

Intelligence

R E S T R I C T E D

HEADQUARTERS I AIR SUPPORT COMMAND
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The following information is compiled from various documents that have been received at this headquarters and is disseminated to all units of the I Air Support Command for the purpose of familiarizing pilots, observers, and Operation and Intelligence personnel with enemy submarine tactics. This material will be classified as "Restricted". All commanders are cautioned to insure that the matter contained in these excerpts does not fall into the hands of unauthorized persons. Additional information may follow.

NOTES FOR AIRCRAFT ON ANTI-SUBMARINE PATROL

This paper gives a short description of types and capabilities of U-boats with notes on their probable tactics, occasions when they may be sighted and the effect of Anti-Submarine action.

TYPES

Particulars of the three main types are given below. Two or three larger U-boats, 275 feet long, are now in commission and several captured submarines may also be used by the enemy. (There are no signs as yet that any of these captured submarines are employed on operations).

Roughly speaking the 750-tonners are employed on long patrols far out in the Atlantic, the 500-tonners for closer ocean work and the 250-tonners for minelaying and short patrols in the North Sea.

	<u>750-tonners</u> <u>(double hull)</u>	<u>500-tonners</u> <u>(double hull)</u>	<u>250-tonners</u> <u>(single hull)</u>
Length (approx)	240 ft.	206 ft.	136 ft.
Speed (Surface)	18 kts(allegod)	16 $\frac{1}{2}$ kts.	13 kts.
" (Submerged- maximum)	8 kts	8 kts.	7 kts.
Torpedoes carried	10	9	5
Guns	1 - 4.1" 2 - 0.79" AA	1-3.5" 1-0.79" AA	1 small AA
Surface endurance	14,000 miles	10,000 miles	3,000 mi.
Normal running	9,000 "	7,000 "	

DESIGN

The pressure hull of a submarine is roughly cylindrical and of great strength to withstand the pressure of water at extreme depths. Hatches, bulkheads, bulkhead doors, front and rear doors of torpedo tubes, glands for periscopes and propeller shafts and top "windows" of periscopes are all designed to stand pressure.

The 250-tonners are single hulled; all their tanks are inside the pressure hull while light plating forms an upper deck casing, a stream lined bow and a fairing for the conning tower. All other types of U-boats are double hulled. As will be seen from the diagram appended, a light outer hull extends along the sides forming ballast tanks, some of these tanks may be fitted to carry oil fuel. When her pressure hull is punctured a U-Boats destruction should ultimately be assured unless she is very lucky and in the vicinity of her own waters. If her outer hull is shattered, however, it is quite possible that she may only suffer inconvenience which may or may not cause her to abandon her patrol.

A U-boat is divided into a number of compartments any of which can be made pressure-tight by closing a heavy door. The normal lay-out is torpedo room, living space, control room, engine room and motor room. The conning tower is a pressure tight dome on the ull communicating with the control room through a pressure-tight hatch; this hatch and the top hatch, known as the conning tower lid, are normally the only openings in the pressure-hull when the U-boat is at sea.

A U-boat runs, while on the surface, on her diesel engines; the induction air being drawn down the conning tower hatches. When submerged she runs on her electric motors, the storage batteries for which occupy a large space under the floor boards of her control room and living space. These batteries may weigh up to 150 tons. Compressed air for flowing (i.e. emptying) tanks is stored in steel flasks outside the battery tanks. A high-pressure air-compressor recharges these flasks or "air-bottles" and tops-up the H. P. air in the torpedoes.

Hydroplanes forward and diving rudders aft control the U-boat's depth whilst diving. Two and sometimes three periscopes are installed, raised and lowered by power and revolved by hands. One periscope has an angling top lens for aeroplane search and probably a power 6 magnification; the other is a thin attack-periscope power $1\frac{1}{2}$, which is used in the final stages of an attack as it shows only a small feather. The main difference between a U-boat and a British submarine, in silhouette, is that the former always has a net cutter in the bows and does not have periscope standards showing above the bridge. The British submarine has no net-cutter and usually, but not always, has high periscope standards showing above the bridge. Several submarines now in service with our forces, notably the Dutch, have net-cutters similar to U-boats.

DIVING

A submarine dives by flooding her ballast tanks which, when filled, give the boat the same weight as the water she displaces. When in "trim" i.e., correctly ballasted, if the submarine is stopped on the surface she will just float with her conning tower awash or just sink. By going ahead on her motors with her hydroplanes in the "dive" position she can be taken under and kept at the required depth.

When anticipating air or surface attack a U-boat will normally be proceeding with certain ballast tanks full or nearly full. She will then be running, possibly, with her upper deck casing awash, only showing her conning tower and perhaps her net cutter. When in this state she can probably submerge completely in about 25 seconds. Once under water her rate of gaining depth is about 2 feet per second.

Ballast tanks are flooded by opening vent valves on the top of the tanks, these valves allow "cushioned air" in the tanks to escape and water to take its place. Tanks are emptied by blowing compressed air into the top of the tanks - having first closed the vents - and forcing the water out at the bottom.

It should be borne in mind that a U-boat dives on a straight course. If sighted on the surface, therefore, and her course estimated accurately, a depth charge attack made straight down her line of advance, would ensure that the aircraft is directly over the U-boat. She will, if surprised into doing a crash dive, be making good about 7 knots. A submarine in a heavy sea will try and bring the sea on the beam when diving; on surfacing she will try to come up head to sea.

VISIBILITY BY DAY AND NIGHT

By Day - in good visibility, a U-boat, even when on the surface can, with two exceptions, rely on sighting her enemy before she herself is seen, if she is keeping a sharp lookout. The two exceptions are:

- (1) A diving enemy submarine.
- (2) An aircraft proceeding up moon or coming out of the low sun.

There are occasions when an aircraft may surprise a U-boat by taking advantage of low cloud, and rain squalls. (note - Our own submarines operating off Norway have reported sudden aerial attacks which they have experienced under those conditions "Aircraft attacked out of rain squall. Dropped two bombs. Slight damage to light bulbs." Possibly if the pilot had been more skillful or had his machine carried a depth charge there would have been no report submitted from the submarine).

During the days of good visibility when there are clearly defined hail or rain squalls, cloud at 1000 feet, patches of fog or coastal haze with clear weather to seaward, a submarine has particular reason to fear aerial attack.

By Night - At night the visual detection of a submarine by aircraft is probably even more difficult than by surface craft which may have the advantage of the U-boat's silhouette against a clear horizon. Except in very calm weather a submarine will not hear an aircraft till she is at close distance.

An aircraft may be fortunate in sighting a submarine if she keeps a sharp look-out up moon; she may sight her bow wave or wake, particularly when the water is phosphorescent; cases have been recorded when the light from inside the submarine shows upwards clearly through the conning tower hatch and shines on the wet oil skins of the personnel on the bridge. The U-boat captain has, or should have, an instinctive dread of illuminants and its reaction to them is a crash dive. It is suggested that a parachute flare should always be dropped over a suspicious object.

AIRCRAFT SIGHTING U-BOATS

The following are the occasions upon which an aircraft may meet a U-boat in order of probability: on passage, on patrol, while charging her batteries, whilst attacking a ship or convoy, while mine laying, when sheltering from weather or carrying out repairs in a bay on the enemy or neutral coast, while re-fueling or re-storing from a ship at sea.

On passage - A U-Boat proceeding to and from patrol normally keeps within 10 miles or so of certain routes while in the vicinity of our coasts. These routes cannot be included in this paper. When in doubt as to her position she will probably obtain fixes by D. F. bearings, but, in dull weather, when no sights are possible, there is a chance of her closing well known navigational marks to make a landfall.

