottom.

Converging points are still favorite hunting grounds. Good weather permits off shore work. Bad weather and long nights bring the submarines into narrow sheltered waters. Large submarines prefer deep water and waters not frequented by patrol craft. We may expect operating areas to be extended in order to create corresponding extension of the escort system and prevent the formation of hunting units. The submarine does not like to be hunted. It much prefers to determine for itself the time when all hands must be on the alert.

(3) *Numbers.*

German submarine situation, June 1, 1918.

Class.	Total built.	Sunk. Identified.	Sunk. Not identified.	Sunk. Total.	Not yet operating.	Total in actual commission.	School subs.	Total actively operating.	Total remaining in commission.
Cruiser	19	1	--	1	12	6	--	6	18
U	121	56	4	60	5	61	11	45	61
UB	122	37	5	42	6	80	8	66	80
UC	79	51	2	53	--	26	3	23	26
Total	341	145	11	156	23	163	22	140	185

On April 20, 1918, enemy submarines were distributed as follows:

German		*Austrian*	
Homeports	77	Adriatic	31
Flanders	24		
Adriatic	43		
Constantinople	21[1]		

Total…….165

[1] Includes 14 captured Russians.

(4) *Submarine tactics.*

The following are extracts from the German Submarine Manual:

Torpedo Firing from Submarines.

"Assume that firing at a range of over 3,000 meters (3,280 yards) is useless, and therefore better not attempted for single boats."

"The rule for submarines remains as before: Proceed unobserved to a position from which a high speed shot can be fired and a hit certainly obtained."

I. MOST FAVORABLE SIDE FOR ATTACK.

"When choice is possible, the sunny side should be chosen, particularly when the sun is not too high, and provided the shot can be fired more or less from the direction of the glare of the sun."

"In a strong breeze the weather side is preferable."

II. STRENGTH OF WIND AND SEA..

"Do not fire in a calm with a perfectly flat sea (except from the direction of the glare of the sun or at a slow cargo steamer)."

"Force of wind 3-4, and sea 2-3, present the most favorable conditions for attack."

"If the sea is 5-6, when it may be just possible to fire, fire at right angles to the direction of the sea."

"Do not attack in a heavy sea and a long Atlantic swell."

III. USE OF PERISCOPE.

"Periscope showing 1.5 to 2 meters can not be seen more than 4,000 meters, provided a suitable speed is maintained and the favorable side for attack chosen."

"With binoculars it has not been possible to distinguish the periscope even at 2,000 meters."

"An unseen attack (periscope used sparingly) implies keeping the periscope low and showing it frequently but for quite short periods (a few inches of periscope only, so that the object glass is almost awash)."

"You must not for any length of time omit to take a look around."

"Lower the periscope completely and go to a depth of 18 meters (59 feet) when high speed (full speed or utmost speed) is necessary to attain the position for firing."

"Never show two periscopes at the same time."

"Come to the surface with periscope lowered."

"Handling of periscope immediately after firing:
"(a) Lower the periscope and dive to the greatest possible depth (45 meters) (148 feet); this applies particularly to small boats with only one periscope.

"A better method:
"(b) Observe the shot and the hit; also whether a second shot is necessary and possible.
"For this purpose, after firing show the periscope as sparingly as possible in every way; that is, show very little of it, and, as

the boat invariably rises somewhat, always first lower the periscope a little; then raise it again according to your depth.
"After observing the hit and the counter measures adopted, then (and not till then) proceed for about 15 minutes at the greatest possible depth. Lower the periscope completely and preserve silence in the boat."

IV. SPEED WHEN ATTACKING.

"The speed of the submarine is a vital factor in an `unseen' attack.

"1. To close the enemy, first proceed at high speed until the bearing does not change. When actually attacking, endeavor to limit yourself to the lowest speed at which the boat keeps her depth well.

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"2. Before using your periscope, always reduce speed.
"3. If the enemy is zigzagging, it is advisable not to proceed at too low a speed."

V. FIRING RANGE.

"The most favorable firing range is 200 to 300 meters (219 to 328 yards)."

"It is advisable, in addition, after firing, to turn away in the direction of the enemy’s stern."

"NOTE. - On active service the most favorable firing range, in the case of ships with which you are not absolutely acquainted, is 300 meters (328 yards)."

"When attacking ships in a formation do not fire at less than 500 meters (547 yards) range, particularly if the vessels are disposed toward you."
"(a) Do not fire at less than 170 meters (186 yards) in the case of a direct bow or stern shot."
"(b) Whitehead torpedoes must not be fired at a range of less than 250 meters (273 yards)." .

"For a long range shot, only a quadruple salvo promises success, and then only under 3,000 meters (3,281 yards)."

PROCEDURE WHEN PURSUED WITH HYDROPHONES.

"1. A rough sea is the best natural protection."

"2. The reduction to a minimum of the sounds caused by your own boat is an effective protection."
"(a) Connect the vertical rudder and hydroplanes for hand working."
"(b) Stop your ballast and trimming pumps. Use compressed air in lieu."
"(c) Let your main motors run at the lowest possible number of revolutions, stopping frequently. Keep the boat trimmed on the periscope."

