The Subchaser Archives

Hull Number: SC 194

Submarine chaser SC 194 was assigned to the second and fifth Naval Districts (Newport and Norfolk) during the war.

This photo shows the chaser on the ways, with ASW devices including the Bearing Indicator in place.

Photo Set - click to view large versions:

Read more

SC 259: Crew Photos

Photos from the collecton of a crewman on SC 259. Thanks to David Robinson for submitting the scans to The Subchaser Archives.

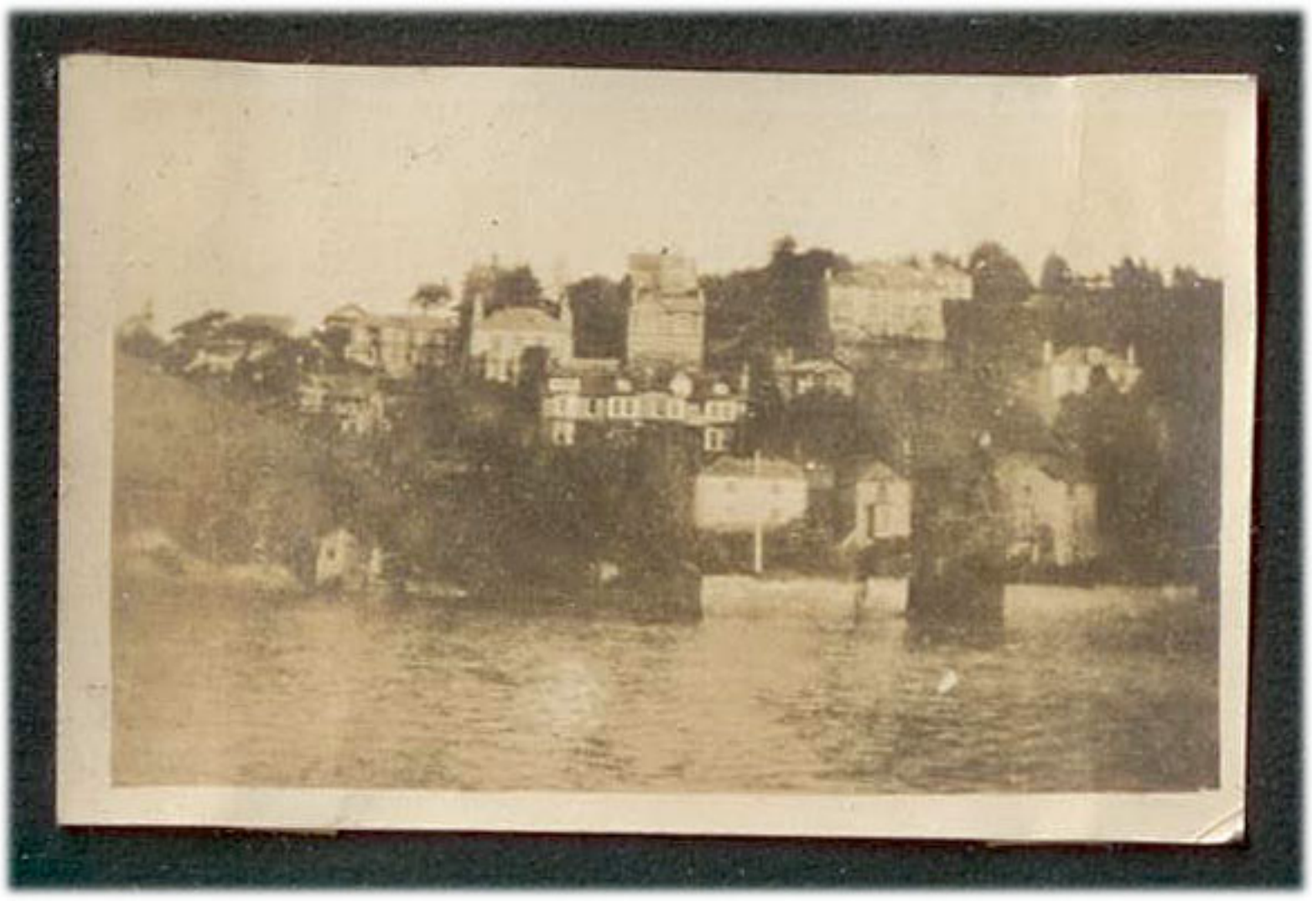
SC 259 was the unit leader of Unit 7 at Plymouth, England (SC 259, SC 83 and SC 87), and was engaged in minesweeping operations in the North Sea after the war.

Photo Set - click to view large versions:

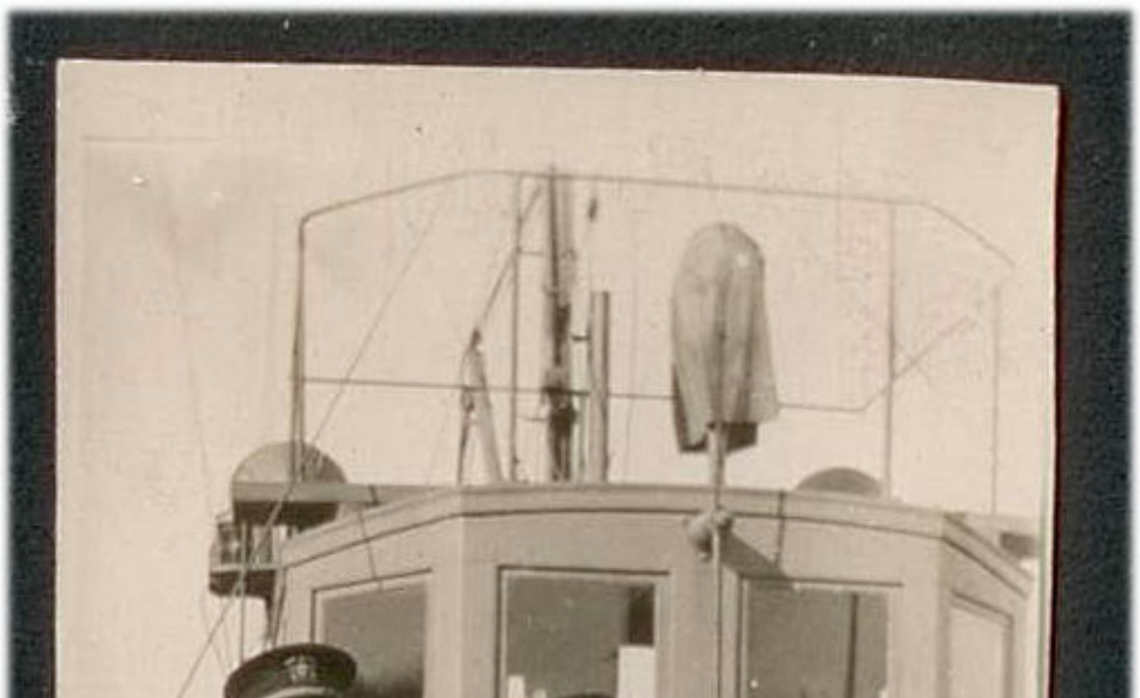

Hook up
Bow

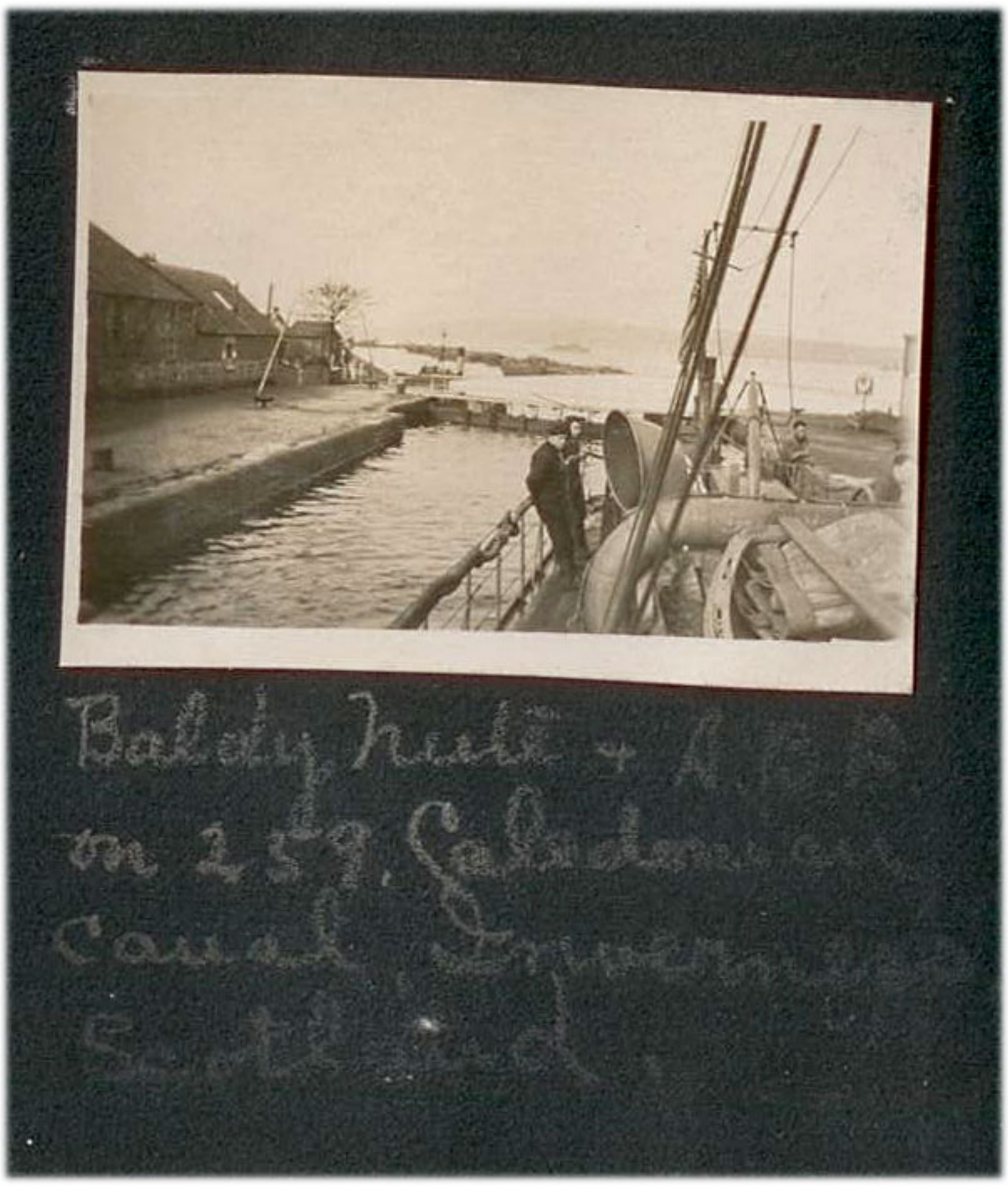

Davison-Paxon
Lot


Our guns on board
the Caldwell




Widow's Home
Berwick Sheep Isls





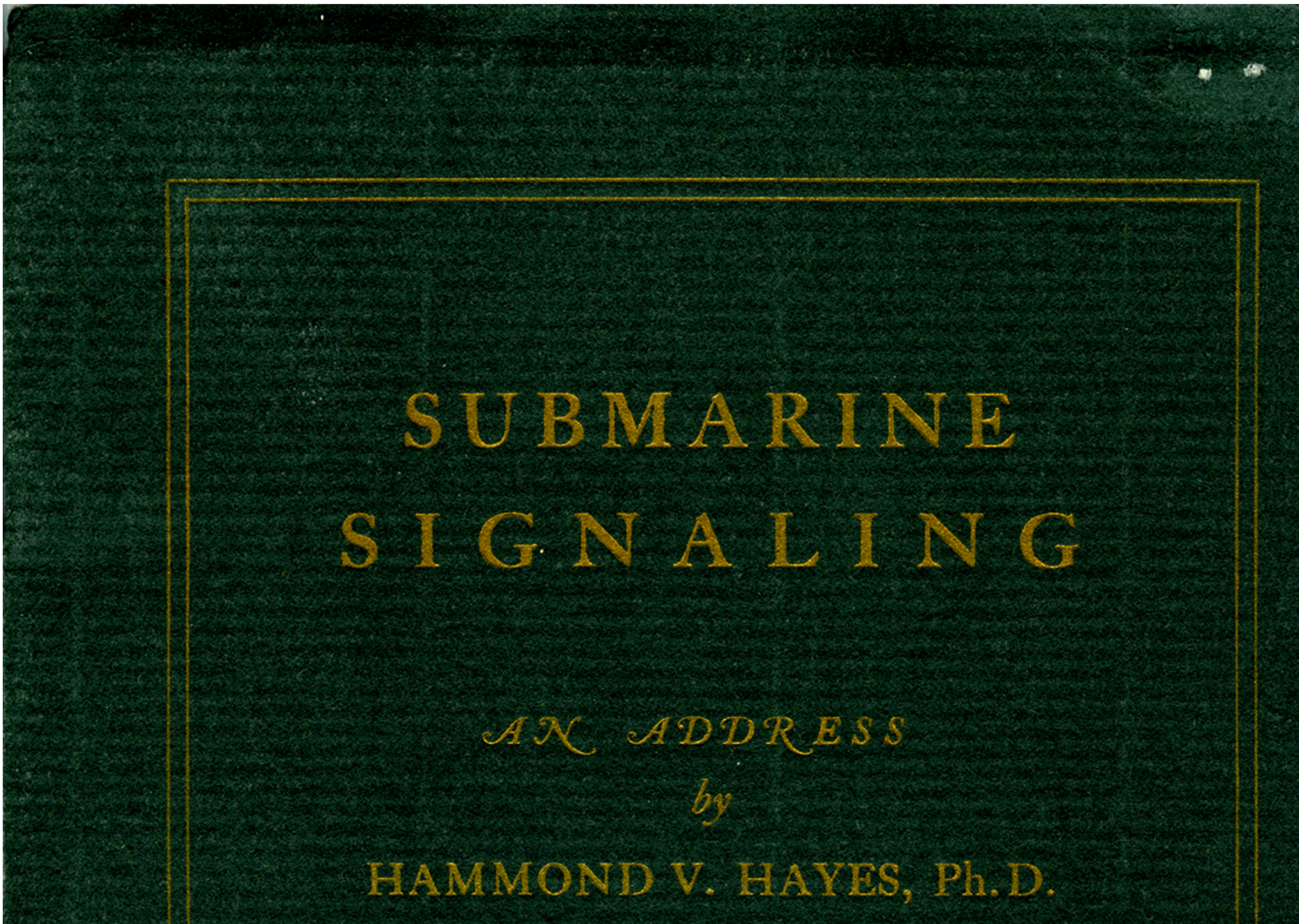
Read more

Submarine Signaling

The Submarine Signal Company designed listening devices used in antisubmarine warfare in WWI. This booklet, published in 1920, describes development and testing of various signaling and listening devices.