She will be running on the surface with full or nearly full buoyancy except in confined or well patrolled waters. Her speed may be as high as 18 knots but, for economy's sake will probably be about 10 or 11 knots. In a flat calm she may leave a slight 'water-lane' and in muggy weather she may show a faint trail of smoke especially if she has just started her diesel engines.

On patrol - During daylight, in waters where she is likely to meet anti-submarine surface vessels and aircraft, a U-Boat will normally keep a diving patrol. As a submarine finds great difficulty in keeping at "periscope depth" in rough weather, she will then probably keep at a depth of over 60 feet, maintaining watch on her hydrophones. (NOTE: A submarine trying to dive shallow so as to see through her periscope in very rough weather has to use high speed in order to keep control; she might then partially break surface or show a distinguishable wake which could be detected from the air, as it would not be in same line as the surrounding foam-lines.

When diving at periscope depth, the top of her conning tower will be some 15-20 feet under water, her upper deck casing, 23 to 28 feet below the surface; her pressure hull will be about $2\frac{1}{2}$ feet deeper. In the North Sea and the Atlantic the chance from sighting from the air the hull of a diving submarine, is very slight, except possibly in very clear water when the condition of light and the colour of the sea bed are ideal. On the other hand a periscope might be sighted in calm weather at 3 miles and the V-shaped wake and "feather", caused by its passage through water, might be sighted at greater distance if the U-Boat were going fast.

In open waters where A/S forces are not likely to be encountered a U-Boat may spend part of her daylight patrol on the surface. The most likely time is about 1200 (local time) when she may be obtaining a latitude sight. When it is safe to do so, a submarine commander prefers to carry out a surface patrol as his height of eye gives him a more distant horizon, he can economize battery power and his crew ~~can~~ benefit from air.

A U-Boat may also be proceeding on the surface, although on patrol in daylight, when she is trying to intercept ships the report of which she has just received by W/T.

Charging Batteries - A submarine normally charges batteries at night when on patrol. While on passage, it may be assumed that her batteries are always being charged up. As mentioned previously she must keep her batteries well charged to insure her safety and fighting efficiency. An ocean going U-Boat with a fully charged battery, if running dead slow and using air purifiers, could remain submerged for 48 hours and run a distance of from 75 to 95 miles. At full speed the distance would be about 18 miles.

A submarine can save electricity and rest the crew by remaining on the bottom if the sea bed is clear of rocks and depth is less than 45 fathoms. She can also, in certain waters where layers of different density occur, maintain a "static trim", ie, remain stopped on a layer of water without sinking or surfacing.

A submarine charges her battery by means of her diesel engines. As those engines require air the submarine when charging must be on the surface with her conning tower lid open. She will almost certainly be underway as speed helps her in a "crash dive". She can, however, charge when stopped by unclutching her propellers.

When a submarine's battery power is nearly exhausted, it requires six hours to charge it completely. It follows that a U-Boat which is forced to dive with a low battery will continually endeavor to surface and charge up, unless she can sit on the bottom in shallow water. When a submarine is put down early in the day, aircraft working with surface A/S vessels should have a good chance of success. In such a case the submarine will be very much on the alert and with her low buoyancy it is unlikely that the aircraft would be over her in time to secure a hit with a contact bomb, a depth charge might well destroy her and, in any case, a signal and smoke float should bring A/S vessels to the spot for an asdic hunt.

The state of the battery is the chief anxiety of a submarine commander, particularly during the months of long daylight and in a lesser degree during full moon periods, in clear, calm weather. A series of crash dives for aircraft when attempting to charge depleted batteries, especially when a few adjacent depth charges have been dropped, is bound to affect the nerves of the captain and crew; it is then that they are likely to take the wrong action in an emergency.

U-Boat attacking a ship or convoy - In a daylight attack, if she considers herself fairly safe from air reconnaissance, a U-Boat will very probably surface some 7 to 10 miles approximately ahead of a convoy in order to try and gauge its exact mean course. If she can judge this accurately she will cut across on the surface, with low buoyancy, and thus save her battery power. Should she fear the presence of our aircraft she will proceed to the attacking position submerged, and at a considerable depth, showing no track; she would however, come to periscope depth from time to time and her periscope might then be sighted. This deep dive would probably be done at high speed which would reduce her battery power considerably. On reaching a point probably about 2000 yards from the convoy's line of advance she will 'waste time' till she can see the disposition of the escort vessels. When she has decided on her final line of attack she will be extremely careful not to raise her periscope for more than a few seconds at a time while showing it will be running slow so as not to show a "feather". After firing, though she will almost certainly be invisible from the air, yet it is at this moment of attack that an aircraft is of particular value owing to her bird's eye view of the scene. There are four things which may help to indicate the position of the U-Boat:

- (a) Explosion of torpedo.
- (b) Track of Torpedo.
- (c) Foam on surface from discharge of torpedo.
- (d) Disturbance caused by U-Boat's increase of speed on diving deep.

Of these signs, (b), (c) and (d) can only be seen for a moment and it is therefore essential to take an immediate bearing and to estimate the distance so that the aircraft can fix the position and take action at once by signal or smoke float and with depth charges if carried.

(a) It is, of course, vitally important to report which side of the ship has been hit, as the attacking U-Boat will have fired from some position on that side of her. Slight indication of the direction may be gained by the position of other ships which are not hit. For instance if the ship torpedoed is protected by the hulls of other ships from right ahead to 80 degrees on her port bow, it is probable that the torpedo track, if visible, would be between 80 degrees and 125 degrees on her port side.

(b) German torpedoes are either air driven or electric. The latter do not as a rule show a track though a shallow run may be visible, especially in calm or phosphorescent water. A torpedo will be actually from 100 to 300 feet ahead of the leading bubbles of a track according to its depth setting. A U-Boat on firing may be anywhere between 600 and 8000 yards from the ship struck. Should a track be seen, the white circle of foam at its starting point would indicate the point of firing.

(c) A submarine which has fired a salvo of torpedoes becomes momentarily light in the bows. In rough sea her bows may break surface and give her position away but normally she can correct this tendency to rise by hydroplanes, and increased speed. The U-Boat then takes an angle down and the increased wash of her propellers which are pointing slightly upwards may be clearly visible to an aircraft overhead.

A U-Boat will not voluntarily come to the surface after attacking an escorted convoy. She is very likely to surface and "gloat over" her victim if the ship is not in convoy. It is therefore recommended that an aircraft suddenly sighting a sinking ship should approach her when possible from the dark horizon or down sun and from a considerable distance.

When sheltering in-shore - A U-Boat which has developed serious defects from weather or A/S action might proceed to a sheltered bay where she would almost certainly lie on the bottom unless presumably safe from our forces or in her own waters.

Re-fuelling from a ship - No cases have yet occurred of U-Boats being detected in the act of re-fuelling or embarking provisions from their own ships but there have been instances when they have remained on the surface for an hour or more when communicating with allied ships before sinking them by gunfire. Such occurrences have become less frequent and only take place in ocean waters. Any ship, however, which is stopped or steering an erratic or unexpected course should be watched for a time from extreme range and later "spoken".

When mine-laying - The 250-tonners are employed on mine laying duties more frequently than the larger U-Boats though the latter can carry 18 to 20 mines. They are usually of the magnetic type and are ejected from the torpedo tubes. Mines are almost always laid in slack water at high or low tide. They can be laid while the U-Boat is on the surface or diving, by day or night. They are usually laid in a depth of water of about 10 to 12 fathoms.

Mine-laying U-Boats have, so far, been most active off our East and South Coasts and on the convoy routes where the depth of water is suitable.

A 700-ton U-Boat is about 240 feet in length while her pressure hull is only 14 feet in diameter in the center of the boat; the conning tower is about 10 feet by 4 feet at maximum length and breadth. A U-Boat is therefore a very small target for a direct hit, especially when flooded down or in the process of diving. The A/S depth charge or A/S bomb is the only really satisfactory weapon and an immediate signal to nearby surface vessels is the next best action.