"3. Proceed at a depth of 45 meters (148 feet)."

"4. It is better to keep near the coast than out in the open sea in cases where the depth is greater than 70 meters (230 feet)."

"5. Lying on the bottom is a good way of evading hydrophone pursuit, provided that the hull is absolutely tight."

"No leakage of air, and, above all, no oil bubbles."

"6. Make the most of the time when your pursuer is going ahead, in order to increase your distance from him."
"The submarine must, however, stop frequently to listen, even at the risk of not increasing her distance from the enemy so rapidly."

When attacked and forced to submerge, a submarine may
(a) Attempt to escape by proceeding at maximum speed.
(b) Proceed at slow speed.
(c) Proceed slowly, stopping and balancing occasionally to listen, or to synchronize with stops of hunting units.
(d) Bottom (in water 40 fathoms or less).
(e) Anchor submerged.

When making an attack on a vessel or convoy, a submarine normally must submerge a considerable distance away, and then maneuver while submerged for position. This may require the use of high speed and consequently exhaust much of her battery power.

By day in crowded waters, or in localities where our own submarines operate, or our patrols are thick, the enemy must spend most of the daylight hours submerged, and devote much of the

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night .to recharging batteries. Recharging may be done while proceeding on the surface at moderate speed.

5. *General intentions of enemy.*
(a) To continue submarine warfare to the end. Its effect is still of the first importance. To give up submarine war on commerce would be a blow to enemy prestige.
(b) New construction will probably be stronger, to permit deeper diving and to withstand better the effect of underwater explosions.
(c) Will attack points of weakness, like slow convoys, vessels in areas where escorts are thin.
(d) Will give greater attention to submarine cruiser warfare. The recent trip of U 151 to American waters accounted for more than one fourth of the tonnage sunk last month.

OUR OWN (ALLIED) FORCES.

We should consider here the types of the vessels available, and the success that has attended different kinds of effort. The types of vessel available are:
(1) *Destroyers*.
Suitable for escorts, and for offensive work generally. Must depend at present principally upon sight contact. The Mason gear will enable destroyers to follow submerged submarine if close contact is made and submarine is not noiseless. Numerous depth charges.
(2) *Eagle boats*.
Special listening equipment. Suitable for offshore work. Primarily a sound hunting vessel, but sight lookout important. Should be able to keep the sea in all weathers.
(3) *Submarine chasers*.
Sound hunting vessel. Efficient in smooth water. Too small to keep the sea in rough weather and be efficient. Very apt to make sight contacts at night.
(4) *P. boats, Q. ships and sloops*.
Seaworthy. No special listening equipment. Depend on sight contacts.
(5) *Trawlers and drifters*.
Have some listening equipment Fish hydrophones. Stay out about four days, but seek shelter in bad weather.
(6) *Motor launches and coastal motor boats*.
Suitable for work in quiet waters. Are being fitted with listening equipment.
(7) *Dirigibles*.
Suitable for convoying and for scouting and reporting submarines and giving information to surface vessels.

(8) *Seaplanes*.
Suitable for patrol and for attack on submarines; also for giving information to surface vessels.

(9) *Submarines*.
Very good lookouts. Frequent. contacts. Fault is in weapon – the torpedo – which more often than not misses its target. Excellent listening vessels.

METHODS OF SINKING SUBMARINES.

The following methods of sinking submarines have been employed with the success indicated:

	Sure.				
	German.		Austrian.	Total.	Probable.
	To 31 March, 1918	Since 31 March, 1918	To 30 June,		
1. Man-of-war rammed	3	--	1	4	--
Total	3	--	1	4	--
2. Destroyers and patrols rammed	7	1	--	8	2
Gunfire	6	3	1	10	6
Depth charge	14	6	1	21	12
Indicator net	--	--	1	1	1
Modified sweep	1	--	--	1	2
Paravane	2	--	--	2	1
Bomb	1	--	--	1	--
Total	31	10	3	44	24
3. Merchant vessels rammed	2	2	--	4	1
4. Decoy ship gunfire	11	--	--	11	7
5. Submarine torpedo	14	4	1	19	2
6. Decoy and submarine	4	--	--	4	--
7. Armed smack	1	--	--	1	2
8. Mined nets towed	1	--	--	1	4
9. Mined nets anchored	4	--	--	4	1
10. Mines	9	4	1	14	2
11. Submarines own mines	6	--	--	6	--
12. Air attack	2	2	--	4	5
13. Accident	2	--	--	2	--
14. Strandings	5	--	--	5	--
15. Unknown	32	3	4	39	--
16. Interned	5	2	--	7	--
Total	98	17	6	121	24
Grand Total	132	27	10	169	48

3. Merchant vessels rammed

It will be noted from the above that the use of the following has proved most successful in the attack of submarines:

(*a*) Gunfire, all classes of vessels..... 21 sinkings
(*b*) Depth charges, all classes of vessels... 21 sinkings
(*c*) Torpedoes, fired from submarines.....19 sinkings
(*d*) Ram, all classes of vessels.....16 sinkings
(*e*) Mines 14 sinkings

(*a*) *Gunfire* has largely been successful on close contact as at night, or in thick weather, or on Q ships. We may expect it to be less effective in future, due to the wariness of enemy submarines of approaching vessels that they think may be traps. The constant readiness of one or more guns on each vessel at night, joined to better distribution of information concerning our own vessels in any

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given area, should enable us to be quicker on the trigger at night, and consequently more dangerous to the enemy submarine. *Every vessel should consider its guns its most effective antisubmarine weapon at night, and take measures accordingly*. If each vessel can step up its gun fire efficiency against submarines 25 per cent – a small increase – the cumulative effect throughout a very few months will be extremely valuable.