(Second ten pages posted, 01-2014. More to come.)

Photo Set - click to view large versions:



PRINTED FOR THE

Submarine Signal Company

BOSTON

MASSACHUSETTS

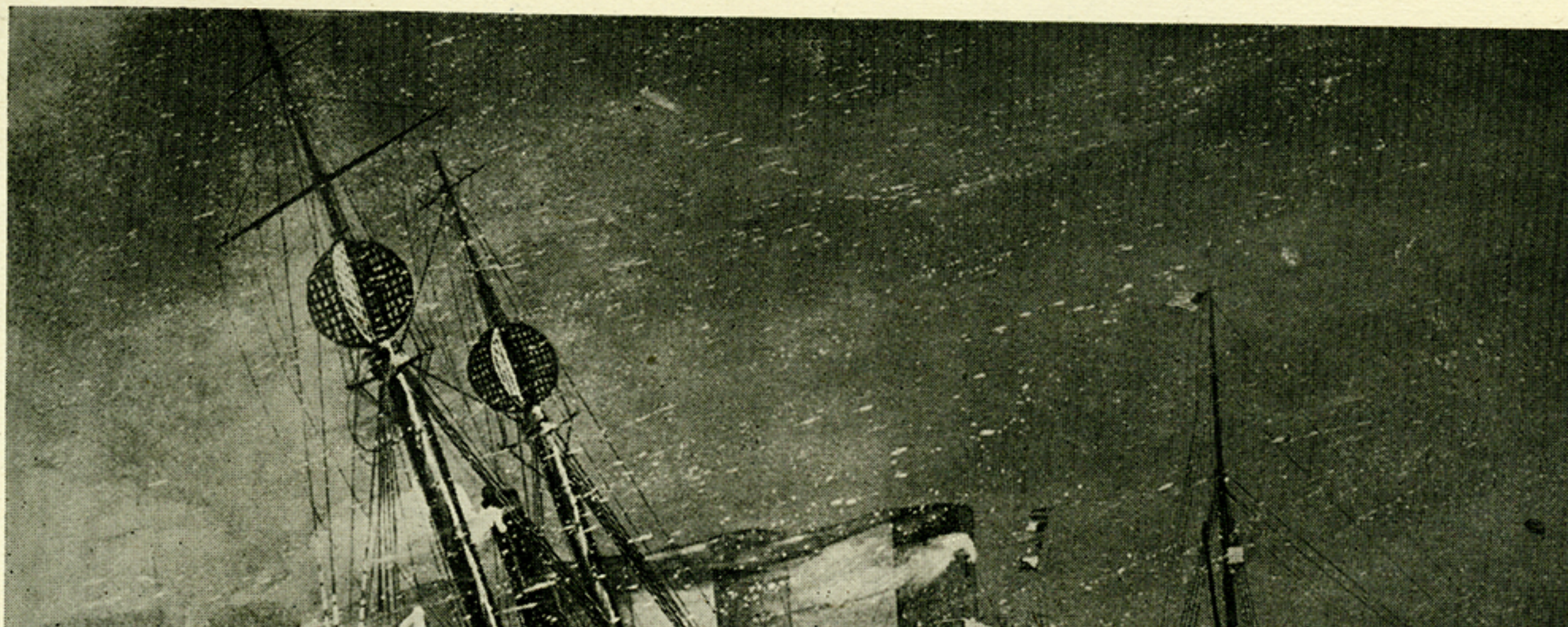
THE following pages describe very briefly some of the apparatus of the Submarine Signal Company as well as the activities of the Company and of those associated with it during the War period.

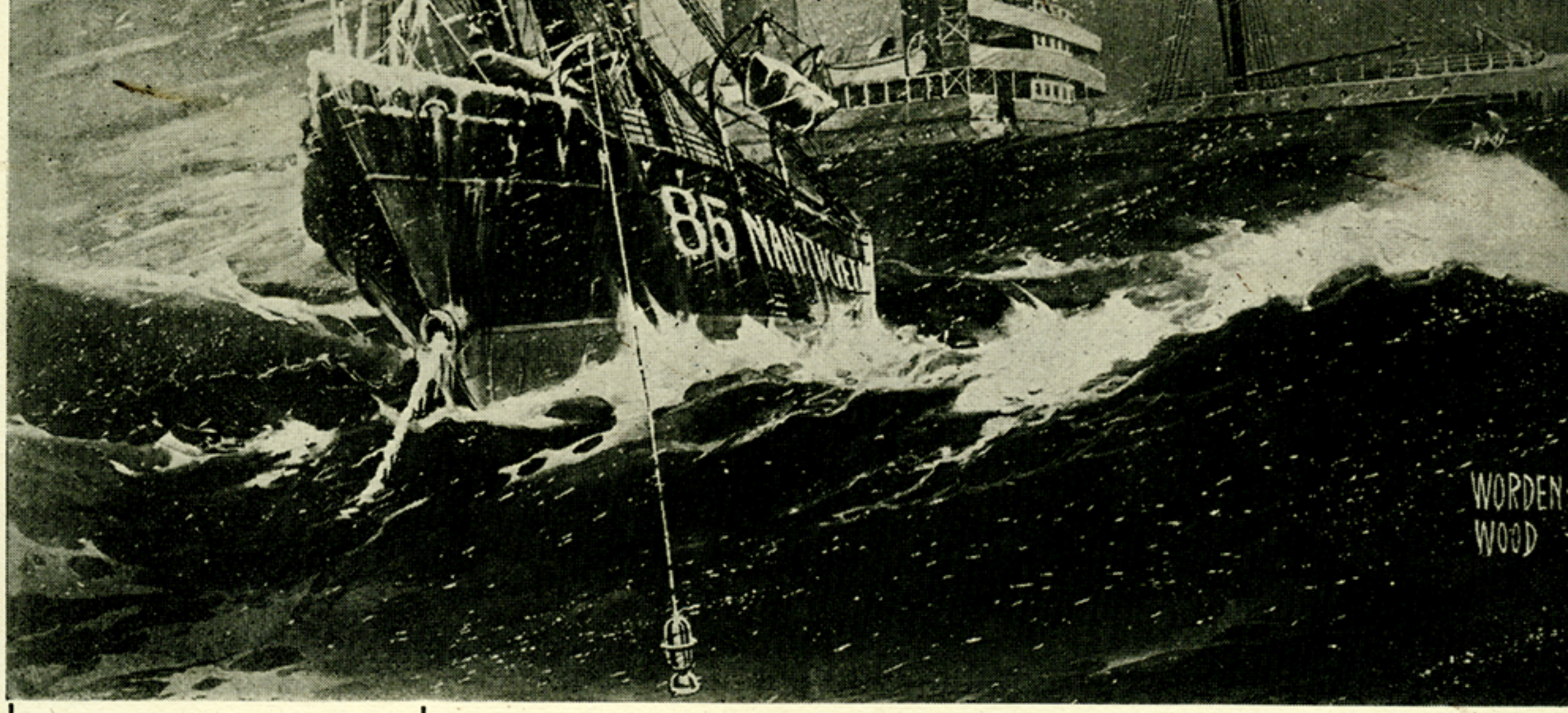
I wish to take this opportunity to record the facts that several months prior to the declaration of War all of the Officers, Engineers, and many of the skilled men employed by the Company enlisted in the Naval Reserve, at the re-

quest of the Navy Department, were given provisional ranks, and were made subject to the orders of the Commandant of the First Naval District.

As a matter of further interest, I have added as an appendix to this pamphlet reproductions of charts showing the positions of the bells of the Submarine Signal Company on the coasts of the maritime nations.

GORDON DEXTER, PRESIDENT
Submarine Signal Company





SUBMARINE PNEUMATIC BELL
IN SERVICE ON LIGHTSHIP

The Bell is suspended from a davit, and is submerged fifteen or twenty feet in the water

SUBMARINE SIGNALING

ITS APPLICATION IN PEACE AND WAR

AN ADDRESS DELIVERED BY

HAMMOND V. HAYES, Ph.D.

AUGUST 30, 1920

PRINTED FOR THE

SUBMARINE SIGNAL COMPANY

BOSTON

MASSACHUSETTS

MASSACHUSETTS

THE "RODMAN SWIFT"

The "floating laboratory" of the
Submarine Signal Company

SUBMARINE SIGNALING

ITS APPLICATIONS IN PEACE AND WAR

THE subject upon which I have been asked to talk to you this evening is "Submarine Signaling: Its Applications in Peace and War."

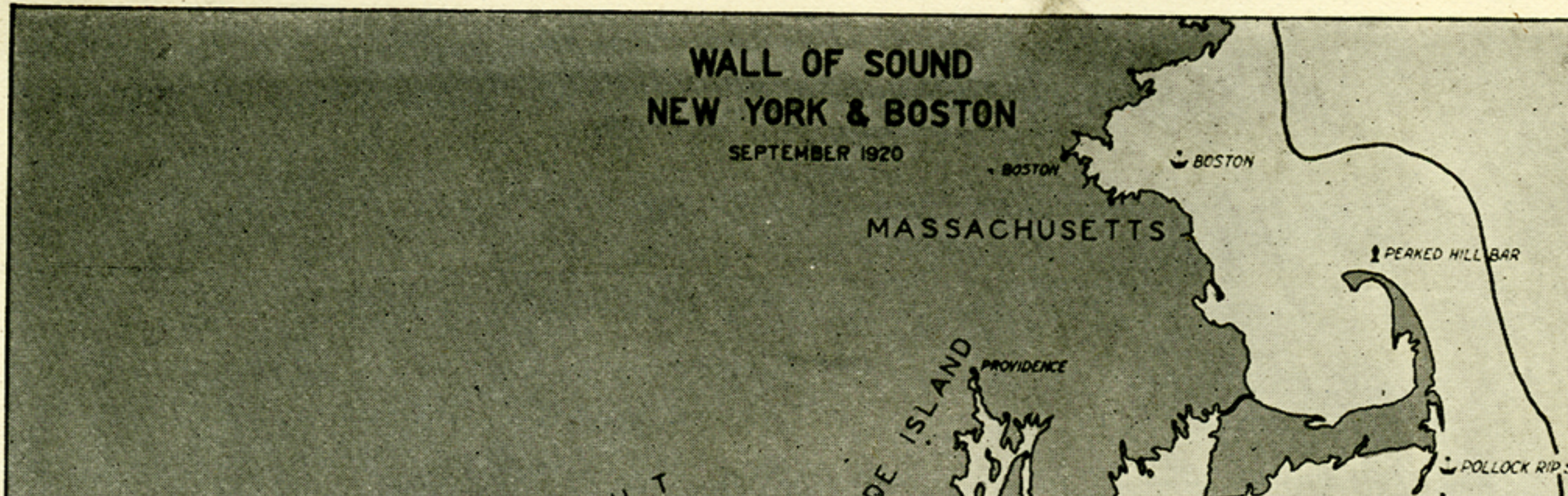
It is a great pleasure to me to address you tonight and to try to interest you in the subject of Submarine Signaling. It seems also particularly fitting that I should speak before you, a group of Massachusetts and Boston gentlemen, and tell you of another great development in applied physics, a development originating and carried through in Boston and by Boston men. For Submarine Signaling is, like the telephone, a Boston invention and a Boston development. I think that I can call the inventor of the telephone, Professor Alexander Graham Bell, a Boston inventor, for at the time that his invention was made he