The lethal distance of a bomb or depth charge depends largely on the type of U-Boat attacked and the position of the damage on the hull. The distances given below are generally accepted as the maximum for a "kill", whilst explosions at nearly double these distances may bring the U-Boat to the surface:

450 lb. Depth charge	- - - -	21 feet
250 lb. Depth charge	- - - -	16 feet
250 lb. A/S bomb	- - - -	13 feet
100 lb. A/S bomb	- - - -	8 feet

Machine gun or cannon fire at the bridge personnel should only be regarded as a supplement to the discharge of heavier weapons and for use when all bombs are expended. The following damage would be caused by the explosion of depth charges:

A very near explosion would crush the pressure hull; the boat would fill and sink.

A near explosion would cause leaks in the hull, also in the glands and connections through the pressure hull. It frequently jams the hydroplanes in the rise or dive position, causing the submarine to break surface or dive to a dangerous depth. Fuzes in the boat would blow and lamps would break. If oil is carried in external tanks, this might leak and show on the surface, giving indication of the U-Boat's course but no proof of destruction.

More distant explosions might cause a number of minor defects such as cracked battery cells, broken lights, damage to periscopes and compass, jammed rudder, etc. The chief value however, especially if she is near a convoy, would be the effect on the crew and the fact that the U-Boat would be kept diving deep, using up her battery power.

Other than in very hazy weather, when they always feel uncomfortable on the surface, our own submarines by day most dislike an aircraft at which cruises around in fairly rough sea conditions at 100 feet or less because the constant spray seriously handicaps the lookouts. Binoculars have frequently to be sent down below to be dried out. The next most disliked is an aircraft at over 3,000 ft in broken cloud conditions. They all agree that aircraft painted white or just off white are extremely difficult to pick up even in excellent visibility. When a submarine is on passage no aircraft can be heard before it is seen unless weather is thick and sea is flat calm.

By night if submarine is idling about and charging batteries an aircraft can be heard up to 2 to 3 miles away and before it is seen even in moonlight conditions. If submarine is on passage an aircraft at say 1200 ft would not be heard until it was within $\frac{1}{2}$ mile unless the sea was flat calm. Our submarines do not dive at night when they hear an aircraft even if it comes right over and low down unless it is actually sighted in bright moonlight coming towards them.

As submarine conditions are alike for all nationalities it is probable that the above holds good for German U-Boats.

U-Boats keep a very good lookout when on the surface, generally with three men backs together and each sweeping 120 degree arc. They use excellent binoculars. It is certain that on every two out of three occasions the U-Boat will sight aircraft and dive before aircraft sights the U-Boat. There is no reason to suppose that a U-Boat's lookout is worse on astern sector than any other.

When on a patrol billet near our bases or coast a U-Boat will be doing a diving patrol at periscope depth by day surfacing only when she thinks the sea and sky is clear or in thick weather. When on the surface she will be trimmed right down with the base of the conning tower awash and in this trim she can get under 25 secs. At night rather more buoyance will be used. D/F's are probably the only way to locate a U-Boat on a patrol billet.

Aircraft are most unlikely to ever sight the periscope of an already diving submarine even after the U-Boat has been recently to dive. There have only been three or four authentic cases during the whole war up to date.

U-Boats when on passage usually do 10 - 10.5 knots and are on the surface day and night. If really badly hunted they may be ordered to dive by day through the areas we have harried them in most. Passage routes can be deduced from D/F plots and actual sightings noting their times and the course of U-Boat so that in a short time the high probability sighting areas can be plotted and appropriate A/S patrols laid on them. Acting against convoys and shipping they usually work in concentrations up to twelve boats. Any boat sighting convoy usually makes a first sighting report called an E. bar report (owing to the distinguishing letter "accentuated E" which prefaces the signal).

The first sighting report is rebroadcasted out to the concentration who all make for the position. As and when these boats sight or locate the convoy they make E. bars until the U-Boat High Command Headquarters have a good idea of the position, course and speed of convoy.

Orders as to attack are sent out to the Pack now concentrated around convoy.

Packs in the past have shadowed a convoy for some days before attacking especially if the first contact is made inside what they consider is our air range for medium range aircraft, although in one case recently the attack followed quickly on the first sighting report.

U-Boats may shadow a convoy from any favorable direction but two instances occurred recently of U-Boats beginning to shadow from one of the flanks of the convoy, then working round the stern to the other flank of the convoy and finally taking up a position fine on the convoy's bow. Shadowing is done at ranges of 20-30' from convoy during the day and from close range during dark hours relying on the very small silhouette for avoiding action or discovery by surface escorts. When all is set, the attack takes place at night, U-Boats going in on the surface at high speed on their engines. They rely on the general confusion following the torpedoings to extricate themselves, still on surface, clear of the flanks where they reload tubes, and may carry out a second attack or may continue to shadow and renew on the next and subsequent nights.

These tactics were first used in June and July, 1940 and have continued with refinements and improvements ever since.

Therefore U-Boats attacking convoys can be regarded as torpedo boats with the additional advantages of being able to dive when in an awkward fix, and of having a very small silhouette which makes close unseen approach possible.

The initial E. bar should up to 40' be taken as an alarm gong and all available aircraft hurried out to sweep round convoy to break the contact and harry the pack who will be closing in from all quarters.

The period noon to dusk is of great importance as it is then the U-Boats are working up to a position ahead of the convoy so as to take up their final positions for an attack during the dark hours.

Aircraft have performed these duties so well in Home Waters that since these anti-U-Boat measures were generalized in April, 1941, only two convoys have been attacked inside 400' (medium aircraft range).

U-Boats chatter incessantly on their W/T. This makes an efficient D/F service of vital importance to an A.O.C. A local submarine

tracking room should be formed who plot, and these together with any information from Admiralty and other sightings or D/F. obtained from neighboring commands should result in U-Boat concentrations being fairly accurately known. This enables A.O.C. to avoid wasting aircraft effort on convoys or ships who are near no danger and to concentrate on threatened targets. In addition, it enables him to carry out the all-important training of aircraft (so conserved) in practice attacks, D.C. dropping, A.S.V. practice and homing exercises. Destruction or damage to a U-Boat is an exact science demanding direct hits or very near misses with the small lethal ranges of DCs and A/S bombs. This is impossible without constant practice on realistic targets followed by standardized analysis and assessment.

No cast iron form of attack for aircraft can be laid down but no pilot can go far wrong if he makes for a sighted U-Boat by the shortest route so as to get his release in before it has disappeared. Thereby he gets a visible aiming mark on the target he is trying to hit. Once it has dived, all he has got as an aiming mark is the swirl left behind on the surface caused by the conning tower and it is a far more difficult task to correctly gauge the distance ahead and range of an unseen moving object. It is the old problem of shooting rabbits when walking up a field of rough with patches of long grass. It is very tempting when the rabbit disappears in a patch to fire at the still waving grass heads and to forget that the rabbit only has been there. Even when correctly gauging how far ahead of the still waving grass the rabbit is, one still has to make a further lay off for the speed at which he is running.

When calculating the distance ahead of U-Boat to drop the stick, always remember that there is a standard allowance for the time of flight from 50 ft. alt. of 2 secs. plus the time the D.C. takes to reach its depth before exploding which for a 25 ft. setting is 3 secs. This makes 5 secs. which is 65 ft. or 22 yards. So that, if a portion of a U-Boat is visible the release must be pressed so as to drop the stick 22 yards ahead of this visible portion (generally the conning tower).