(*b*) *Depth charges* are now considered the principal weapon for attacking submarines. Two or three thousand charges a month are used with only a small number of successes. The problem of the more efficient use of depth charges is one that requires the most constant and painstaking thought and organization of which the Service is capable. We can not expect any revolutionary results, but if we can increase, by more careful methods, the efficiency of several contributing factors, we may very possibly increase total efficiency by 50 per cent. If there be four contributing factors of efficiency, and if our present efficiency is represented by 80 per cent, and if we by increased effort raise these factors to a 90 per cent efficiency, we shall have increased our total efficiency by 60 per cent plus. The following discussion may therefore not be out of place:

When a submarine is sighted by an antisubmarine vessel in its near vicinity, there are several problems that must be solved correctly in rapid succession, in order that the submarine may be sunk by depth charges. The end in view is to explode a depth charge within 70 feet of the submarine. The problems requiring solution are, in chronological sequence-

(1) *To mark the spot on the surface of the water where the submarine was seen.*

Comment. – It must be presumed that the submarine will submerge promptly and leave no trace of its position. An unmarked spot on the surface of the water can not be followed by the eye; therefore the inevitable result of a submarine disappearing below the surface is for the unaided eye to lose track of the point of submergence. If the vessel on which the observers are is obliged to turn through a considerable angle the uncertainty of the submarine's position when last seen is greatly increased. Numerous reports from both American and British sources indicate that many depth charge attacks take place at points quite distant from the submarine, because the position of the submarine when last seen could not be marked, and because it was in consequence wrongly estimated while maneuvering for attack. The concensus of opinion is that the distance of the submarine is usually underestimated.

No complete solution to these difficulties has been found. Ensign H. J. Nichols, U.S.N.R.F., of the U.S.S. *Emeline*, has suggested a marker shell that can be fired at the submarine, which shell upon hitting the water will explode and leave a small smoke producer

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where the shell struck the water. If the fall of this shell is spotted with reference to the submarine it should furnish a good guide to subsequent maneuvers. A second or third shot May be spotted closer to the submarine. No shell of this nature is as yet developed. *There is urgent need for such a shell.*

Lacking a marker shell we must consider how best to solve the problem without it. We can always mark a line on which the submarine was seen by observing the compass bearing of submarine and by dropping at the same time a buoy. If in addition an estimate is made as to the distance of the submarine, we obtain a valuable point of departure for all subsequent maneuvers.

The following rules should govern the dropping of the buoy:
(*a*) Drop buoy as near as possible to submarine; but drop it before submarine disappears.
(*b*) Note compass bearing of submarine at instant buoy is dropped.
(*c*) Estimate distance of submarine from buoy at instant buoy is dropped.
(*d*) Start stop watch at instant buoy is dropped.
(*e*) Note course of submarine with relation to line from buoy to submarine, then convert to compass course.
(*f*) Transfer data to mechanical mooring board.

(2) *To maneuver into position for attack.*

Comment.— The attacking vessel should work out in advance plans for approaching the submarine, based on all the typical positions and courses of the submarine with relation to the buoyed line of position, so that every officer will be ready instantaneously with the correct decision, no matter in what position the submarine may be nor what course it may be steering. To be thus ready may result in saving just that minute that will give success. The commanding officer of each vessel should hold school for officers on this and similar points.

As the turning circle of submarines is smaller than that of destroyers and as submarines almost invariably turn or zigzag when they submerge to escape, it may frequently be advisable to head the attacking destroyer for a point to one side of the submarine, such that if the submarine turns toward that side a depth charge barrage will get him. The attack can then be continued along a retiring search curve toward the other flank in such manner that the first circle of the destroyer will cover 360° of the submarine's possible courses instead of 180° provided for by plan given in force commander's letter of March 29, 1915.

(3) *To drop depth charges in the most probable positions of the submarines.*

Comment.— There are two principal cases under this heading:
(*a*) Submarine leaves visible trace of oil or bubbles.
(*b*) Submarine leaves no visible trace.'

In the first case the attacking vessel must—

(*a*) Determine distance ahead of oil or bubbles that submarine is.

This distance depends upon submergence of submarine and submerged speed of submarine. Submergence is always an uncertain quality. U boats dive voluntarily to over 300 feet. *U 104* used 98 feet depth to escape and 164 to 197 feet when forced to dive where mines were considered probable. Cruiser submarines dive to 492 feet and are to be tested to 525 feet. At least one U boat made a practice of remaining as near the surface as possible in order to avoid depth charges and in order to watch attacking vessels.