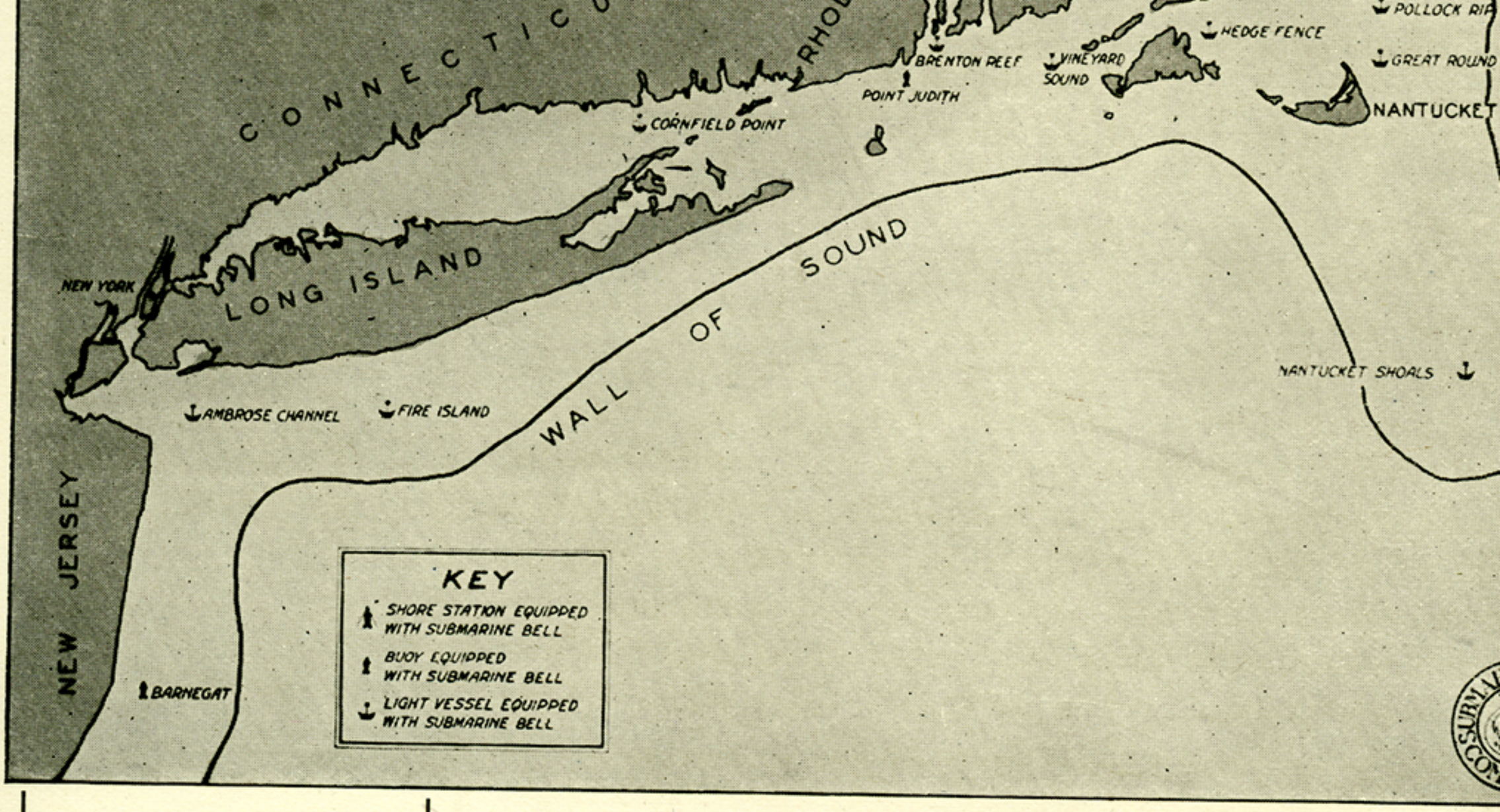
Submarine Signal Company, a Boston Enterprise

was a resident of Cambridge and the development of his invention was made in Boston. It was Boston enterprise and Boston capital which developed the telephone from a "scientific toy" to its present condition as one of the most valuable aids in commerce. Moreover, practically every feature of the telephone has been invented, developed, and perfected in the United States so that today American standards in telephony are recognized as the best standards throughout the world. And, gentlemen, it is the same with Submarine Signaling. It was invented and developed by Boston men and with Boston capital. It has been brought to such a state of commercial usefulness by the Submarine Signal Company of Boston that it is almost without competitor and its apparatus, the apparatus of this Boston company, is in use on the shores of practically the entire world and on the ships of most maritime nations of the world.

About twenty years ago, a group of Boston scientific men and inventors became convinced that, if sounds could be made under water and received with suitable apparatus, means would be provided of giving warning signals from danger points along the shore, signals which would be much more effective than the lights and fog horns, then and now in use. Under-water sounds, submarine signals, can be heard at all times whether in fog or darkness. Such signals are distinctive and unmistakable and, if the sound-producing devices are placed at intervals along the coast, there is created practically a wall or barrier of sound which gives to an approaching ship

Initiation of Submarine Signaling





MAP SHOWING POSITION OF SUBMARINE BELLS ALONG NEW ENGLAND COAST

The heavy line marked "Wall of Sound" indicates roughly the area protected by the bell signals

immediate indication that it is nearing the shore and, i most cases, an actual indication of its position. Ha these gentlemen appreciated the difficulties which the would encounter in the development of submarine signa ing apparatus, it is a question whether they would hav dared to undertake the solution of this problem; but thank to their unselfish devotion to their task, to their ski and patience, but probably even more to the courage o those who have invested their money in this enterprise submarine signaling has been brought to its present stat of high development.

Difficulties of Development

For submarine signaling is by no means as simple as thos unfamiliar with the problem might imagine. It is no simply ringing a bell under water and listening to it. As shall show you later, an ordinary bell can not be used unde water nor could any known device be used effectively fo the reception of submarine signals.

The experimenter in electricity, light, or heat is able in well-equipped, lighted, and heated laboratory to carry on hi investigations; he is supplied with delicately made an

calibrated instruments by which quantitive figures can be obtained from which he can study the operation of his apparatus under different conditions. He is able in the laboratory to control the conditions of experiment and test. None of these conveniences are available to the engineer working out a submarine signaling problem. He has his well-equipped laboratory on shore, of course; he has his floating laboratory, the little vessel which you have seen at the dock here tonight, from which certain experiments can be made under more or less practical conditions; but the final tests must be made at sea in all weathers, and frequently under most trying conditions. The inventor of sound-receiving apparatus must equip a ship with his device, must go to sea with it and note its operation under actual service conditions, knowing that he will be able in a voyage, possibly of weeks, to obtain observations only during the few minutes that the ship is passing in or out of the wall of sound.

But the Submarine Signal Company has succeeded in the development of practical devices capable of withstanding the severe conditions to which they are subjected at sea, sound-producing devices with which submarine signals are sent from danger points on the shore at all times, year in and year out, and sound-receiving devices which can be mounted on shipboard and enable the captain or navigating officer of a ship, properly equipped, to hear the warning signals of the submarine bells and to shape his course with certainty to port. The submarine bells of the Submarine Signal Company are on the coasts of most maritime nations. Over three thousand ships of many nationalities are equipped today with the receiving apparatus of the Submarine Signal Company, apparatus best suited for the reception of underwater bell sounds. Moreover, navigators are learning by practical experience to depend more and more upon submarine signaling apparatus, and to rely upon such apparatus

Present Use of Submarine Signaling Apparatus

for ascertaining the exact position of their ships while approaching and leaving port. As an example of this, recently one of my associates made a trip from Norfolk to Boston for the purpose of trying out under practical conditions a new device which he was developing. There was a fog and the captain did not see a light or land from the time his ship left Norfolk until it entered Boston Harbor. The ship was navigated with confidence as its position was always defined by one submarine bell after another

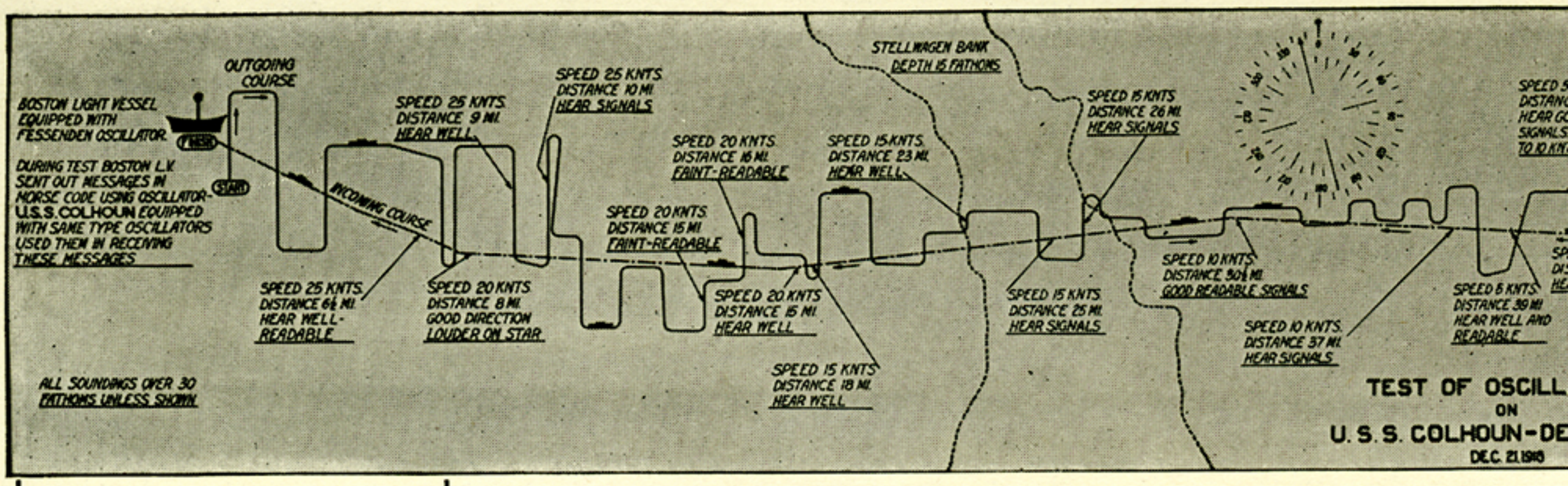


Diagram showing the distances at which oscillator signals originating at a distant source were heard on a moving ship. It should be noticed that signals were clearly audible at all speeds and regardless of the direction of the moving ship relative to the source of sound

Fessenden Oscillator

whose signals were heard and the position of the bell, re tive to the ship, easily ascertained.

But apart from the standard receiving apparatus which I have just been speaking, the Submarine Sig Company has, through the genius of Professor Regin A. Fessenden, acquired a form of sound-sending dev which is even more powerful than the submarine bell a by the use of which under-water signals can be transmitt distances of 20, 30, and possibly 50 miles. But this ra of signaling is not the only property of the Fessenden cillator. It possesses the remarkable characteristic t signals can be produced from it with such speed and c tainty that messages can be transmitted and received w much the same speed and accuracy as telegraph messa are sent and received on our telegraph land lines. T Fessenden oscillator thus offers a means of communicat between men-of-war, in fleet formation, but more parti

larly fills a use which no other device has yet filled, in th
communication can be had between two submerged su
marines, or between a submerged submarine and a moth
ship.

Oscillator Used to Produce Warning Signals in Fogs and Darkness

The importance of the Fessenden oscillator for the abo
purposes must be apparent to you, but, to my mind, th
is an even greater field of usefulness for the oscillator
field which the world has not as yet learned to appreci
It seems to me as if the time has come when the oscilla
must be placed on every steamship upon the ocean. Thi
of what it will mean for the safety of lives and property
sea to have ships equipped with a device which will produ
warning signals that can be heard at distances of 20,
or more miles, signals far superior in their characteristics
the siren and fog horns now used, and particularly when
is realized that, with the listening apparatus which I w
describe to you later, it is possible on another ship to
certain the exact position of the ship sending signals on
oscillator. An oscillator warning signal which can be hea
so many miles and the position of the source definitely

SUBMARINE SIGNALING

certained is, or will soon be, available for our public, and there seems every reason to feel that it will supply another almost invaluable means of safeguarding lives and property at sea.

The problem of submarine signaling which the early investigators had to solve was to find the best means for producing powerful under-water signals and the best way to hear the signals at the sound-receiving station. Innumerable devices were tried in efforts to produce under-water sounds. Submarine explosions, water sirens, and various forms of electrically operated mechanisms were tried and abandoned. Except for the Fessenden oscillator no form of sender has been found superior to the bell. But

Submarine

no form of sender has been found superior to the bell. But a bell which is designed for use in air has not the requisite power when struck under water and, as a consequence, a special form had to be developed which would withstand a powerful blow and would send out its signals to the greatest possible distances.

Bells

The next problem was to find means whereby the bell could be best operated. I will not trace the development of the submarine bell further than to say that two forms have been evolved which have been extensively used; one of these is operated by compressed air and is today a part of the equipment of a very large proportion of the lightships scattered throughout the maritime world,[1] and the other a bell which can be attached to a large buoy. This latter form is operated by the rise and fall of the buoy caused by the movements of the ocean waves. Bells of this kind are located at many points where there are no lightships and, as a consequence, power to operate the bells can be obtained in no other way.

Pneumatic Bells

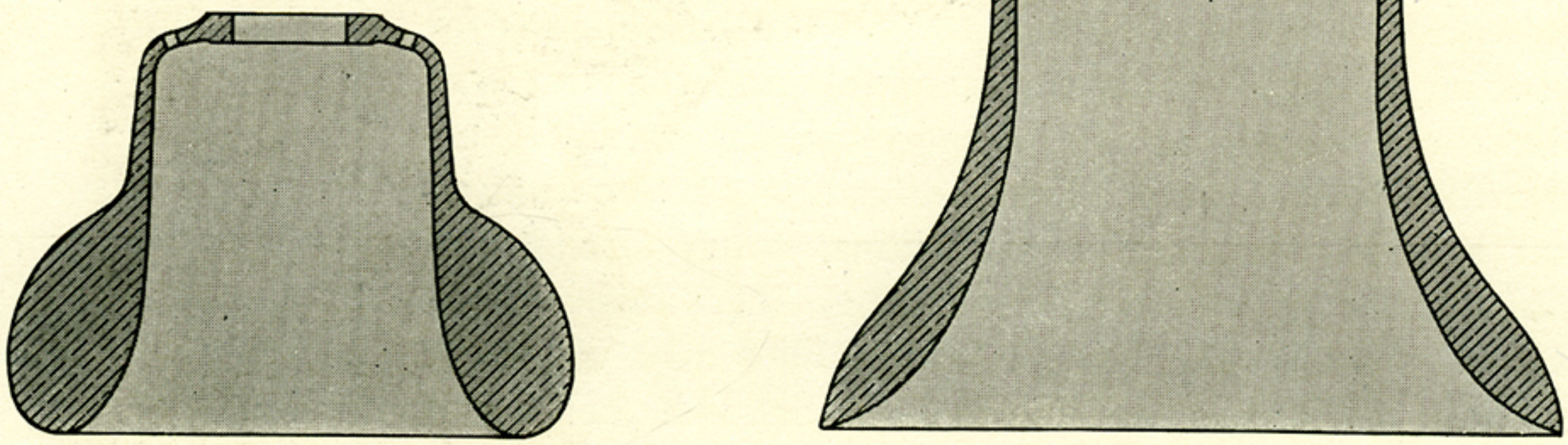
Bell Buoys

These two types of bells, one operated where there are lightships and the other operated at danger points from buoys placed at the necessary intervals along the shore, form what has been called a wall of sound to indicate to approaching ships the proximity of the shore and the position of the ship.