If the U-Boat has disappeared, then an extra distance must be added to this standard allowance depending on the length of time that the U-Boat has disappeared before the release is pressed. If this time interval is say 20 secs. the extra distance ahead to be allowed would be 20×4.4 yards = 88 yards and the stick must be released so as to fall 88 plus 22 yds = 110 yards ahead of the apex of the swirl left by the dived U-Boat. When making a beam attack always beware of releasing too soon even if all calculations as to distance have been made correctly. 95% of misses have been misses astern or when on a beam attack misses short of track.

Other refinements in the approach will come with practice such as attacking down sun, up to a dawn or dusk horizon and up the moon path.

Efficient A.S.V. is of enormous assistance in locating and completely surprising surfaced U-Boats by using cloud cover when it is down to 2 or 3,000 ft. to patrol in, in hazy weather and of course at night using delayed flares to attack by on dark nights and the moon path when in good moon conditions (See appendix entitled A.S.V. as an anti-submarine weapon).

German U-Boats when detected on the surface by aircraft almost invariably dive. The normal procedure of a rapid or "crash dive" is quite simple and is described in the publication issued by D.A.S.W. on U-Boats. The following is, however, not mentioned and is given for interest.

As well as flooding the usual main ballast tanks, a centrally placed "crash dive tank" may be flooded thus giving the U-Boat a large amount of negative buoyancy to increase her speed descent. When reaching 60 ft. or so, this tank is put to "blow" and by the time the U-Boat is at 100 ft. approx. it will be blown dry thus restoring the neutral trim which is always present when main ballast is flooded. Very high pressure air in comparatively large volume is necessary to blow a tank rapidly out at this depth and as the usual way of determining whether a tank has been completely blown dry is by listening for the roar of air going out through the Kingston valve at the bottom of tank, a large volume of H.P. air will escape to the surface.

It will arrive from 100 ft down with considerable velocity and cause quite a large though temporary upheaval on the surface and at a distance of about 300 yards ahead of where she disappeared. If the aircraft has delivered what the pilot considers a very good attack, he may think this upheaval is caused by some explosion in the U-Boat and that he has made a kill. This has happened in home waters on more than one occasion. In these cases at home subsequent D/Fs of the U-Boat have disproved the kill.

After an attack which the pilot feels to be a good one there are various indications on the surface which mean a lot and others which mean very little.

Everyone knows that D.C.s themselves give off a dirty oily residue after explosion.

Air bubbles seen immediately thereafter may only signify that the U-Boat is adjusting a temporary upset and is blowing or perhaps venting out-board some internal tanks. Oil appearing on the surface immediately after will probably only be the result of D.C. blast through the water acting on the comparatively flimsy external fuel tanks like a blow on bellows and forcing oil out through the self compensating system. This system is a means whereby sea water takes the place of oilfuel as it is used by the engines and so automatically compensates for the weight of oil used when on the surface.

A very near D.C. may split one or more oilfuel tanks and in this case very large quantities of oil will arrive on surface in gouts. This certainly is evidence of a close miss and will give away the position of the U-Boat should there be another aircraft with a magazine of D.C.s in the vicinity or if surface A/S forces can be directed quickly to the scene, but in itself it is no evidence of any damage to the vital pressure hull.

A continual stream of small air bubbles is evidence of damage to the external connections to bottles of H.P. air which are often carried in the casing under the upper deck and above the pressure hull, again this is annoying to the U-Boat but not serious.

U-Boat may break surface either momentarily or for a period of some minutes and may take up quite large angles either stern up or bow up but this may only be due to temporary loss of trim or control and is no evidence of serious damage.

Large bubbles causing a commotion on the surface and lasting for a considerable time is evidence of trouble and if going on for ten minutes or more may be evidence that serious internal flooding has taken place and main ballast is being blown out dry to try and restore buoyancy. Accompanied suddenly by masses of oil indicates that she may be desperate and is blowing out her fuel tanks as well. If she does not re-appear soon on the surface it may mean that she is going down "not under control" and if in ocean depths she will finally collapse and be a total loss without any further evidence appearing on the surface.

If sea bottom is within 600 ft. of surface she may survive and make a getaway in a crippled condition when darkness falls. For this reason, when a pilot has seen his D.C's exploding close to and round a U-Boat who is still visible he ought to signal to base that he has made a first class attack so that every possible endeavor can be made to get neighboring aircraft, relief aircraft from base and/or surface A/S forces on the spot as quickly as possible. If a U-Boat who is in the act of diving (even after 30 seconds disappearance) is mortally hurt by D.C's or bombs it is nearly certain that she can regain the surface by blowing everything and going full speed on motors with hydroplanes at "Hard to Rise" for long enough to get the crew out of the conning tower and over the side.

The following article by Hanson W. Baldwin, which appeared in The New York Times on March 7, is reproduced for your information.

THE WAR ON U-BOATS

Extension of Nazis' Effort to U. S. Waters Is, Paradoxically, Proof of Our Sea Rule.

The continued though reduced successes of the Germans in their submarine attacks on our Atlantic coastal shipping last week were a dangerous drain upon the shipping pool of the United Nations, the inadequate size of which is already the principal restrictive factor in our war effort.

Nevertheless, the German operations at sea represent the tactics of attrition and commerce raiding --- tactics always employed by an inferior sea power against a superior sea power. The very success of the German efforts is a recognition of our continued sea superiority, and the fact that the submarine war has now been extended to our coasts and its scope broadened to include vast new areas of ocean is a tacit indication that the anti-submarine and anti-aircraft measures of Britain and the United States have been increasingly effective in the waters of the eastern and central Atlantic and the approaches to the British Isles.

It is quite possible, too, that our counter-submarine measures on this side of the Atlantic have been more successful than we realize, though not until the toll of sinkings of coastwise shipping has been materially reduced will these measures approach success.

Verification is Difficult

But the very nature of submarine warfare makes it difficult, and often impossible, to know whether or not a submarine raider has been sunk. Frequently the Navy Department reports of engagements between our surface ships and enemy submarines have been misleading and overoptimistic.

One recent account of an engagement between a new destroyer and a submerged submarine spoke of an oil slick on the surface as if it were conclusive proof that the submarine had been destroyed. Yet one of the oldest tricks of submarine warfare practiced by the Germans in this war and in the First World War, is the release of oil from a submerged submarine to trick the attacking surface craft into the belief that the attack was successful.

Even if the oil should leak from ruptured seams, that is not proof of destruction. Even sailors' clothing, bits of wreckage, and waste are not certain evidence of success. German submarines have been known to eject such material from torpedo tubes. Too often this floating evidence has fooled the unwary or inexperienced surface-ship commander into the belief that his opponent was destroyed.

If the engagement occurs in deep water a surer guide to probable destruction is the absence of sound in the surface ship's supersonic detection devices. Submarines can never maintain an exact "balance" when submerged; their engines must always be kept running, even if at very low speeds, to give the vessel steerage way and to enable its bow and stern planes to "bite" into the water.

Would Rise or Go Down

Without steerage way a submarine would rise to the surface or sink to the bottom. The former might lead to her destruction; the latter would certainly do so if the water were much more than 300 to 400 feet deep, for even the cylindrical "pressure hulls" of submarines cannot withstand the crushing effects of much greater depths.

In shoal water --- in depths of 200 to 300 feet (the water pressure is 88.4 pounds to the square inch at 200 feet) --- a submarine may safely lie on the bottom with engines stopped and may thereby elude detection.

The supersonic detection devices with which both surface craft and submarines are fitted pick up the sound of moving propellers but do not locate "sunken" objects.

These detection devices are not by any means infallible; their efficiency and the distances over which they are effective are a direct product of variable conditions, such as the state of the sea, the position of the detector on the ship's hull, the number of other surface vessels near by and, above all, the experience of the operator. The experienced personnel of our Navy has had to be heavily diluted by green men, who have had to be trained during actual operations. But as time goes on our skill in tracking down submarines will increase.