As to speed submerged when being attacked it appears most probable that a speed near the maximum, 9 knots, is used until a considerable distance is run from the point of complete submergence.

Tables have been prepared giving the distance in yards the submarine is ahead of the oil or the air bubbles under various assumptions as to submergence and submerged speed. In order to determine the point for dropping depth charges, allowance has to be made for travel of submarine after bubbles or slick are passed, and until depth charge explodes. As the bow wave may obliterate the slick so that the depth charge officer can not see it, it is desirable to mark the end of the slick by dropping a buoy from the bridge. The depth-charge officer may then use this as a point of departure for his depth-charge calculations.

Depth charges sink 6.5 feet per second.

Depth charges countermine at 245 feet.

At nine knots a submarine travels 5 yards a second, or 38.5 yards while a depth charge is sinking 50 feet – two and one third times as fast as a depth charge sinks.

In estimating course of submarine assume—
(*a*) That if submarine is attacking it will continue in an effort to get in its shot-- and may not see attacking vessel.
(*b*) That if submarine is escaping it will turn sharply, and will make wide zigzags.
(*c*) That after an attack submarines as a routine will turn toward direction from which convoy came.

The following points have been emphasized by the Chief of Staff at Queenstown:
(1) There should be on each antisubmarine vessel a depth charge officer with battle station aft, who should supervise the handling, depth setting, and dropping of depth charges in accordance with signals from the bridge; or, according to his own judgment if signals fail.
(2) There should be a depth charge crew, thoroughly organized and trained in handling, setting, and dropping depth charges. This crew may be that normally stationed at the after gun. The after magazine ammunition crew might be stationed to reload the Y guns.

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(3) There should be an efficient system of depth-charge signals from the bridge – capable of repeat back. Following suggested: Siren whistle signal; electric bell; electric gong; klaxon horn; ship's whistle; air whistle.

The following should be kept in mind:

Experience indicates that vessels almost invariably underestimate—
(*a*) Distance submarine is ahead of slick or bubbles.
(*b*) Distance traveled by submarine from point of submergence until attacking vessel arrives.
(*c*) Distance traveled lay submarine while depth charge is gaining its depth.

When submarine leaves no visible trace entire dependence must be placed on calculations based on the original observation and corresponding marks. Nearly all reports indicate that the desire of the commanding officer of the submarine to have a look around will bring the submarine up within half an hour. The best answer to this habit is special lookouts, and special vigilance after a daylight attack or a daylight sighting, in the hope that a new point of departure may thus be gained.

As to methods of getting depth charges in the water.— These are: Y guns; thorneycroft throwers; depth charge racks.

For all depth charge attacks made soon after the submergence of the submarine, the initial attack is of special importance, for then the position of the submarine is known better than it will be known until it is sighted again. Y guns and throwers make it possible to enlarge the pattern of the attack. If a submarine appears inside the turning circle of a vessel, there is only one way to drop a depth charge near the submarine and that is to turn away and stand off until submarine can not get again inside turning circle before attack is delivered. Y guns and throwers may throw depth charges toward the submarine and thus meet in a way this special situation. The usefulness of the thrower would be greatly increased if it could be trained.

The concensus of destroyer opinion is in favor of more than one depth charge thrower on each vessel; of permitting a 300 foot depth-charge setting; of carrying a few 600 pound depth charges on the later destroyers.

Radius of destruction of a 300 pound charge is 70 feet; of a 600-pound charge is 95 feet; 600 pound depth charge weighs 800 pounds. Depth charge throwers capable of throwing a depth charge containing 260 pounds T. N. T. 300 yards weigh about 4,000 pounds.

Torpedoes fired from submarines have been very effective against enemy submarines, but many opportunities for success have been lost through the difficulty of hitting so small a target as a submarine. With the enemy submarine showing its periscope only and probably in the act of diving, the torpedo set for 25 feet is apt to miss. Expe-

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rienced officers believe that the depth setting should be changed to permit of a 60 foot setting. Independent, however, of depth of submergence, the submarine is a very difficult torpedo target. The problem of increasing the probability of torpedo hits is of extreme importance. There are two ways of increasing the probability of hits—

(1) *Firing more torpedoes*.

Comment.— It has been suggested that a small torpedo be developed that can be fired in groups simultaneously from the same torpedo tube—so directed as to scatter shotgun fashion.

It is, of course, assumed that every care is taken to keep each torpedo in efficient condition, and that on each occasion of a profitable opportunity to fire at any enemy submarine, every torpedo that can be fired effectively will be fired.

(2) *Increasing the danger space of torpedoes*.

Comment.— Each torpedo carries an explosive charge, which, if detonated within 70 feet of a submarine, will sink or disable the submarine. Many torpedoes fail to hit the submarine, but still pass within 70 feet of it. It is probable that the number of successful shots would be increased not less than 50 per cent if each torpedo passing within 70 feet of a submarine detonated. No other torpedo problem in design is of such immediate importance as the following:

To attach to all torpedoes now used by submarines a device that will detonate the torpedo should it, while making a war run, pass within 70 feet of any vessel.