The sound-receiving device which is in common use today is a special form of microphone. It consists of a metal case having a fairly thick diaphragm upon which there is carried a so-called "button" which acts to vary the current in an electrical circuit. When this microphone is submerged its diaphragm is agitated by the incoming sound waves and the resistance of the button is changed.

Submarine Microphone

[1]See frontispiece.



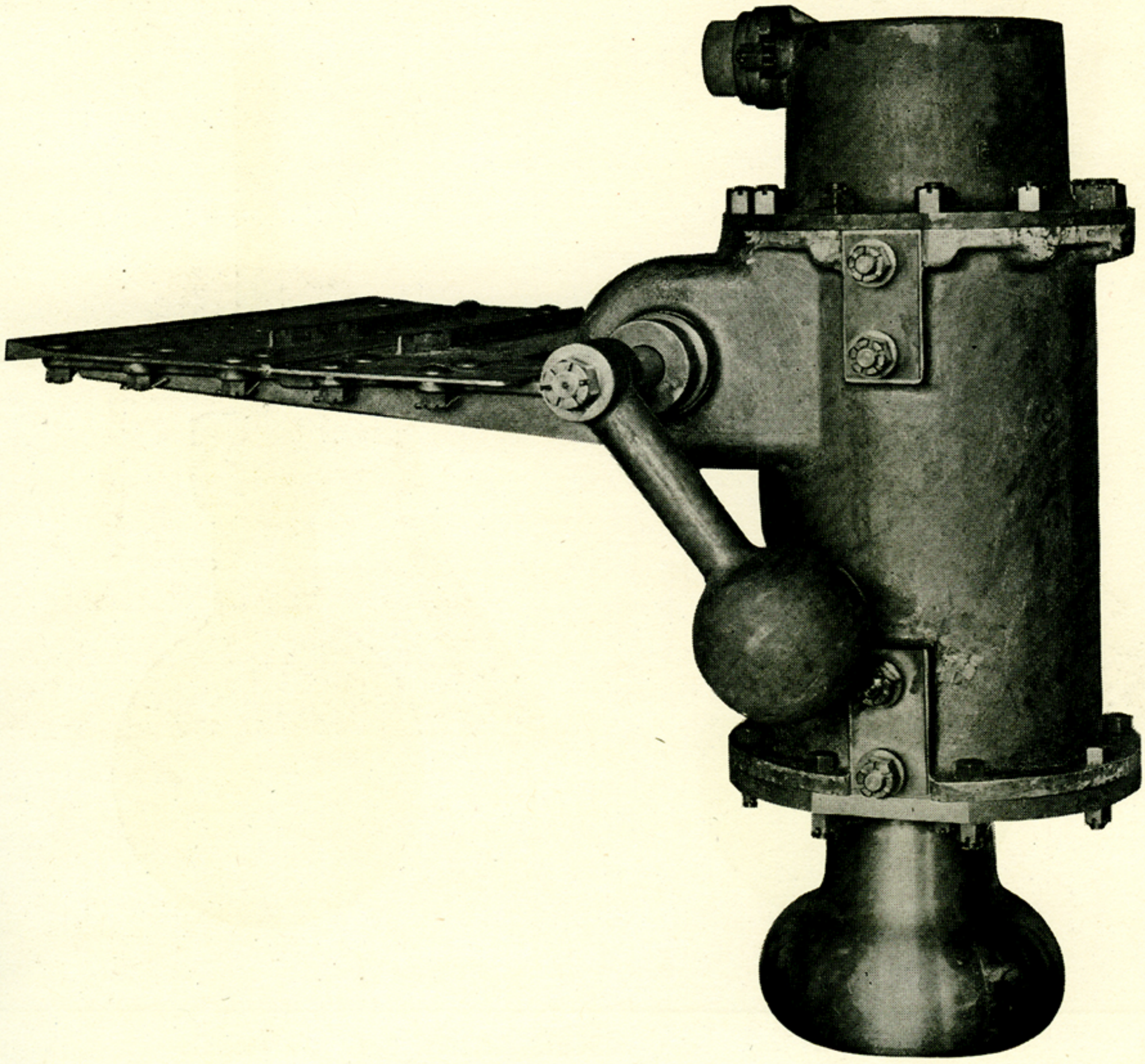
CONTRAST IN SHAPES OF AIR BELLS
AND SUBMARINE BELLS

Note the weight of the rim of the Submarine bell (on left) as contrasted with the tapering rim of the bell used in air

Tank Mounting of Microphone

The button is connected in an electrical circuit with battery and with telephone receivers, the current throug which is varied by the changes in the resistance of t transmitter. This device, simple as it looks, is the resu of years of study and experimentation.

I now come to the most serious problem in submari signaling, a problem which has been solved by the enginee of the Submarine Signal Company in a manner whi has made their system simple, economical, and efficien The microphone is an extremely sensitive device and r sponds to the slightest changes in pressure exerted upo its diaphragm. If the microphone is hung overboa from a moving ship, the noises produced by the wat passing by it would be so great as to entirely overpow the signals made by a distant bell. If the microphon was mounted on the side of the ship the noises produce by the water striking the sides of the ship and by th machinery upon the ship would overpower the signa

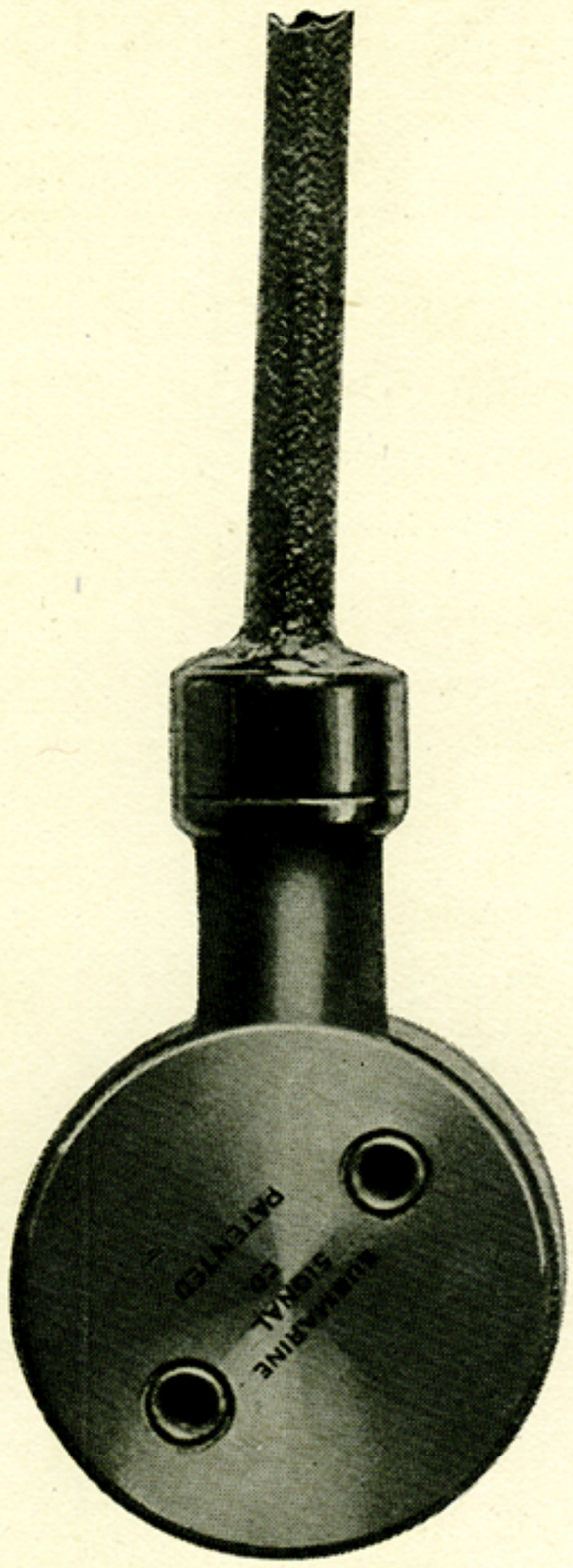


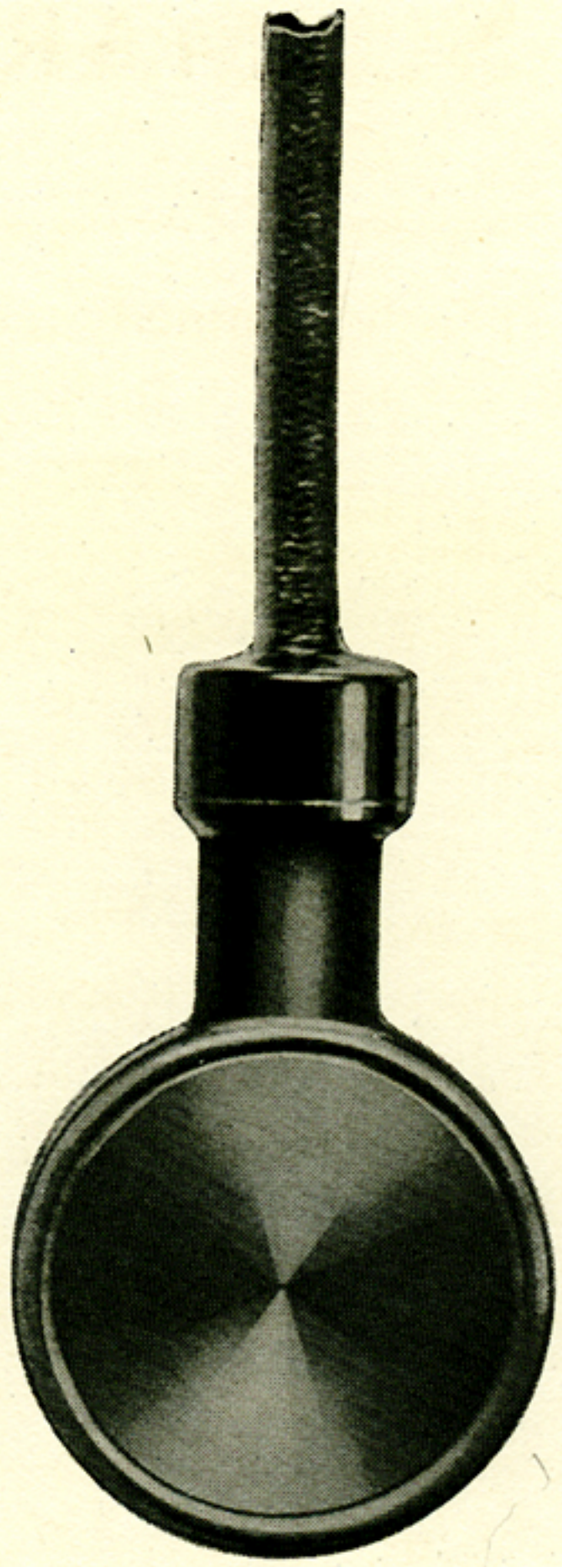
SUBMARINE AUTOMATIC BELL

This bell is supported under water by a floating buoy Note the large wing or vane projecting from the side of the bellcase. When the buoy and bellcase rise and fall with the waves the wing moves less. As a result of this difference in motion the energy required to operate the bell is stored

from the distant bell. The difficult problem which had to be solved was to find some way whereby the water and ship's noises would be reduced or eliminated with the least possible loss in the sensitiveness of the receiving microphone to the bell signal. This result has been attained in a very simple and practical manner by the use of tanks

filled with water, which are placed against the inner skin of the ship and are firmly held in place. One face of the tank is the skin of the ship. It was found that sound waves from a distant source would pass through the ship's plates without serious loss in intensity so that, if microphones were suspended within the tank, the distant signals would be audible notwithstanding the interposition of the ship's plate. Moreover, as the tanks are placed low in the ship and sufficiently far aft to be unaffected by the broken water at the bow, the water noises, which are so objectionable, are very largely reduced. Again the posi-





SUBMARINE MICROPHONE

tion of the tanks and the method of mounting them a

such that there is a minimum of disturbance introduc
by the ship's machinery. The discovery of this meth
of mounting was a distinct achievement and is perha
one of the most important factors in the perfection
submarine signaling devices.

I have described the method and apparatus used
producing submarine signals. I have described the sour
receiving devices and the method of mounting them. Th
is still another feature of this system which adds grea
to its usefulness. The microphone tanks are mounted
the sides of the ship and at some distance from the bo
If the tank is mounted on the port side of the ship, the b
sounds having their origin on the port side of the sh
will be readily heard and recognized; but, if the source
sound is on the starboard side, nothing will be hea
To hear bell signals when the source is on the starboa
side, a second tank with microphones must be used. It
customary, therefore, to use two tanks, one on each si
of the ship, in which to suspend the microphones. T
feature of the duplication of tanks and microphones affo
a most valuable aid in navigation. If facilities are giv
to the observer wherewith he can listen to a microph
on one side of the ship, and then to one on the other si

Direction Finding with Standard Receiving Apparatus

SUBMARINE SIGNALING

he is enabled to tell immediately on which side of the ship the source of sound lies. If the course of the ship is changed so that signals can be heard upon each microphone, the observer knows that he is heading more nearly toward the source of sound. When the sounds obtained from both microphones are of equal intensity, he knows with remarkable certainty that his ship is heading directly toward the source.