Other factors that affect submarine and counter-submarine operations are: conditions of visibility, the greater speed and superior maneuverability of the surface craft as opposed to the submerged submarine, the fact that a submarine under water cannot back without danger of breaking the surface, the elements of surprise and relative invisibility which are the submarines' greatest asset.

One of the major enemies of the submarine is the plane. In bad or indifferent weather planes, if they can operate, are handicapped in visibility and are not a great menace to the submarine; but usually in operations near an enemy coast, or in narrow waters, submarines must keep a close watch on the skies and be prepared to "crash-dive" whenever a plane is seen. But planes are of little use at night, and that is one of the reasons why many of the submarine attacks of this war, particularly recent raids made against our coastal shipping, have been at dusk, at dawn, or at night.

In the past, news of the sinking of enemy submarines has been a carefully guarded secret. The Navy, following the British example, has held that to reveal such sinkings would: (1) relieve the tension of uncertainty about the fate of their comrades that, it was said, tended to undermine the morale of men in the enemy submarine service; and (2) enable the enemy to reorganize his operations, sending new submarines to the area in which others had been destroyed.

Lately there has been some evidence of more matured judgement in the Navy Department and a realization that these points of view are scarcely tenable ones and that not only is the public entitled to know more about the anti-submarine success --- or lack of it --- of our Navy, but that such news, widely published, might be a positive war weapon.

January 30, 1942

I have been asked to make a few comments to assist Army flying officers in their work in connection with patrol missions overseas, and particularly, in connection with the identification of war, merchant ships and submarines which they may encounter. Before going into this subject, I would like to take this occasion to comment briefly on the extreme secrecy which is attached to the movement of ships. In the performance of your duties you will learn of the movement of ships; you will also see ships enroute; you may also hear of ships that have been sighted enroute. Regardless of how you obtain this information, the fact remains that movements of these ships is a vital secret which should not be divulged, discussed or even retained in your own mind after the immediate usefulness of the information to you has passed. Also, the destruction of enemy vessels and of our own vessels is information which should be released only through the proper channels and should not be discussed by anyone except the proper authorities. Bear in mind that it makes no difference how you acquire the information -- by official channels, by seeing the occurrence, or hearing of it by rumor -- do not pass it on.

In the accomplishment of an observation or reconnaissance mission, one of the most essential things is an accurate report of what you see and where you see it. What you see is a matter of how accurately the mind retains what the eye observes. The camera and the photo is the most accurate method, but the development of a photograph is usually a matter of hours, and maybe further a matter of hours in the transportation of the photograph to the proper authorities. The making of a sketch is a matter of minutes, and the information contained in the sketch may be transmitted to the proper authorities in a very few minutes. I mean by this, to stress the importance of -- whenever possible -- requiring all occupants of the plane which sight a ship to sketch the ship they have seen. After I have discussed the mimeographed sheets with which you have been furnished, I hope the task of making the sketch will not appear so arduous

Attached to these notes are the mimeographed sheets on which the distinctive features of war and merchant ships are indicated. The entire subject of ship recognition may be approached through the method of silhouettes of American and foreign ships, which are furnished by the various intelligence branches of the army and the navy. This approach is subject to error, as the silhouettes of ships are often changed in navy yard overhauls. This approach is never up to date because no silhouette book ever has the latest of new construction. This approach is complicated because even to the most experienced observer, it is difficult to recognize and distinguish the many types of our own destroyers, cruisers and submarines, much less to recognize and distinguish those of foreign navies. However, the subject need not be approached from such a complicated view. After all the observer who has identified a ship according to its type, that is, whether it is a destroyer, a cruiser, a submarine, a battle-ship, and aircraft carrier, or any of a number of navy auxiliary vessels, or a merchant vessel, has done well and it is seldom necessary to specifically name the ship. Given the name of a specific ship, it is but slightly more difficult to pick out the ship if the proper foundation for this method of identification has been laid

This brings us to the second method of identification, which is embodied in the mimeographed sheets attached to these remarks. As you will see, in looking over these sheets, I have attempted to subdivide any ship into the six or seven natural subdivisions into which a ship may be divided. These features are: the bow, the stern, the type of deck, the masts, the stacks, the length to beam ratio and the turret arrangements. On the mimeographed sheets I have indicated all of the more common types in which these different features appear. In making your observation of the ship, you should attempt to mentally appraise and then immediately sketch the ship, insofar as these large distinctive features are concerned. To do this, first draw a line to indicate a broken, flush, or curved deck. At the forward end of this line, indicate the type of bow and at the after end, the type of stern; then, in the approximate position in which they appear on the ship indicate by a simple sketch, the type of foremast and mainmast. Then, in its proper position, indicate the type of stacks. Next, place in their proper position, the center line turrets -- by center line turrets I mean those on the center line which runs from the bow of the ship to the stern as opposed to those smaller turrets which are located off of this line

and do not properly appear in silhouette. After this, fill in other large features such as bridge structures, searchlight towers, hangar spaces or catapults. Finally, after the proper position is attained to recognize the length-to-beam ratio, indicate on your sketch the approximate ratio of the length of the ship to the beam. This last feature is very important, because the destroyer which in profile may be very similar to the cruiser and the cruiser profile which, in turn, may be very similar to the battleship profile, would cause confusion between the types if it were not for the very dissimilar length-to-beam ratios which exist in the various types.

On the second sheet of the mimeographed pages is a self-explanatory table indicating the tonnage range, the maximum speed range, the main battery strength combinations, the number and type of stacks and masts, the type of deck and the type, or types, of bows and sterns which may appear in the various types of warships. Also, on the second page, I have indicated the distinctive features of submarines. The submarines of almost all countries, except Germany, have in general a conning tower which appears to be long and low -- that is, it has a greater length than height. Peculiar to the German submarine is a conning tower which appears to have a greater height than length. Normally, the gun -- if a submarine has only one gun -- is located forward of the conning tower but, in the latest American submarines, of which we are now building a great number and in this type of submarine only, the gun is located aft of the conning tower. At the present time, the fact that a submarine had its gun aft of the conning tower would be a very sure indication that it was an American submarine of comparatively recent construction. Later, I will discuss submarines at some length.

At the bottom of the second page I have indicated the various types of ventilators which are usually seen on merchant ships and also cranes and catapults which may be filled in as additional features on your sketch of either merchant or warships. On the third page of the mimeographed sheets I have handled merchant ships, and naval auxiliaries in the same general way that warships were handled on the first page. You will also find there a table where merchant ships are generally classified not only as regards their merchant ship use but also as regards their use as a naval auxiliary. At the bottom of that page is a sample observation report to be studied in conjunction with the sample sketches on the last page. The sketches shown are copies of sketches made by men of an operating squadron and show how informative a rough sketch made by someone with no artistic ability, can be, if systematically prepared. These sketches show nearly all the features that would be necessary for an experienced officer, with access to the proper silhouettes, to rapidly identify the ship which the observing plane had seen and sketched.