The ram as a weapon needs little discussion here. Prompt, bold seamanship is all that is required for its successful use. No captain should ever hesitate to ram if his vessel is strong enough to damage seriously the submarine. Every submarine sunk is $10,000,000 a year saved to the Allies.

Mines.— The enemy submarines that have been sunk by mine have been sunk in fields of anchored mines. In previous studies we have pointed out the importance of making our primary mining effort barrages closing the exi[s]ts to enemy submarine bases. No change in conditions has altered our opinion as to the soundness of this policy. When mines are available over and above those required for barrage operations, they may be used as deep trap mine fields in localities where submarines are apt to bottom, or where patrol vessels may force them to submerge. The danger that deep mine fields offer to shipping makes it advisable that mine fields should not be laid on traffic routes.

Wherever a surface minefield is laid as an antisubmarine measure it should be above a deep minefield, otherwise the submarine will soon learn to dive under the surface minefield.

The suggestion has been made that, since a small mine detonating in contact with the hull of a submarine will destroy the submarine,

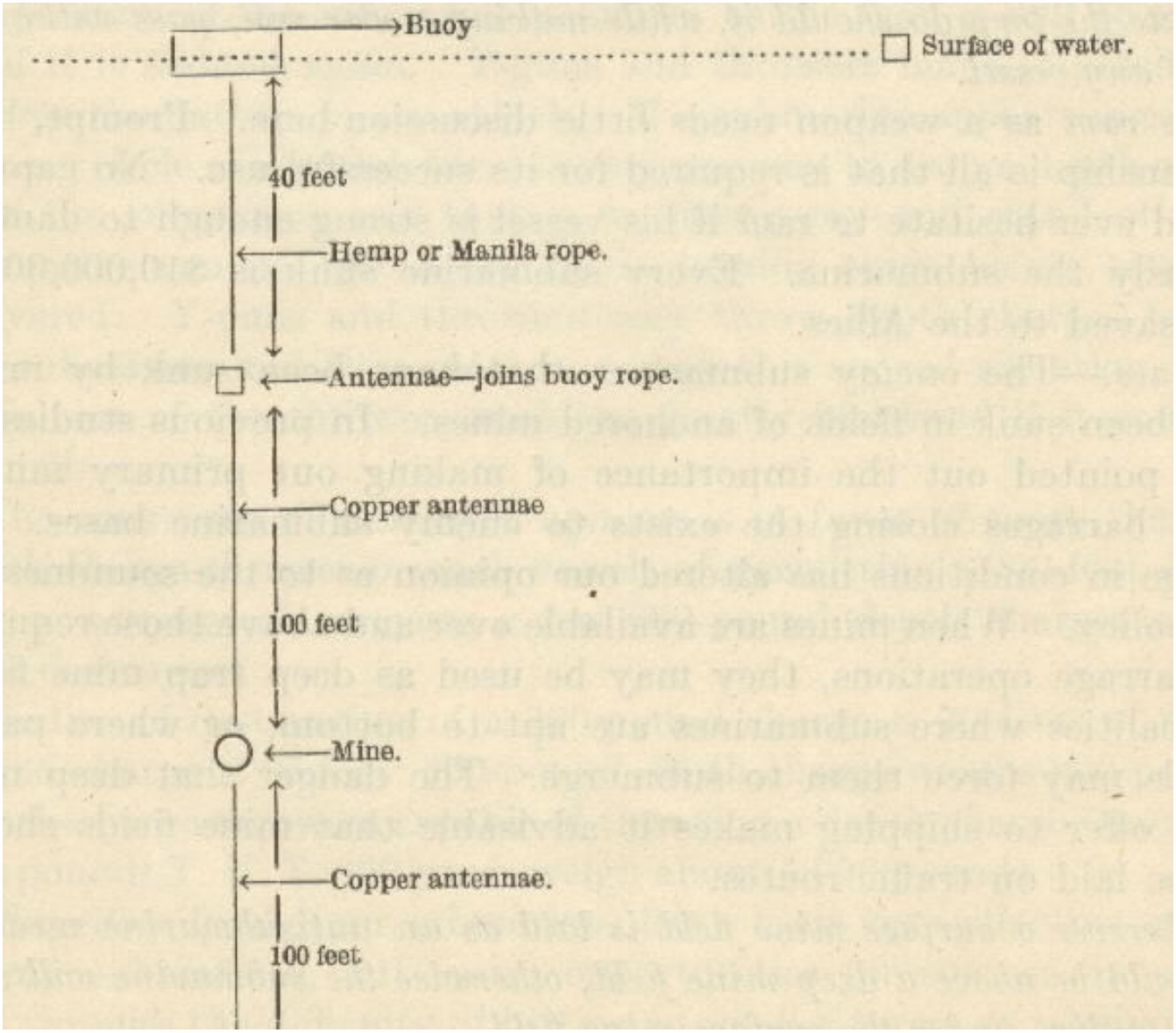
it might be profitable to attach to a single mooring rope as many as five 100 pound horn mines of the existing type spaced 25 feet apart. This arrangement, although possibly difficult to lay, would economize greatly in wire rope, and might be considered a substitute for our antennae mine should an answer be found to that mine.