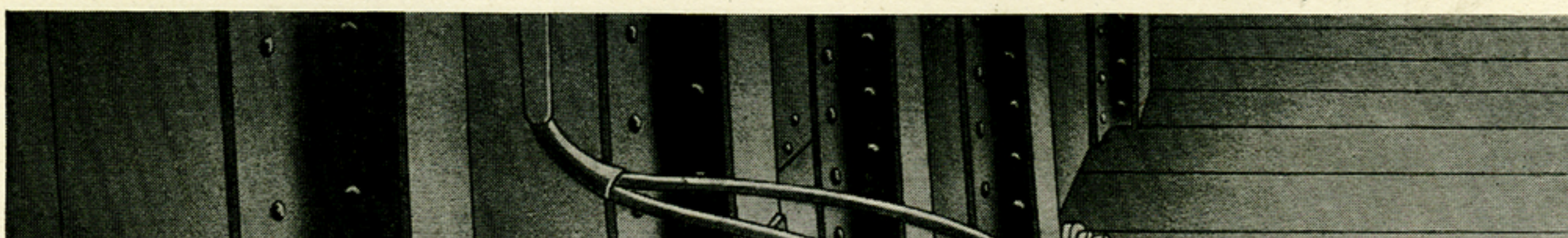
I have attempted to describe and show you what is known as the standard receiving system of the Sub-

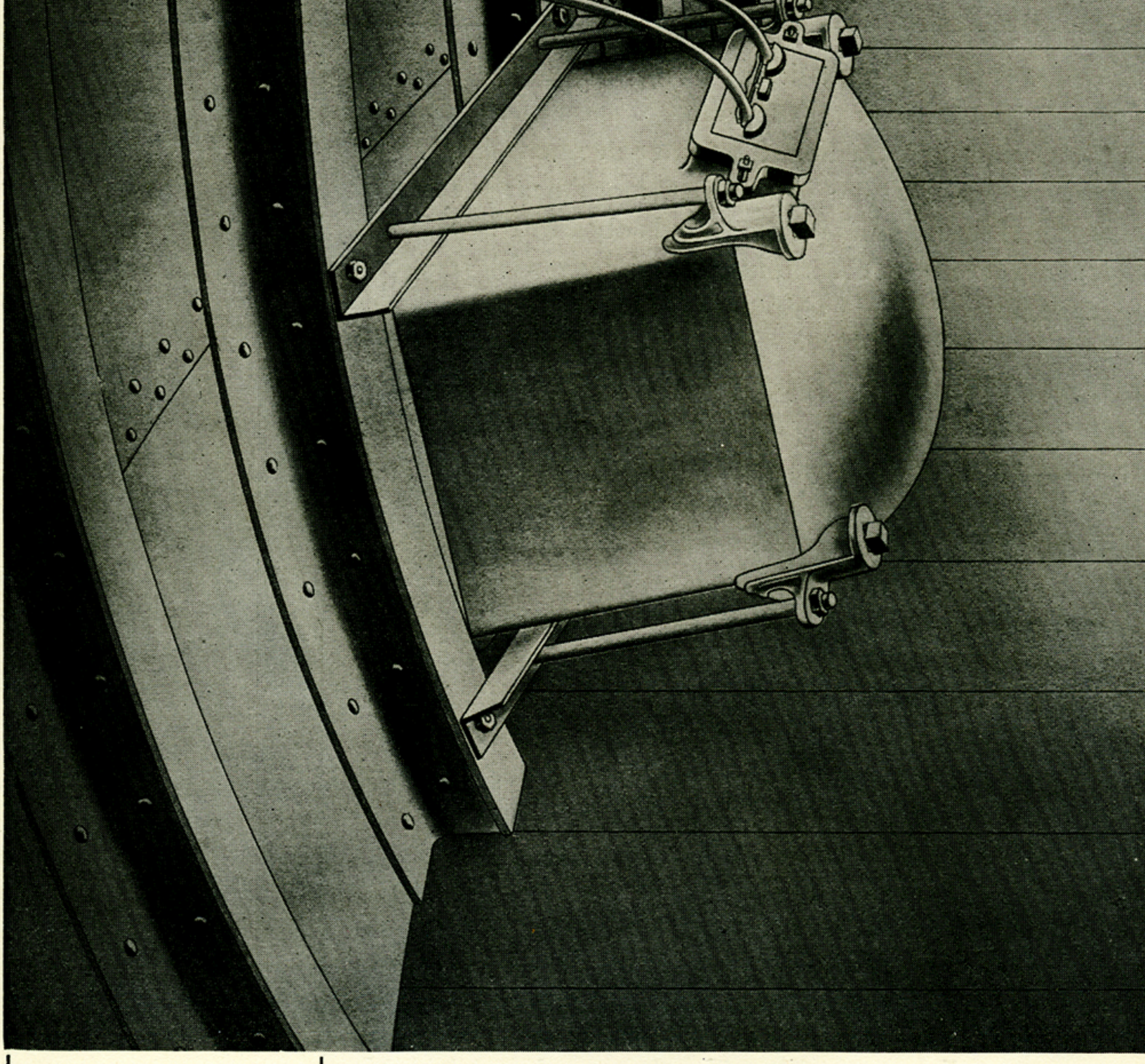
marine Signal Company. Before entering upon a description of war and antisubmarine devices I want to describe to you the Fessenden oscillator which is one of the most beautiful electro-mechanical devices ever invented. It is possible with the oscillator to create submarine sound waves of enormous energy. To create these waves a large expenditure of electrical energy is required, but so perfect is the design of the oscillator that signals can be sent from it by the operation of a simple telegraph key similar to that used generally today in telegraphic communications over land lines.

Fessenden Oscillator

When a bell is struck an impulse of considerable power is given off and the bell continues to vibrate but with an energy considerably less than that derived from the blow. Sound waves of this kind are said to be very highly damped. When listening to a submarine bell tone it very often happens that the waves following that produced by the blow are too weak to be heard, and the sound as it comes to the listener is little more than a click. It is practically impossible with a bell, therefore, to send code signals with which to establish communication. The pneumatic bells on lightships do send a code of sound signals similar to flashes of light which indicate the station's number, but such a method for communicating by telegraph or Morse code would be commercially impossible. Professor Fessenden has overcome this difficulty in his oscillator. He uses an alternating current which moves the diaphragm backward and forward 540 times a second, and each of these 540 movements is of the same amplitude. In other words the oscillator produces a series of undamped waves, which can be broken up into series of greater or less length to correspond with the dots and dashes of the telegraph code. Again the oscillator is an extremely sensitive receiving device and can be used in place of microphones to

Oscillator as Producer of Telegraph Signals





SUBMARINE SIGNAL COMPANY'S TANK

These tanks are mounted against the inner skin of the ship and are filled with water. Note the wires supporting two microphones within the tank

Mounting of Oscillator

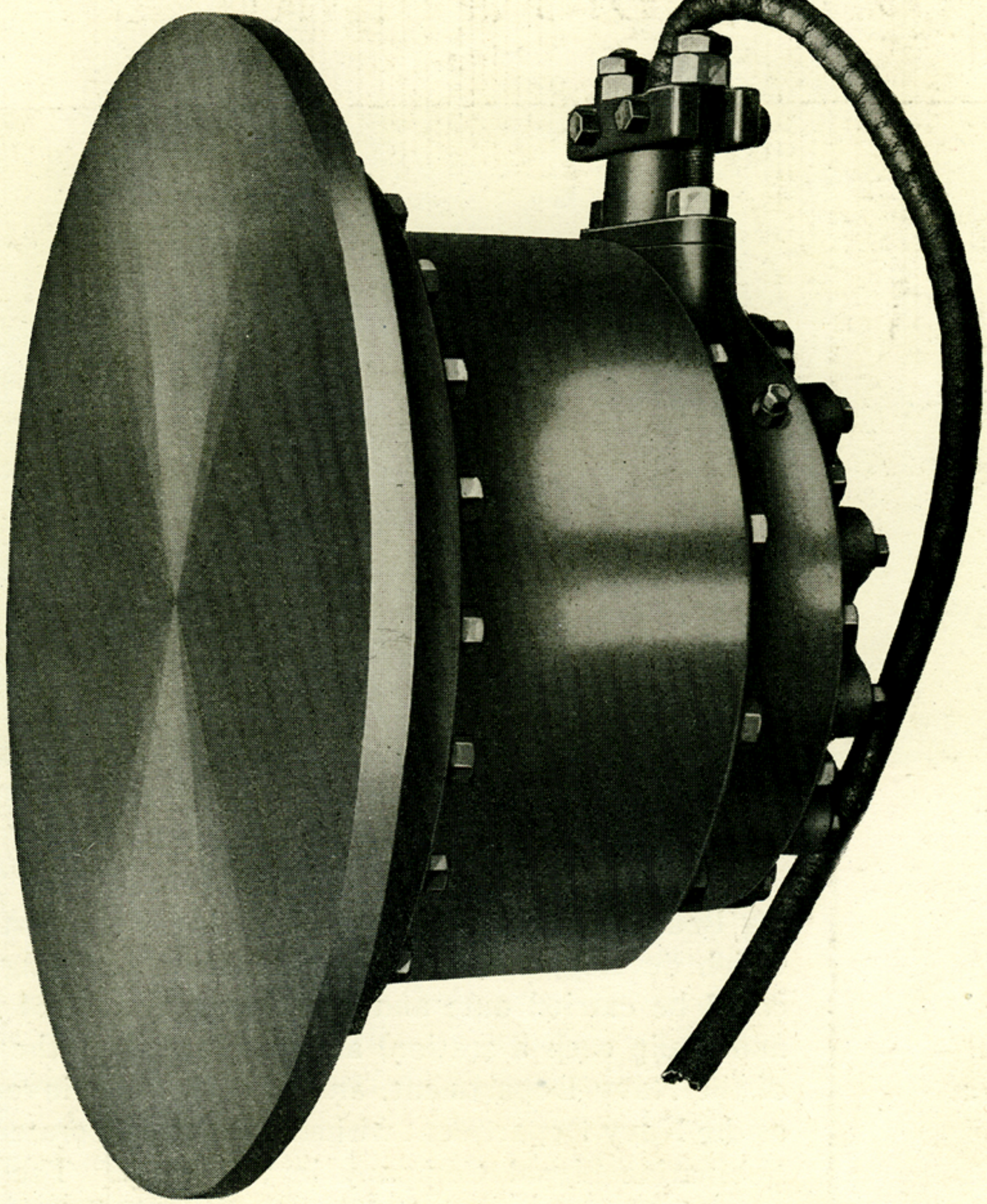
pick up and transform into electrical waves the compre sional waves which have been produced under water.

The oscillator has a diaphragm about two feet in diamet and weighs about 1200 pounds. It can be mounted in t side of a ship by cutting away the ship's plate and su stituting the oscillator diaphragm, or it can be mount in the forepeak tank of a ship.

I come now to a most fascinating application of submari signaling—its use during the War in the detection of su marines or of distant invisible vessels.

As soon as it became evident that the United Stat would go to war with Germany, the Submarine Sign Company placed at the disposal of the Navy Departme

all of its apparatus, its knowledge of the art of subaqueo



FESSENDEN OSCILLATOR

The large surface on the left is the diaphragm which is moved backward and forward by the electrical mechanism within the oscillator. The oscillator diaphragm is of steel about three-quarters of an inch in thickness

acoustics, the services of its engineers, and its special facilities for experimentation on submarine devices. It was largely in consequence of this that the Navy Department and those working with it were enabled to avoid the repetition of much of the experimental work which had been conducted during the previous fifteen years by the Submarine Signal Company, and to devote their energies immediately to the design of special devices based on acoustical, mechanical, and electrical principles which had already been established by the earlier work of the Submarine Signal Company.

Several months prior to the declaration of War, the Submarine Signal Company convinced the Naval Consult-

Beginning of Development of Apparatus for Detecting and Locating Submarines

THE NAHANT STATION
of
SUBMARINE SIGNAL COMPANY

ing Board of the importance of having a shore station

Submarine

Signal Company and Navy Department

Nahant Station of Submarine Signal Company

could be carried out; and the Company offered to bui
and equip such a station, and to place it at the dispos
of the Navy Department, and of such other investigato
as the Navy Department wished to have cooperate with t
Submarine Signal Company in this work. The Gener
Electric Company and the Western Electric Company, wi
the approval of the Navy Department, accepted th
invitation of the Submarine Signal Company.

The Submarine Signal Company through the generosi
and public spirit of the heirs of General Charles J. Pai
and of Mrs. K. W. Sears and Miss Clara E. Sears was pe
mitted to build an experimental station on their land on t
shore of Nahant; and in the early part of April 1917 w
had the most unusual condition of three companies, ea
more or less rivals in a specialty, revealing all their heret
fore secret information, waiving all questions of patents
ownership in inventions, and cooperating with the utmo
friendliness and loyalty in efforts to develop new devic
for a useful practical purpose.

Later the Navy Department became convinced of t
importance of the work which was being done at t
Nahant Station and decided to establish a similar expe
mental station at New London for the study of all nav
problems relating to the detection and destruction
hostile submarines.

SUBMARINE SIGNALING

Nahant Station and New London Station

The Naval officers in charge of the station at New London were kept informed of the work at Nahant; in fact a representative of the Navy was stationed at Nahant, and there was naturally the desire on the part of those engaged at the two stations to produce the most effective apparatus.