With regard to submarines, as it is this type of vessel which is most apt to be operating in our coastal waters, I want to take some time to discuss their features and characteristics. At the start, it must be remembered that the submarine is the most difficult vessel to distinguish as to nationality. In addition to their inherent similarity, you must remember that they will normally be seen while in the act of diving and but the briefest time is available to study what little of them may still be exposed. The speed of a submarine on the surface ranges from 10 knots in the older and smaller boats, to 22 knots in the newest types. The speed may be reduced by 3 to 5 knots when a submarine is on the surface and charging its battery. Of course you know that a submarine on the surface proceeds by Diesel Engine power, while submerged, it derives its power from an electric storage battery. The speed and radius of a submarine, submerged, is very limited. A submarine can make a maximum speed of 9 knots for a maximum period of about two hours and thus cover 18 miles, at which time its battery would be exhausted and it would have to either surface or else settle on the bottom, if the bottom were at some convenient depth not over 400 feet. At reduced speeds, say such as two knots, a submarine could remain submerged from 24 to 36 hours and at a speed of one knot to one--and-a-half knots, it could remain submerged for from 36 to 48 hours. A submarine that cannot lay on the bottom must maintain some speed, as a submarine depends on its diving planes for the control of its depth and attitude in the water, in much the same way that a blimp depends on its horizontal planes to control its altitude and attitude in the air. A submarine's primary method of attack is by the torpedo which may be launched on the surface, while submerged at periscope depth, or while at deep submergence below periscope depth. Normally, a sub

marine submerges before daybreak, makes any daytime attacks while submerged, and surfaces after nightfall. At night, a submarine makes its attack from on the surface, relying on its small silhouette to give it security from detection while it attacks the larger surface ships whose silhouette is readily visible from the submarine on even the darkest nights. A submarine is equipped with devices which make possible the detection of airplanes in its vicinity before the plane s actually see the submarine. The submarine can go from the surface condition to the completely submerged condition in approximately 50 seconds; having done this, no trace of the submarine remains except a diving slick created by the sudden submergence of the submarine, and the bubbles from the ballast tanks boiling to the surface as the submarine vents the air out of its tanks in order to dive. This diving slick is a pear-shaped area of disturbed water which may be clearly recognized except in the roughest of seas. Usually, the plane will see the conning tower of the submarine disappearing in the forward narrow end of the pear-shaped slick. After the submarine has dived, it normally does not expose its periscope until it has trimmed down and reduced its speed from the six-knot diving speed to the approximate $1\frac{1}{2}$ knot periscope observation speed. The periscope, when exposed, protrudes approximately 18 inches above the surface of the water, and, the periscope for which you will be looking is only about an inch in diameter and is moving through the water at the dead-slow speed of $1\frac{1}{2}$ knots. The slight white cap and wake created by this very slow moving and very small object will not be seen except by the greatest of luck on even the smoothest water surface. All this adds up to the fact that once a submarine has dived and disappeared beneath the surface of the water it is, for all practical purposes, lost from the sight of the airplane. This serves to emphasize the importance of immediate direct attack, with all appropriate offensive weapons, by the plane, which must be initiated the instant that the submarine is detected in the act of diving. There simply is not time to circle off and then hope to come in on a deliberate bombing approach on the submarine. By the time you have circled off and wish to start your bombing approach, the spot where the submarine was will look no different from all of the rest of the miles of ocean. Thus you see that the submarine, unless attacked immediately, is practically immune to aircraft attack. On the other side of the picture, however, it should be borne in mind that the submarine has, for all practical purposes, no defense against the airplane attack which is delivered before the submarine is submerged. The anti-aircraft guns would only be used by the submarine when it could not dive, and if they are used by the submarine, they are very ineffective and hardly worthy of the name of a defense. So much for submarines.

I would like to make a few remarks on the merchant fleets of the axis and allied powers. The British, American and associated countries have merchant fleets which, in general, were designed to make money in time of peace. As a result, much of their tonnage is still in old delapidated steamers whose maximum speed is probably not over 8 knots. Typical of these ships are the straight ungraceful lines, the spindly stack, the straight bow and the counter stern. A study of the merchant fleets of the axis nations indicates the extent to which their government subsidized merchant marines designed for war usage. Their ships are generally more streamlined and often have such water streamlining innovations as the spoon bow and stern. Many of their ships, built for the best part since about 1930, have speeds up to 18 knots. The new American and British merchant marine now being constructed will be undoubtedly a great improvement over the old merchant ship which is now carrying the great burden of the convoy shipping. The axis merchant marine is readily adaptable to use as seaplane tender, submarine tenders or commerce raiders. Clever camouflage may easily make a fast, modern ship look like a typical slow, innocent tramp steamer. A merchant ship, by itself, off the sea-lanes on a suspicious course, should immediately be noted, photographed, sketched and reported. Remember that enemy merchant ships have an adequate supply of British and American flags to show whenever they think it convenient.

To summarize my remarks, I want to mention again 3 or 4 specific points. First of all, remember that a submarine to be attacked effectively from the air must be attacked with all available offensive weapons immediately on sighting. If you have expended your offensive weapons, remain the area, and be sure to take into account the drift which you will experience but that the submarine will not. Accurately report the navigational position of the submarine and, if possible, remain on station until relieved.

With regards to the recognition of naval and merchant vessels, try to think of the subject as neither mysterious nor very difficult. Attempt to break down each complicated ship into its relatively simple components. Take photographs of all ships of which photographs are authorized. Sketch all ships seen and require each member of the combat crew to do likewise. Compare the sketches and the photographs and encourage competition among the crew members as to who can get the best and most informative sketch.

Above all, remember that any information derived as to the movements of naval or merchant vessels, is highly secret and, no matter how legitimately or how much by chance you come upon the information, it is just as damaging when passed along to anyone except the proper designated authorities. Build up sufficient resistance to overcome the temptation to just, "breath a word of it", if you know of a successful anti-submarine or other action against the enemy.

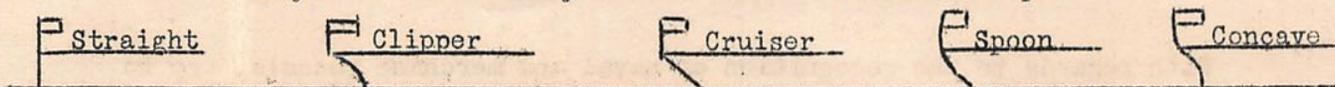
* * * * *

E. C. STEPHAN,
Lt. Commander,
U.S. Navy.

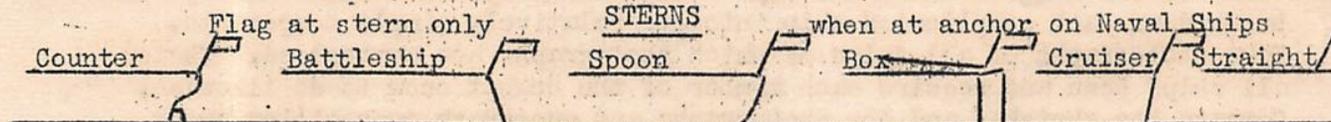
DISTINCTIVE FEATURES OF WARSHIPS

BOWS

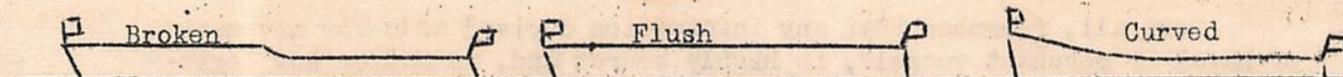
Navy Jack at bow only when at anchor on Naval Ships