We must always consider the possible necessity of abandoning the antennae mine; and therefore should complete without delay up to the point of readiness for quantity production, a type of mine that does not depend in any degree for its efficiency on secrecy regarding its design.

The foregoing discussion on mines does not bear directly on the tactical use of mines in antisubmarine warfare. We shall now consider the tactical use of mines against submarines.

The depth charge detonates without reference to the presence or absence of a submarine within its restricted area. If it is to be effective, the depth charge must arrive at its set depth at a time when there is an enemy submarine within the radius of its destructive effect. When we consider the great number of depth charges that are expended without definite known result, we are led to inquire if there be not some other more effective way of using underwater explosives. The following is suggested:

A tactical antennae mine to be laid from antisubmarine vessels in a barrage around all submarines with which close contact is made. The present United States mine to be used as indicated in the sketch.



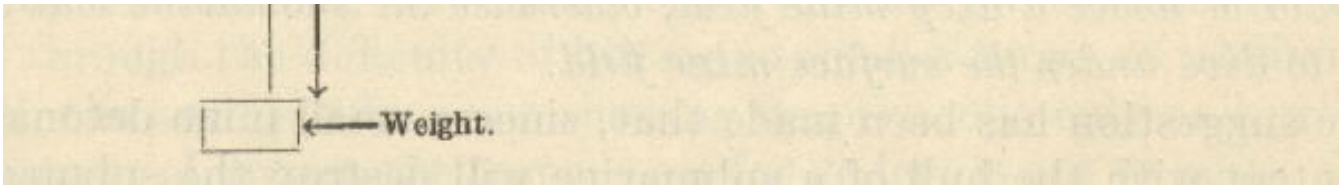


Image of tactical antennae mine: from buoy at surface of water, with 40 ft. of hemp to antennae, with 100 ft. of cooper antennae to mine, with 100 ft. of cooper antennae to weight.

The mine is suspended from the buoy. Forty feet of buoy rope makes the mine dead to surface craft. The buoy furnishes an additional safeguard to vessels navigating on the surface. The antennae both up and down make the mine effective over the entire depth of any ordinary submergence of a submarine. The mine is not anchored, and must be arranged to sink after a reasonable period say two hours.

Assuming contact with a submarine which permits locating the point of her submergence within 200 yards, and allows the attacking vessel to reach that point within three minutes, the submarine may then be as much as 1,200 yards from the point of submergence when the attacker arrives on the scene. If the attacker carries 50 antennae mines, she can lay a mine field of about 2,000 yards in length (at intervals between mines of 120 feet) which will give a good chance of being exploded by a submarine passing through the field. By laying the field on a retiring search curve, an arc of about 60° (starting on a 1,200 yard radius) can be covered. We therefore will have one chance in six of selecting the proper arc; or about one chance in 18 of mining the submarine by a single destroyer. Judging from experience this chance is much greater than that of successfully depth charging the submarine unless the submarine be seen. The tactical mine barrage should be particularly useful in the case of an attack upon a convoy because
(*a*) The submarine initially will be close to escort vessels.
(*b*) The approximate depth, speed, and direction which the submarine will take may be predicted with fair accuracy.

Large handy vessels of the convoy might carry large numbers of tactical mines with a view to using them against any submarine attacking a convoy.

The tactical value of mines would be greatly increased if they could be made to detonate whenever a vessel came within the radius of their destructive power. The antennae may be regarded as a partial and, possibly, temporary solution of the problem. A complete solution extending the sensitiveness of the mine 100 feet in all directions would be invaluable. It would reduce the cost and increase the practicability of barrage operations enormously, while it would immediately justify the adoption of the tactical mine as the chief antisubmarine weapon.

We recommend that the problem of a self contained mine detonator, sensitive to vessels within a radius of 100 feet, be considered urgent and of great importance.

TACTICAL OPERATIONS.

Whenever possible, the attitude of the *hunted*, rather than that of the *hunter*, should be imposed upon the enemy submarines. Every

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time that an enemy submarine is forced to submerge it enters a danger area where machinery accidents and errors of personnel produce their maximum effect.

The fact that 32 enemy submarines have been lost through unknown causes is an indication of the value of making submarines navigate submerged.

Drive them under, keep them under.
The tactical operations that we have to consider are:
(1) Hunting by sound.
(2) Hunting by sight.
(3) Counter attack by escorts.

In all hunting operations it is essential that the services of information and communications be efficiently and intimately coordinated with the hunting efforts, to the end that hunters may make frequent and timely contacts with the enemy. There should be a constant inspection and checking of the communication system and a flexibility of hunting arrangements such that, whenever a submarine appears near the coast, it shall meet with a reception suited to its important character. Aircraft, surface vessels, and friendly submarines, must all have their efforts coordinated. There must be the freest possible flow of information to and from all units.

In general, hunting will be most profitable—
(*a*) In water over 40 fathoms deep, where submarine will not bottom.
(*b*) Immediately after submarine has made an attack (battery power reduced).
(*c*) After a submarine has passed through a thick patrol (battery power reduced).
(*d*) At night; in areas where, during the day our own submarines operate, or where there has been much traffic (battery power reduced, submarine probably on surface).
(*e*) After a submarine's hull has been caused to leak air or oil, or has been otherwise damaged by depth charges or other causes.
(*f*) In narrow waters; requiring the submarine to make frequent observations for navigational purposes, and restricting his choice of courses while submerged.
(*g*) Along routes of passage to and from operating grounds of submarine. The general course most likely to be taken after submerging can then be predicted.
(*h*) For hunting by sound, in areas where there is little traffic.
(*i*) During summer; good weather and long days.