I will make no comparison of the value of the work produced by the Nahant or the New London groups of experimenters. As I was personally more closely in touch

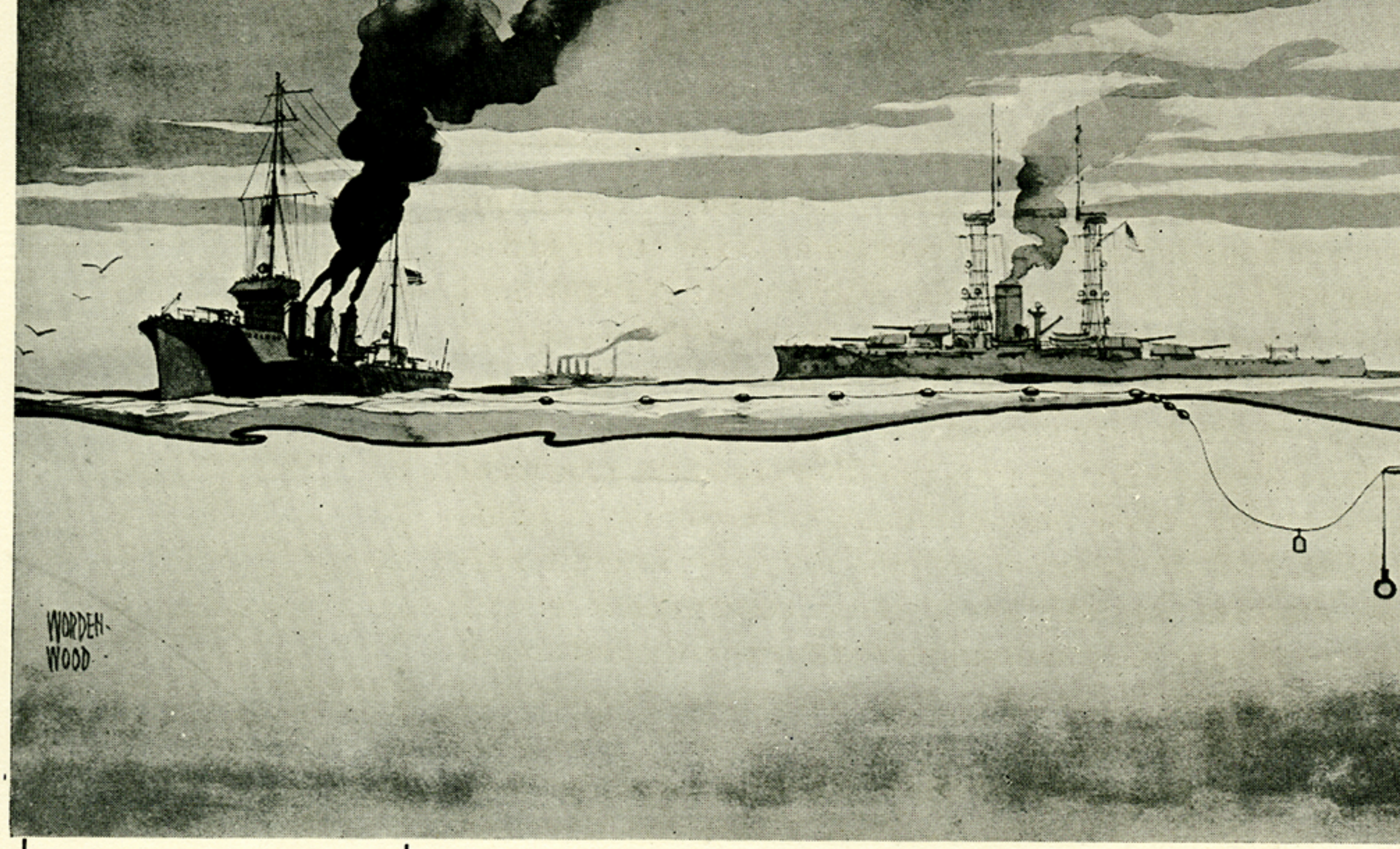
with the Nahant group of investigators, my interest naturally centered in their work. As a consequence what I shall say tonight will be descriptive rather of the apparatus developed at the Nahant Station than of that produced at the New London Station.

I think, however, that I can state without undue partisanship that the Nahant group, thanks to the initiative of the Submarine Signal Company, had a start of several months over the workers at New London, and had already produced apparatus, apparatus which was used in actual war service, before the work at the New London Station had been fairly begun. It must be appreciated also that the work at Nahant was done by three private companies with their own men and at their own expense, while the work at New London was carried out by scientific men selected for their attainments, who were given the full resources of the United States for the production of their experimental apparatus.

Investigators at Nahant Station Supported Entirely by General Electric Company, Western Electric Company, and Submarine Signal Company

The first problem before the experimenters at Nahant was to find out the nature of the sounds produced by vessels both on the surface and submerged, and to obtain some idea of the distances at which such sounds could be heard. The Submarine Signal Company had experimented somewhat, many years before the War, in anticipation of the possible need, in time of war, of detecting apparatus of this kind, but the incentive had not been sufficient to warrant the expenditure of the time needed in development work of this character. As a consequence, only meager results had been obtained. The Submarine Signal Company, however, had the Fessenden oscillator, and it was thought that possibly by the use of this device as a receiver some idea could be obtained of the character of the noises produced by moving vessels. A Fessenden oscillator was accordingly placed under water upon a tripod off the shore of the Nahant Station at a distance of one half to three quarters of a mile, and was connected with the shore station by a cable. There had been developed, within the past few years, one of

Oscillator and Pliotron at Nahant Station



THE DRIFTER SET

The microphone is supported at a depth of about fifteen feet by a float. The cable connecting the microphone with the observer is supported by floats

Nature of Noises Produced by Submarine and other Ships

the most remarkable devices of modern days, known as "pliotron" or "audion," which is a vacuum tube, looki to the layman something like an incandescent lamp, the use of which extremely feeble electrical currents, cu rents so attenuated as to be inaudible in a telephone, cou be amplified and made clearly audible in a telephone. T General Electric Company connected this pliatron wi the Fessenden oscillator and, for the first time probably the world, it was possible for listeners to hear movements ships at distances of many miles. Not only were su sounds made audible in telephones but phonograph recor were made of the sounds and, possibly even more remark ble, photographs of the sounds produced by distant invi ble ships were taken.

These under-water sounds are produced, not only b the movements of the propeller blades in the water, b by the auxiliary machinery with which practically a ships are equipped. Most ships, it was found, had the own characteristic noises and it became possible lat for men who had become expert in listening, not only report the type of ship but the individual ship by recogni ing some characteristic of noises heard. Moreover

was found that even a submarine lying at the bottom
the ocean gave sufficient noises to indicate its presen
unless extraordinary precautions were taken on shipboa
against the movement of men or of machinery. The d

SUBMARINE SIGNALING

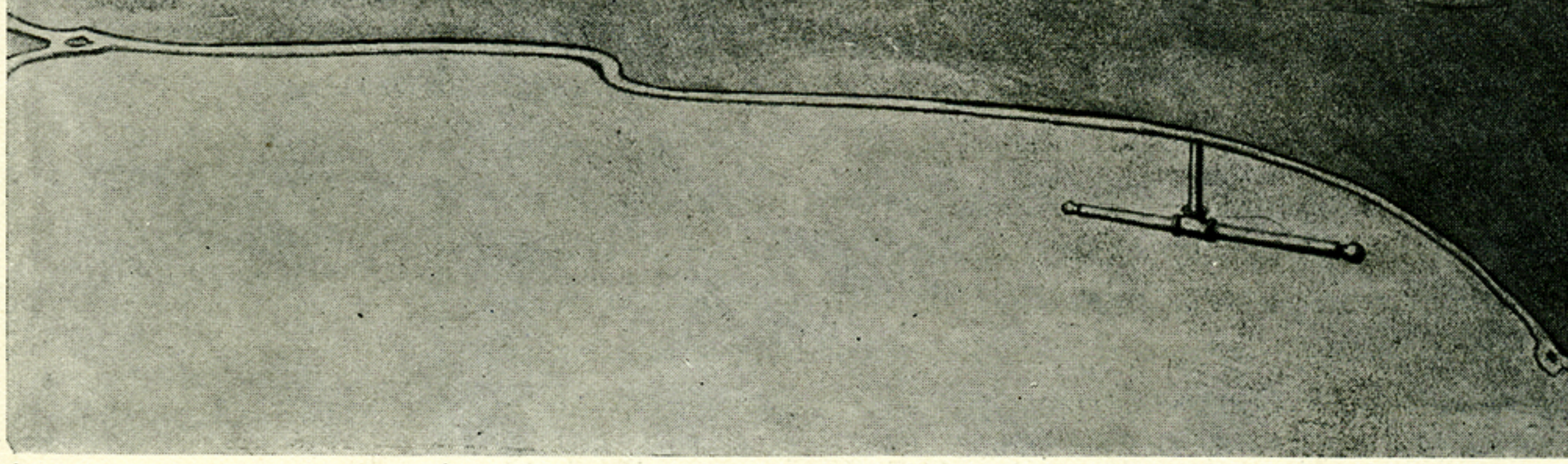
tection of submarines, therefore, as developed during the War was confined practically entirely to the detection of the noises on such boats, and to the determination of the direction from which such noises were coming, rather than to any other means. Efforts were made to detect boats by the use of some sensitive receiving device which would be affected by the presence of iron; another method, suggested and tested, was to sweep the ocean with a beam of sound and endeavor to obtain the echo which might arise; another inventor felt that no body like a surface ship or a submarine could move in the water without bending to a certain extent and thus produce movements of slow periodicity which it was hoped could be detected by the use of proper apparatus. None of these methods was developed into practicable form during the War and, as a consequence, sound was the only agency by which detection was practically carried out.

Under-water Sound the Only Agent Used practically for Detection of Submarines

The Submarine Signal Company developed, almost immediately after the initiation of the work at Nahant, a form of microphone, which had extraordinary sensitiveness. It was found that this device, if hung in the water in the proper manner, would respond to noises produced at a distance equal to that obtained from the oscillator and pliotron or greater, but the difficulty with this device and, in fact, with every submarine sound-receiving device is that, while the instrument may be extremely sensitive to sounds coming from a distance, it is liable to be affected even to a greater extent by the noises produced by a nearby source such as the noises made upon or by the boat from

Tension Tuned Microphone

which the sound-receiving device is used. Thus, if the sensitive microphone, of which I am speaking, were hung from the side of a boat, even with all its machinery shut down and no man moving upon it, the noises produced by the water striking the sides of the boat and by the movement of the device itself arising from the rolling of the supporting boat would be sufficient to overpower, completely, the sounds incoming from a distant source. It was, therefore, necessary to find some way of supporting the microphone. The necessary quietness was obtained by an arrangement devised by one of the engineers of the Submarine Signal Company. In this arrangement the microphone was hung from a float of a buoyancy such that it was submerged below the surface of the water; the microphone was connected with the telephone receivers of the listener on the boat by a cable held near the surface



THE C TUBE SET

Two under-water ears attached to the end of a bar held under water in a horizontal position. The observer turns the bar until the sounds of an invisible ship seem to him to originate from a point directly in front of him

Drifter Set

of the water by floats placed a few feet from each othe
The method of using this arrangement was for the bo
from which it was used to shut down its machinery a
drift. The cable was paid out until the microphone w
at a distance of 100 or 200 feet from the boat. With t
machinery of the boat shut down, the splashing of t
water upon the boat's sides could not be heard at such
distance, and the microphone and its support were
far submerged that there was no disturbing moveme
of the microphone in the water. This arrangement w
extraordinarily sensitive and the presence of vessels cou
be detected although they might be at very great distanc
from the listener.

SUBMARINE SIGNALING

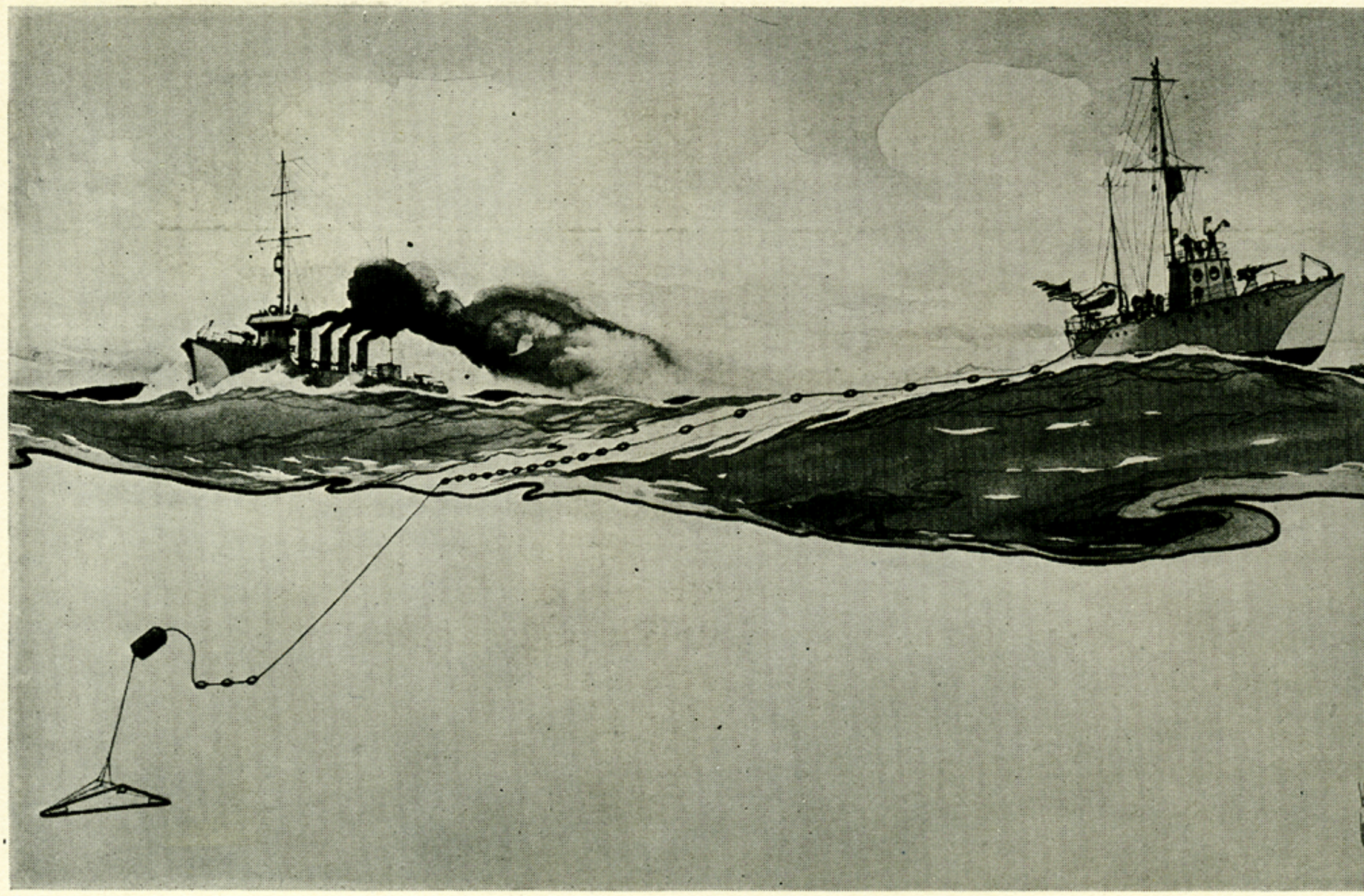
The difficulty with the "Drifter Set," just described, was that, although with it the presence of an invisible ship could be ascertained, it afforded no means of ascertaining the position of such a ship nor the direction from which the sounds created by it were coming. A completely

satisfactory device must be one which will enable an observer on a submarine chaser or destroyer, not only to note the presence of a hostile submarine but to find its exact position relative to his own ship, to the end that the submarine can be followed and when the following ship is sufficiently near, depth bombs can be dropped and the submarine crippled or destroyed.