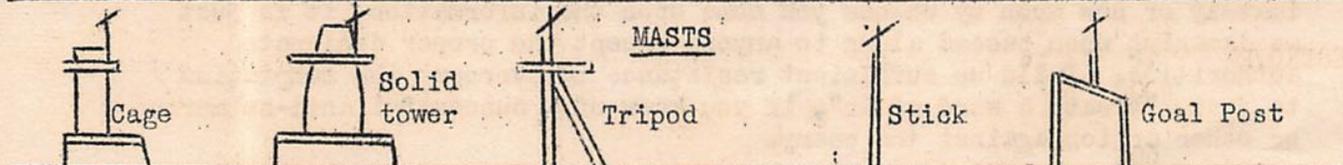
STERNS



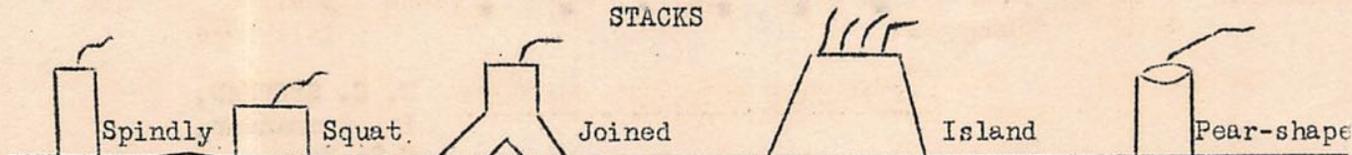
DECKS



MASTS

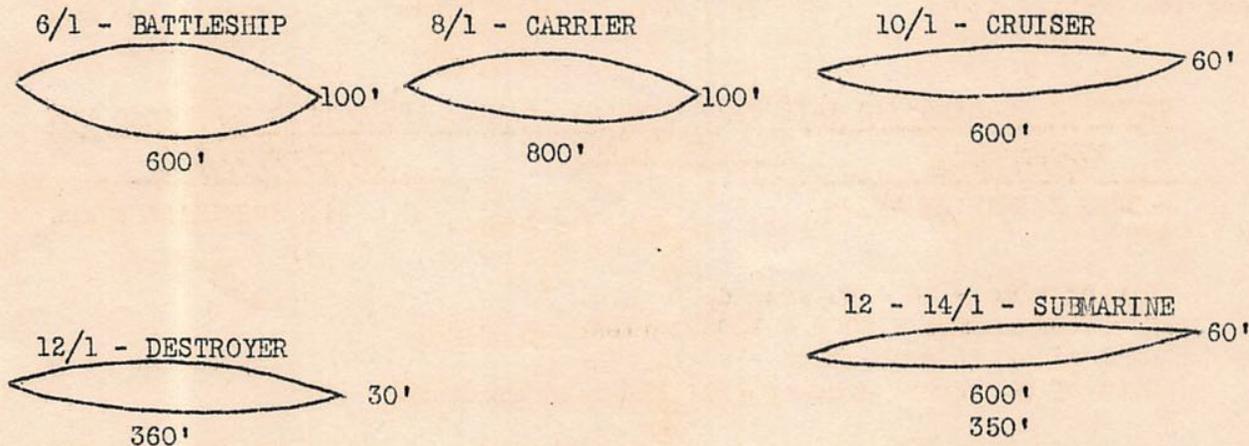


STACKS

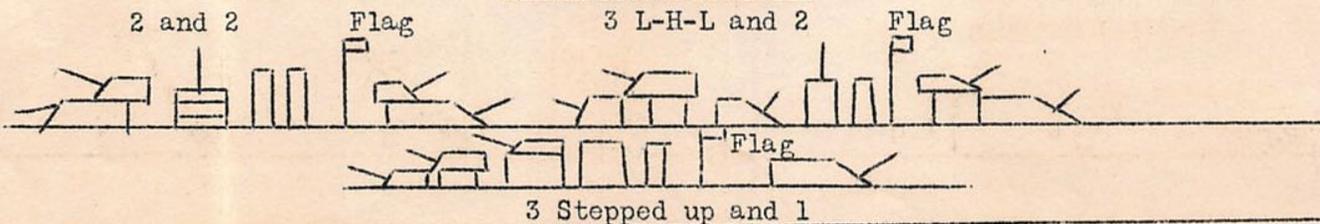


ALL STACKS MAY BE RAKED
ie SLANTED AFT

NORMAL LENGTH/ BEAM RATIOS



TURRET ARRANGEMENTS



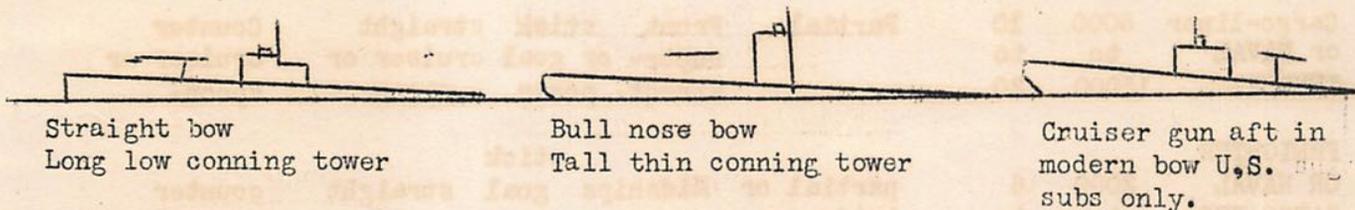
U.S. NAVY PERFORMANCE TABLE AND CHARACTERISTICS

	<u>TONNAGE</u>	<u>SPEED</u>	<u>MAIN BATTERY</u>	<u>TURRETS</u>	<u>STACKS</u>	<u>MASTS</u>	<u>DECKS</u>	<u>BOW</u>	<u>STERN</u>
BATTLESHIP	25,000 to 35,000	21 to 30	3 to 6	3	1	2 cage or tripod or 1 tower	flush or cave	con-	straight

U.S. NAVY. PERFORMANCE TABLE AND CHARACTERISTICS

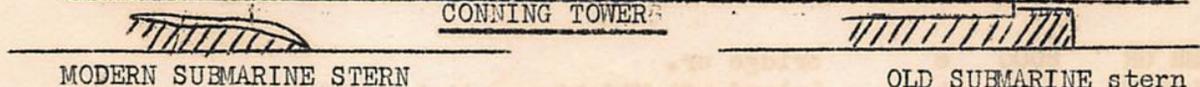
	<u>TONNAGE</u>	<u>SPEED</u>	<u>MAIN BAT.</u>	<u>TUR.</u>	<u>STACKS</u>	<u>MASTS</u>	<u>DECK</u>	<u>BOW</u>	<u>STERN</u>
BATTLE-SHIP	25,000	21		3-6	1 or 2	2 cage	flush or	concave	straight
	35,000	30				tripod or 1 tower	broken	clipper or cruiser	battleship or cruiser
AIRCRAFT CARRIER	20000	25		0-4	disappear-	tripod	flush	clipper	cruiser or
	35000	35			ing or is- land	and stick	flying deck	or cruiser	spoon
CRUISERS	6000	30		3		tripod	curved	clipper	
	to 12000	to 40		to 5	2 or 4	and stick	broken or flush	or cruiser	all types
DESTROYER	1000	30		2		tripod	flush		cruiser
	to 2000	to 45		to 4	1 or 4	or stick	or broken	cruiser	battleship or box
SUBMARINE	600	22	Max. Sur-	1 or				straight	
	to 3000	to 9	face submerged	2 guns	none	none	flush	cruiser bull nose	sub

DISTINCTIVE SUBMARINE FEATURES



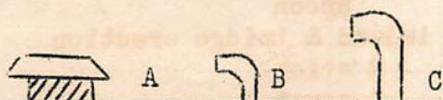
GERMAN SUBMARINE HAS TALL THIN CONNING TOWER-- ALL OTHERS HAVE LONG LOW

CONNING TOWER

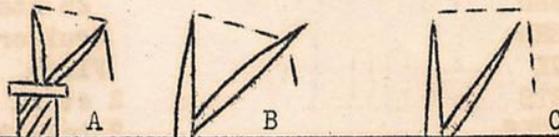


Diving time - 40 - 80 seconds
 Cruising radius - 2000 - 10000 miles
 Anti-aircraft protection - negligible
 Size of periscope exposed - 1' - 5' x 1 1/2 diameter