The primary object of hunting by sight is to force the enemy submarine to remain submerged until she is compelled to emerge. Incidental opportunities for attack will of course be taken advantage of.

Owing to submerged radius of submarines and to their ability to proceed unobserved, this form of hunting can not be successful except that an area of at least 25 miles radius be placed under good observation.

A submarine can proceed 25 miles submerged in 3 1/2 hours at 7 knots – batteries exhausted; 5 hours at 5 knots – batteries 40 per cent exhausted; 12 hours at 2 knots – batteries 20 per cent exhausted.

A formation deployed so as to have an area of 25 miles radius under observation, with center over last known position of submarine, will then have from 5 to 12 hours in which to sight the submarine before she can escape.

Meantime if the submarine is sighted, the formation may move its center over the new position and start afresh, with the advantage of having partially exhausted the submarine's batteries – and perhaps of having shaken its morale by a depth charge attack.

Aircraft and kite balloons would be of great assistance to the hunting group. Listening devices also would be of great assistance.

At dark, in fog, or at the end of the time when it is judged that the submarine may have reached the limit of observation without discovery, it will become necessary to move the formation in the supposed direction which the submarine may have taken, and at her assumed speed.

For these reasons, this form of hunting will be most profitable in northern latitudes during summer; and also along the route of passage between enemy operating ground and bases. Deep water is essential to prevent the submarine from economizing power through bottoming.

In order to cover an area 25 miles in radius, about 20 vessels are required with visibility of 5 miles. If vessels are equipped with kite balloons, able to see a submarine on the surface 15 miles, only six vessels will be required for observation; but they will require additional vessels to prevent the submarine from remaining on the surface for considerable periods of time out of gun range from them, which periods he may utilize for recharging batteries.

Owing to the necessity for driving submarines under promptly with gun fire, the interval between units of a group hunting by sight, should not exceed 15 miles, even when equipped with kite balloons.

Twenty two vessels 15 miles apart can cover an area of 45 miles radius. If the center vessel and the outer line carry kite balloons having visibility of 15 miles, but 14 of the 22 need to carry kite balloons.

The enemy can reach the outer limits of observation starting from the center of the formation in 7 1/2 hours at 6 knots with batteries exhausted; in 9 hours at 5 knots with batteries 75 per cent exhausted; in 23 hours at 2 knots with batteries 40 per cent exhausted.

If units of a sight hunting group are equipped with listening devices, the opportunities for obtaining information of the enemy's approximate location will be increased. His escape on the surface, even at night, will be rendered difficult by this means.

Even in the large group sight hunting, coordinated starting and stopping of the engines of all units will be essential if listening devices are used—although the sound interferences between units will not be so serious in the large sight hunting group, owing to the great intervals of deployment.

Destroyers, Eagle boats, P boats, are suitable units for sight hunting groups in the open sea. Trawlers, submarine chasers, motor launches, and coastal motor boats, are suitable units for sight hunting groups in sheltered waters.

In general, the hunting procedure would be about as follows—operations being conducted in northern latitudes during summer, over deep water, and preferably along passage routes, and near any patrols that may be operative:
1. Information received of submarine position nearby.
2. Deploy at 15 mile intervals with center of formation over last known enemy position, getting kite balloons out.
3. Zig zag at 15 knots about center of formation.
4. Stop simultaneously about three times per hour for five minutes to listen.
5. Upon getting sight or sound contact, shift center of formation over new enemy position, vessels making sound contact retaining it, and other vessels stopping and starting so as to facilitate hunting by sound.
6. Move whole formation in direction enemy is assumed to have taken, at such speed as to keep center of formation over enemy assumed position.
7. If enemy is heard at night on surface, or charging batteries, search for him to drive him under; closing intervals if necessary, and keeping formation center near his last known position.

PATROLS.

A system of patrol of a large area by a few vessels, generally speaking, is unprofitable. It is expensive in wear and tear and fuel; it is not an economical distribution of forces, because areas in which the enemy is operating are covered no thicker than other areas; contact with the enemy depends largely upon chance, and even when contact is made, there is insufficient force present to deal with the enemy efficiently.

The most useful thin patrol is by means of our own submarines, whose operations will annoy and handicap the enemy (and occasionally damage him) by inducing him to remain submerged during most of the day, rather than risk a surprise torpedo attack.

The next most useful thin patrol will be at night, in areas which the enemy is suspected of using to recharge batteries.

Air patrols will be useful in obtaining information which will put our forces into contact with the enemy, and occasionally useful in attacking him.

Thick patrols are very useful in narrow passages through which the enemy must pass frequently, provided the patrol has a formation of great depth, or is maintained over a deep mine field.

CONVOY COUNTER ATTACKS.