Direction Finding

It consequently became necessary to find some way to ascertain the direction from which the under-water sounds were coming. After considerable study recourse was had to a most interesting physical and physiological phenomenon, the binaural sense of direction. As this binaural sense of direction was employed in practically all detecting devices developed by this country during the War, I would like to enter a little into the scientific side of this phenomenon. If a sound is made near a listener, he is usually able by turning his head to face the sound and to say the direction from which the sound is coming; similarly, practically, although probably with less accuracy, he is able without turning his head to indicate the position of the source of sound. The question arises as to how he is thus able to know the direction from which the sound is coming. This subject had been studied for many years prior to the War, but almost entirely as a physiological problem rather than as one of acoustics, although Lord Raleigh had investigated the subject carefully. Without going into detail it can be said now with considerable certainty that this binaural sense of direction arises from the ability of a listener to detect differences in the times of arrival of the sound waves at his two ears. Thus, if a sound is immediately in front of him, the sound waves strike the two ears at the same moment, and, to use a technical expression, are in phase, at the time of arrival. He, therefore, knows that the sound is directly in front of him. If the source of sound is somewhat on his right, let us say, the sound wave strikes his right ear before it does his left and there is a difference in phase between the two sounds. By turning his head slightly the listener can bring the sounds again into phase and when this is the case, he is facing the source. It is a fact which has now

Binaural Sense of Direction



THE K TUBE SET

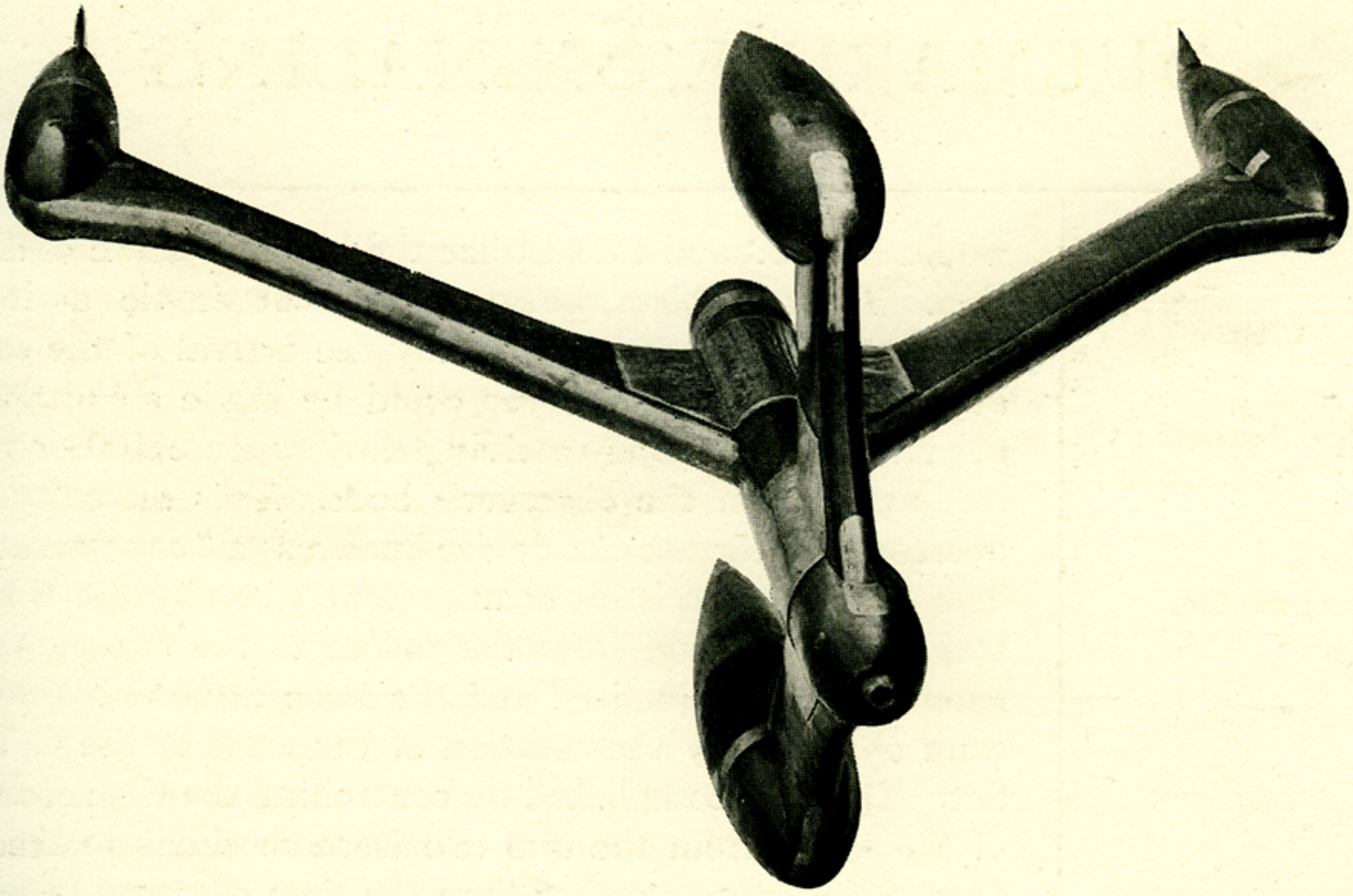
The microphones are attached to the apexes of a metal triangle. The triangle and microphones are submerged about fifteen feet and supported by a submerged buoy. The microphones are connected with a compensator on the observer's ship by a cable supported by floats

C Tube Set

become well established that the ears, combined with t
binaural sense, are able to detect differences in time
small as one one hundred thousandth (.00001) of a secon

The direct embodiment in a submarine-detecting devi
of the binaural method of direction finding was an arrang
ment developed at the Nahant Station in which two soun
receiving devices were submerged under water, the
sound-receiving devices operating in the manner of t
human ears. They were placed at a greater distance fro
each other than are the human ears, to compensate for t
difference in the medium in which they were used. Th
was necessary for the reason that sound travels more rapi
ly in water than in air; and to get the required direction
effect, the separation between the sound-receiving devic
in water had to be greater than between the ears in a
The sound receivers used in this first device were so
rubber hollow spheres, each one of which was connected
a pipe to an ear of the listener. These artificial ears we
mounted on the end of an inverted T, on the vertical po

tion of which, near its upper end, was attached a wheel b
means of which the cross bar supporting the receive
could be rotated. This device was supported from th
side of the observer's ship and was lowered overboard f
an observation after the ship had come to rest and bee
made quiet. The listening observer when he heard th



THE OV TUBE

Three microphones, one in each fish-shaped body on right and left and one in the lower body, were used. A cable was led through the hole in the central body and carried to the towing ship. The stream-line shape of all parts made towing easy, and dimensions of arms and fins prevented yawing

sounds of the distant ship would have a mental impression that it was on his right or left as the case might be. By turning the cross bar until the sound seemed directly in front of him, he would be able to know that his two receivers, his under-water ears, were equi-distant from the source and that the source of sound consequently must be in a direction at right angles to the cross bar. A scale upon

the rod showed the position of the submerged cross bar, and means were thus provided for reading accurately the direction of the source. As the binaural system of direction finding was that which was practically universally adopted during the War, we can point, I think, with considerable pride to this device, the so-called C Tube Set, as a distinct accomplishment, and as having showed the way in which the problem of detecting submarines would be solved.

The Nahant investigators were not satisfied with this device for the reason that acoustic receivers, so called, such as were used in the C Tube Set just described, were not nearly as sensitive as microphones. Moreoever, the noises made by the water striking on the ship's sides and the difficulty of listening over the side of the ship were so great as to make the arrangement insensitive, cumbersome, and difficult to operate at sea. Accordingly they set themselves to work to devise apparatus which would embody the principle of the Drifter Set but in which two or more microphones

Compensator	would be used and thus utilize the binaural sense of dire tion. Their problem, however, was not simple, as it w necessary to find a way whereby the arrival of the sou at the ears of the observer could be made simultaneo even when the sound-receiving devices were 100 or mo feet away from the observer's boat. This difficulty w overcome by the use of a device known as a "compensato The compensator is an arrangement whereby the time travel of the sound from the source to the two ears of listener can be equalized and the same results obtained were obtained by the rotation of the arms of the C Tu Set. This is accomplished by controlling the time of trav of the sound from the two telephone receivers to the t ears of the listener rather than the time of travel from t source to the two sound-receiving devices as is done in t

C Tube Set. Thus, if the source of sound is equi-dista
from the two microphones, and the paths from the m
crophones to the two telephone receivers and from t
telephone receivers to the listener's ears are the sam
the sounds will reach the ears at the same time, i. e., th
will be in phase and the source of sound will seem to t
listener to be directly in front of him. If the source is near
one microphone than the other, the compensator affor
means whereby the path from the telephone receiv
connected with the nearer microphone to the listener's e
can be lengthened until the time taken for the sound
travel over that path is exactly the same as over the oth
path, or until the sound again seems to be directly ahea
By noting the difference in the lengths of the air paths fro
the two receivers to the ears, the observer, knowing t
difference in velocity of sound in air and water, can tell
how much one microphone is nearer the source of sou
than the other microphone. Now, as the distance betwe
the two receiving microphones is fixed and as the differen
between the two sides of the triangle formed by this ba
and the distant source of sound is known, the direction
the source can be readily ascertained. It is thus possib
to calibrate the compensator to show directly in degrees t
direction of the source with relation to the bar supporti
the two receiving microphones. To prevent ambiguity
to whether the source is on one side of the microphones
the other, three microphones held equi-distant from ea
other are used and observations can be made upon ea
two, and the exact direction of the source relative to t
detecting devices thus defined.

SUBMARINE SIGNALING

The compensator was on the listener's boat. The three microphones were rigidly supported upon a triangle and were thus held at equal distances from each other. The

precisely the same manner as in the case of the Drifter Set. Special microphone cases had to be designed for use in this set as it was found that when metal diaphragms, such as had been previously used in under-water microphones, were employed there was difficulty in utilizing the binaural sense most effectively. The Submarine Signal Company's microphone button, however, proved the most satisfactory form and was, as a consequence, made a part of these instruments.