VENTILATOR TYPES

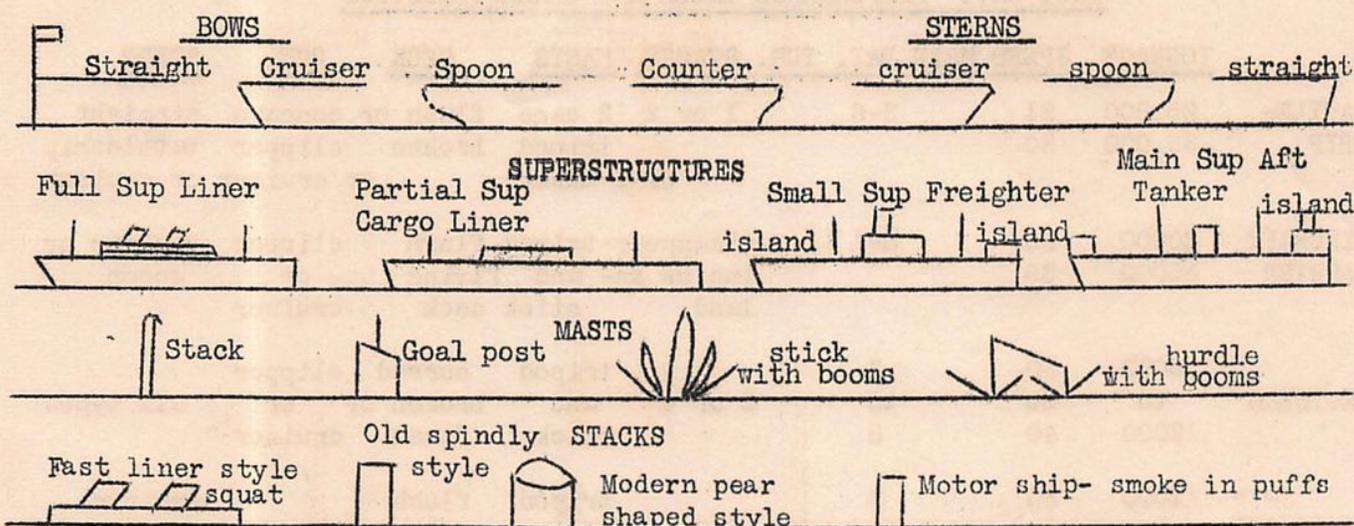


CRANE TYPES



CATAPULT TYPES





PRINCIPAL TYPES OF MERCHANT SHIP AND NAVAL AUXILIARIES AND PERFORMANCE WITH CHARACTERISTICS

	TONNAGE	SPEED	SUPER- STRUCTURE	BRIDGE	MASTS	BOW	STERNS
LINER OR NAVAL TRANSPORT	10000 to 70000	15 to 30	Full	Front Super- struct.	stick	Cruiser or spoon goal post	Cruiser or Spoon
Cargo-liner or NAVAL TENDER	5000 to 15000	10 to 20	Partial	Front super- struct.	stick or goal posts	straight cruiser or spoon	Counter cruiser or spoon.
FREIGHTER OR NAVAL CARGO VES- SEL	2000 to 10000	6 to 12	partial or bridge er.	Midships	stick goal post or booms	straight or spoon	counter or spoon
TANKER OR NAVAL TAN- KER	2000 to 12000	8 to 16	bridge er. islandsaft	Midships	stick	all types	All types

"SKETCH ALL SHIPS SEEN"

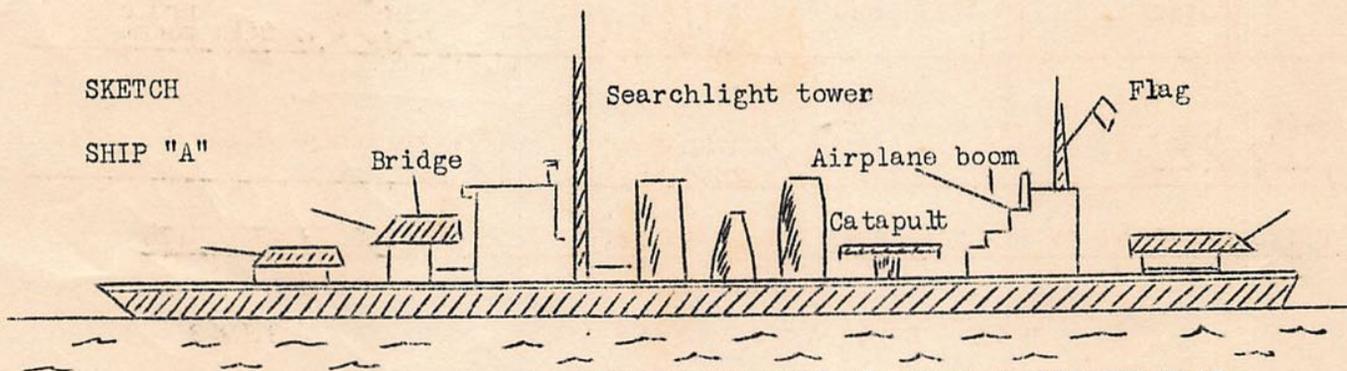
SAMPLE OBSERVATION REPORT

<u>TIME</u>	<u>LOCATION</u>	<u>SHIP "A"</u>	<u>SHIP "B"</u>
1. COURSE		180°	270°
2. SPEED		25 Kts	12 Kts
3. STERN		Cruiser	Spoon
4. DECK		Flush	2 island & bridge erection
5. MASTS		2 stick	2 stick
6. STACKS		2 tall thin	1 squat
7. LENGTH/BEAM RATIO		8/1	7/1
8. TURRET ARRANGEMENT		2 Fwd. 1 aft.	Mast bridge stack arrange-M-B-M-S
9. SUPERSTRUCTURE		Large erection fore and aft small between stacks	small forward-large aft
10. ESTIMATED TYPE		Cruiser - Quincey type	Tanker
11. BOW		Cruiser	Spoon
12. MISCELLANEOUS		Catapult and plane boom for- ward of after masts	Bridge supported by framework only. Catwalk from fore to aft.

SAMPLE SKETCHES FOR USE WITH SAMPLE OBSERVATION REPORT

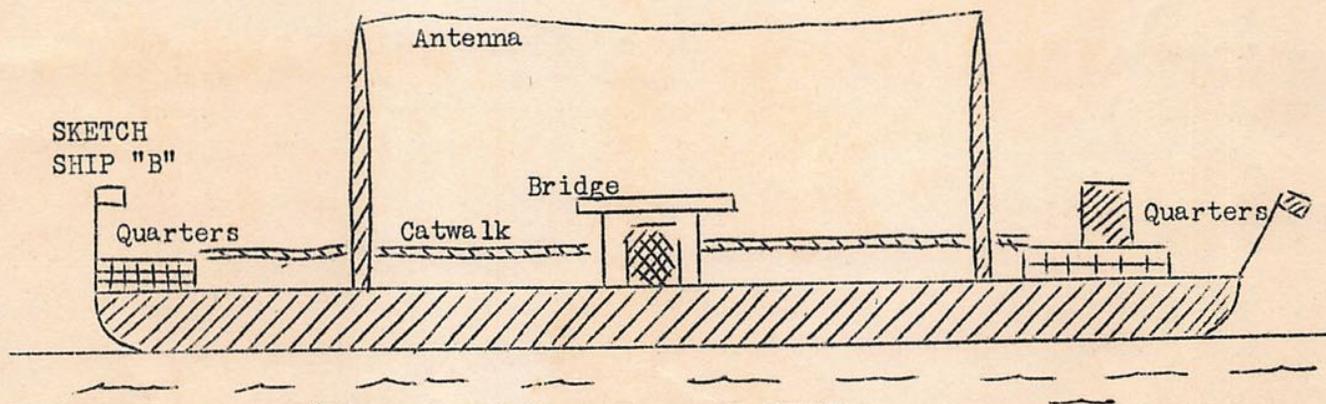
SKETCH

SHIP "A"



NAVAL SHIP ALWAYS FLIES FLAG FROM MAIN MAST AS SHOWN IF IT USES FLAG AT ALL

SKETCH
SHIP "B"



MERCHANT SHIP USUALLY FLIES FLAG FROM STERN AS SHOWN IF IT USES FLAG AT ALL