The opportunity normally presented for effective action against enemy submarines immediately following an attack upon a convoy is so good as to warrant unusual efforts to take advantage of it.
(*a*) There is present a large concentrated force of antisubmarine craft.
(*b*) The position of the enemy submarine is near and is usually known within narrow limits.
(*c*) His probable immediate action may be predicted with fair accuracy.
(*d*) His battery power is usually reduced considerably.
(*e*) Usually the water is too deep for bottoming.
(*f*) Immediate further danger to the convoy has been eliminated, except in the very rare case of another submarine being in the near vicinity. This possibility is so remote as not to justify serious consideration until at least several hours have passed.

Under the circumstances we are fully warranted in employing practically the entire escort force in a counter attack, and, should the counter attack fail, in a search for a number of hours by a part of the escort. As destroyers become more numerous, it will be desirable to organize a part of each escort into a hunting group that shall leave the convoy upon contact with an enemy submarine, and shall thereafter hunt that submarine, until obliged to abandon the hunt to get fuel. The antennae tactical mine, already discussed, should be specially useful on escorting vessels.

The frequency with which convoys get close contact with the enemy as compared to close contacts obtained in other ways, may justify special hunting vessels, such as Eagle boats, accompanying convoys in good weather through a part of the zone, in order that a hunt may be initiated under very favorable circumstances. No decision in this matter can be reached until the capabilities of these vessels are known more fully.

In fast convoys, where vessels have on board experienced personnel, it is desirable that the vessels of the convoy carry a considerable number of depth charges, and that whenever the tactical situation makes the safety of the vessel lie in turning toward the submarine, that each vessel so turning shall use its depth charges freely.

Important vessels manned by naval personnel should carry depth charge throwers.

ATTACK OF ENEMY BASES.

The blocking of exits from enemy submarine bases by block ships has not been attended with sufficient success to justify further effort. Destruction of enemy bases and of enemy vessels therein is valuable. The discussion of such efforts is outside the scope of this paper.

AIRCRAFT.

The United States is about to undertake a very extensive system of aircraft antisubmarine patrol. Its success will depend very largely upon cooperation with surface vessels through an efficient communication system.

DECISIONS.

GENERAL.

1. To perfect services of information and communication so that hunters will be given timely information of enemy submarines operating in their vicinity, and so that aircraft, surface vessels, and friendly submarines may all have their efforts coordinated. There should be the freest possible flow of information to and from all units.

WEAPONS.

2. Every vessel should consider its guns and ram the most effective antisubmarine weapons at night or in thick weather and plan its actions accordingly.
3. To determine experimentally the relative value of heavier depth charges; lashing two 300 pound depth charges together is suggested as a substitute for our 600 pound depth charge.

TACTICS.

4. To mark the line on which close contact with a submarine was made by dropping a buoy and simultaneously observing the compass bearing of the submarine, and thereafter to use this line as an origin of maneuver. See rules on page 8.
5. To organize on each vessel a depth charge crew under a depth charge officer, and to give special attention to the training of these and to the system of signals and the doctrine governing their action. See page 9.
6. To experiment with the antennae mine as a tactical antisubmarine mine, and to supply a part of all escort vessels with these mines as soon as developed. Large handy vessels in certain convoys to be used as tactical mine barrage vessels.
7. To continue present plans for hunting by sound with chasers and submarines; areas for the latter to be separated from other antisubmarine effort.

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8. To counter attack with a large force on each occasion when a convoy is attacked, and to continue the attack with a considerable portion of the escort. Drive the submarine under, keep him under, and impose upon him the attitude of the hunted instead of the hunter.
9. To organize in each escort a regular hunting unit with definite plans of action.
10. To organize sight hunting units for operations in northern latitudes during summer, and along routes between enemy bases and operating grounds.
11. To organize similar units of small vessels for narrow waters.
12. To use kite balloons whenever possible.
13. To issue depth charges to vessels of fast convoys so that whenever the tactical situation makes the safety of the vessel lie in turning toward the submarine, it may use depth charges freely.
14. To place depth charge throwers on transports and cargo vessels which have a suitable personnel.
15. To direct submarines to use torpedoes freely upon every profitable opportunity for attack.

INVENTIONS.

16. To develop a marker shell that can be fired at a submarine about to submerge, which, upon hitting the water, will explode and leave a small smoke producer on the surface at the point of impact, is urgently needed.
17. To design depth charge throwers so as to permit of variations of range and train.
18. To. develop as soon as possible up to the point of readiness for quantity production a type of mine that does not depend in any degree for its efficiency on secrecy regarding its design.
19. To develop a torpedo firing mechanism that will be sensitive to the presence of a vessel within 70 feet of the torpedo, and to attach this firing mechanism to all torpedoes used in antisubmarine warfare.
20. To develop a mine firing mechanism that will be sensitive to the presence of a vessel within 100 feet of the mine, with a view to using this mechanism in antisubmarine mines.

NAVY DEPARTMENT,
OFFICE OF OPERATIONS,
September 8, 1918.
1. Approved for circulation to the forces for information.
W. V. PRATT, *Acting*.

Source: "ONI Publications, WWI" ZV file, Navy Department Library.

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30 May 2006