K Tube Set

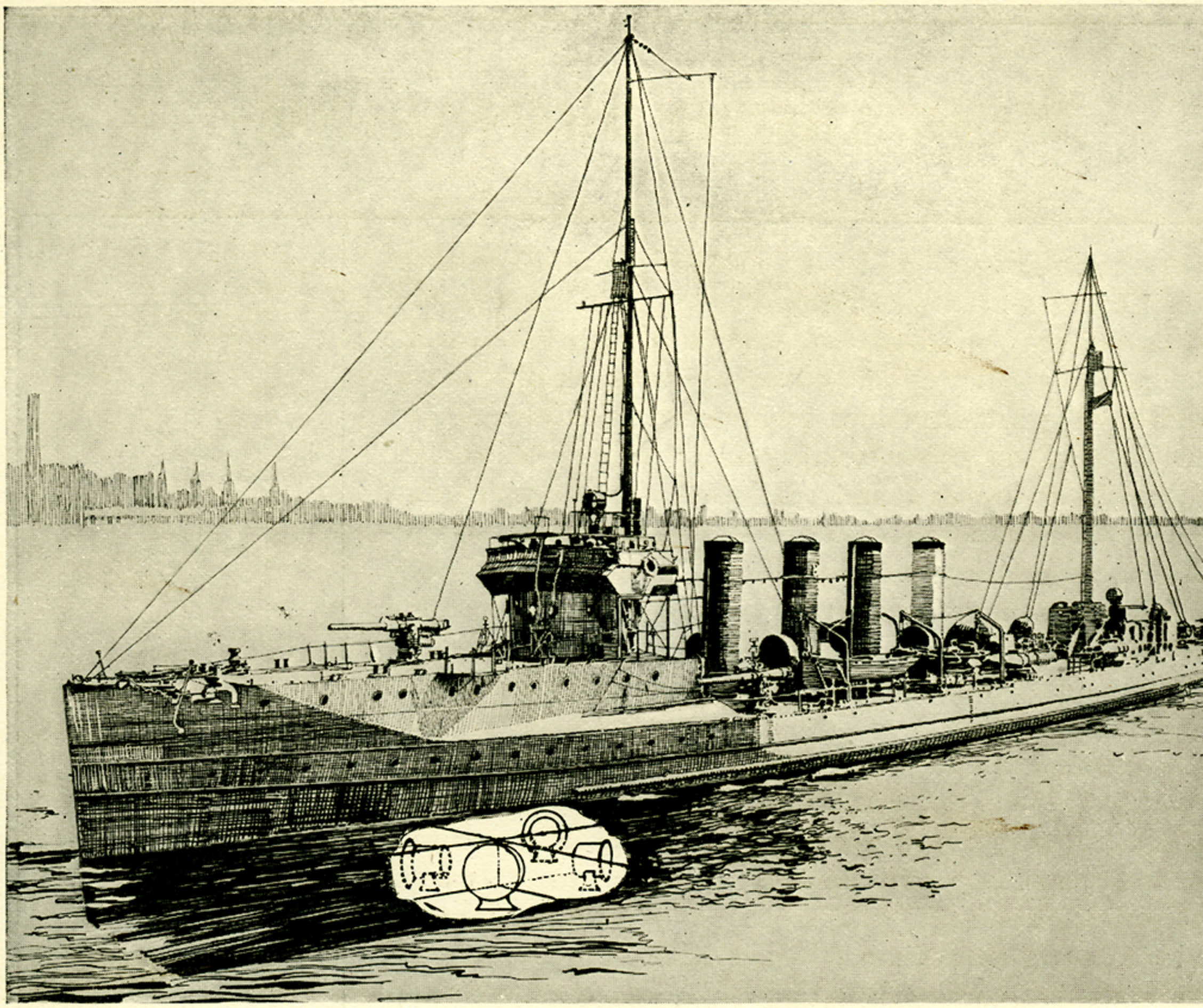
The arrangement which I have just described was known as the "K Tube Set" and was extensively made and used during the War. It was sensitive, reliable, and accurate but had one serious limitation. It could be used only from a ship which was drifting. To chase a submarine with such an instrument much time is lost in shutting down the machinery on the chasing ship and in putting overboard and recovering a drifting device like the K Tube Set. It was imperative that some way should be found by which direction could be determined from a chasing boat while underway and moving at a desired speed.

Difficulties with Drifting Apparatus

I will not now take the time necessary to describe the forms of detecting and direction-finding devices which were made in an effort to obtain a satisfactory towed device, but will show you a mechanism, designed by one of the Submarine Signal Company's engineers, which we feel represents the highest development in towed direction-finding devices.

OV Tube Set

The problem was to design a frame which could be towed at any speed without introducing water noises in the microphones supported upon the frame. The frame should not sink but should remain sufficiently submerged even though the ship, to which it was attached, should shut down its machinery and drift. When towed, the frame should remain submerged at a proper depth regardless of the speed at which it was passing through the water; it should be so designed that it would not yaw but would maintain a definite and known direction relative to the observer's boat; the frame had to be sufficiently large to support the three microphones at a distance of four feet from each other and at the same time not exert an undue strain upon the electrical cable connecting the microphone with the compensator located on the towing boat.



FOUR-OSCILLATOR INSTALLATION ON DESTROYER

Four oscillators are mounted in a fore tank of a destroyer. The oscillators are so mounted that the diaphragm of each is at an angle of 45 degrees with the ship's keel, and at 90 degrees with each other. A sound screen in the vertical plane of the ship's keel separates the two port oscillators from the two starboard oscillators. A second screen at right angles with the first separates the two forward oscillators from the two aft

"Dinosaur"

The OV Tube Set, named by the investigators a "Din
saur," was developed, perfected, and fulfilled all of th
above requirements.

Very soon after the initiation of development work o
detecting and direction-finding devices it became evide
that the ultimate device must be one which could be moun
ed entirely on shipboard and not be used overboard
are the devices which have just been described. It was fe
by the engineers of the Submarine Signal Company tha

oscillators properly placed on shipboard could probably
made, especially if used in connection with amplifiers,
give better results than microphones similarly mounte
As a consequence, while the workers at Nahant and els
where were engaged in the development of the simpl
apparatus which could be made immediately available f
use by the Navy Department, the engineers of the Subm
rine Signal Company undertook the more difficult task

SUBMARINE SIGNALING

Four-Oscillator Equipment on Destroyer

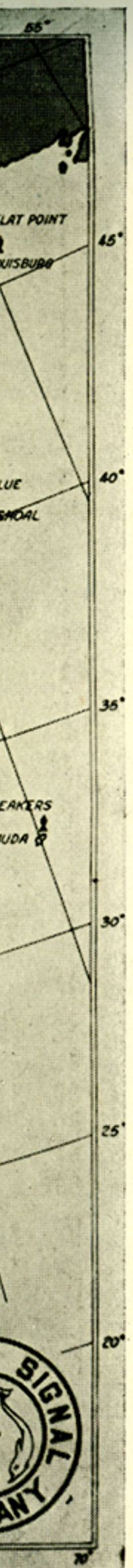
finding a way of detecting and locating submarines by the use of oscillators and associated apparatus mounted in destroyers. The problem was a most difficult one; but it was solved and two destroyers were equipped with oscillators so arranged that an observer on a destroyer, while moving at a high speed, could follow the movements of an invisible submarine. Four oscillators were used and were located in a forward tank of the destroyer. Sound screens were placed between the oscillators with the result that each oscillator was respondent only to sounds incoming from a single quadrant.

Work of Others

I have said little or nothing of the work of others than the engineers of the Submarine Signal Company and of those associated with that Company in experimental work at the Nahant Station. Elaborate devices were developed at New London and elsewhere with the object of providing apparatus which could be mounted on shipboard. Considerable success had been obtained by the time of the armistice, and effective instruments had been designed which could be made a part of the ship. Such devices, I feel safe in saying, utilized the principles first developed at the Nahant Station, employed the Submarine Signal Company's type of microphone button, and largely the methods of mounting receiving apparatus on shipboard which had been perfected by the engineers of the Submarine Signal Company

prior to the War. There can be no question whatever that it was due to the initiative of the officers of the Submarine Signal Company and to the unselfish policy adopted by them in establishing the Nahant Station and in giving to the Navy Department and to the investigators working with the Submarine Signal Company at Nahant complete information of the art of submarine signaling that enabled this country to produce and place in service abroad submarine-detecting and direction-finding devices at an early date, devices more accurate and useful than any developed, so far as we yet know, by any foreign country.

Conclusion


55°
LAT POINT
45°
40°
35°
30°
25°
20°
70°
SIGNAL


SUBMARINE
THE
SUBMA
BOSTO
WHITE FISH POINT
VERMILLION
SAULT STE. MARIE
DETOUR
ST. IGNACE
MANISTIQUE
DETOUR
MARTIN R
POE REE
ESCANABA
LANSING
SHOAL
GRAY'S REEF
ELEVEN FOOT SHOAL
MACKINAW
CHEBOYGAN
ROGERS
MENOMINEE
WISCONSIN
N. MANITOU
SHOAL
GLENHAVEN
TRAVERSE
MICHIGA
POR
DETR
KEY
SHORE STATION EQUIPPED WITH SUBMARINE BELL
BUOY EQUIPPED WITH SUBMARINE BELL
LIGHT VESSEL EQUIPPED WITH SUBMARINE BELL
SUBMARINE SIGNAL
CHICAGO

SUBMARINE BELL INSTALLATIONS
ATLANTIC & PACIFIC COASTS

OCTOBER 1920

SUBMARINE SIGNAL CO

BOSTON MASS U.S.A.

CANADA

UNITED STATES

MEXICO

SAND HEADS
SWIFT SURE BANK
UMATILLA REEF
COLUMBIA RIVER
TACOMA
PORTLAND
ORFORD REEF
CAPE MENDOCINO
BLUNTS REEF
SAN FRANCISCO
SAN FRANCISCO

WHITE FISH POINT
DETOUR
MARTIN REEF
GRAYS REEF
LANSING SHOAL
ELEVEN FOOT SHOAL
POE REEF
MANITOU SHOAL
LAKE HURON
SOUTHEAST SHOAL

LITTLE METIS
UPPER TRAVERSE
RED ISLAND
WHITE ISLAND
ST. JOHN
HALIFAX
MOUTH
BRAZIL ROCK
LURCHER SHOAL
MANANA ISLAND
PORTLAND
BOSTON
PEAKED HILL BAR
POLLOCK RIP SL
POLLOCK RIP
GREAT ROUND
HEDGE FENCE
VINEYARD SOUND
BRENTON REEF
NANTUCKET SHOALS
POINT JUDITH
CORNFIELD POINT
FIRE ISLAND
AMBROSE CHANNEL
BARNEGAT
NORTHEAST END
FIVE FATHOM BANK
OVERFALLS
FENWICK ISLAND
WINTER QUARTERS SHOAL
CAPE CHARLES
CHESAPEAKE BAY
TAIL OF THE HORSESHOE
DIAMOND SHOAL
CAPE LOOKOUT SHOALS
FRYING PAN SHOALS
FRYING PAN SHOAL
NEW YORK
PHILADELPHIA
BALTIMORE
WASHINGTON
NORTH EAST BR
BERM

CHARLESTON
MARTINS INDUSTRY
BRUNSWICK
ST. JOHNS RIVER
MOBILE
NEW ORLEANS
ST. AUGUSTINE
HOUSTON
GALVESTON
HEALD BANK
SOUTH PASS
KEY WEST
TAMPICO

KEY

- SHORE STATION EQUIPPED WITH SUBMARINE BELL
- BUOY EQUIPPED WITH SUBMARINE BELL
- LIGHT VESSEL EQUIPPED WITH SUBMARINE BELL

SUBMARINE
COMP

SUBMARINE BELL INSTALLATIONS
BRITISH ISLES & NORTH SEA

OCTOBER 1920

SUBMARINE SIGNAL CO

BOSTON MASS U.S.A.

6° 4° 2° 0° 2° 4° 6° 8°

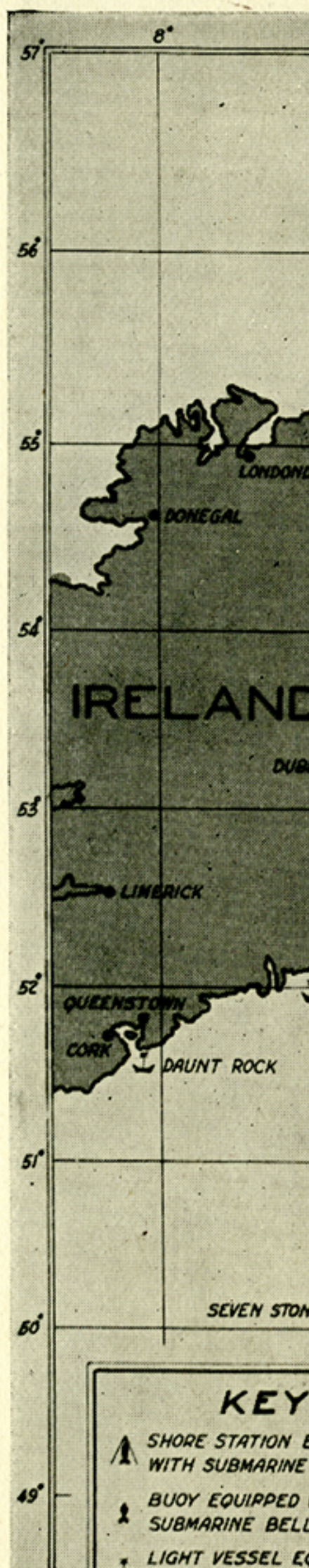
57° 56° 55° 54° 53° 52° 51° 50° 49°

PERTH
EDINBURGH
GLASCOW
BELFAST
STOCKTON
MORECAMBE BAY
HULL
HUMBER
NORTHWEST
NORTH STACK HOLYHEAD
BAR
LIVERPOOL
KISH
CARNARVON BAY
ARKLOW
STRUMBLE
CONINGBEG
ST GOVENS
BRISTOL
BREAKSEA
LONDON
DOVER
PORTSMOUTH
PORTLAND
PLYMOUTH
SHAMBLES
NAB
OWERS
ROYAL SOVEREIGN
FOLKESTONE PIER
CALAIS
BOULOGNE
CALAIS
BOULOGNE
DUNKIRK
OSTEND
BLANKENBURG
ANTWERP
EAST GOODWIN
SANDETTIE
WEST HINDER
NORTH HINDER
WANDELAAR
MID BARROW
TONGUE
KIRBY
SUNK
ALDBOROUGH
SHIPWASH
OUTER GABBARD
MAAS
AMSTERDAM
SCHEVENINGEN
ROTTERDAM
HOLLAND
BELGIUM
FRANCE
WALES
ENGLAND
N. DOGGER BANK
S DOGGER BANK
AMRUM BANK
AUSSEN EIDER
AUSSEN JADE
ELBE I
BORKUM RIFF
NORDERNEY
WESER
CUXHAVEN
BLEXEN
SCHILLING
EMDEN
BORKUM RIFF
HAAKS CHANNEL
HAAKS
HARLINGEN
GRONINGEN
HINDELOPEN
ALKMAAR
SWARTE BANK
OUTER DOWSING
HAISBOROUGH
SMITHS KNOLL
CROSS SANDS
HASBOROUGH
SPALDING
YARMOUTH
CHERBOURG
HAVRE
CHERBOURG
ROUEN
SAINT MALO
USHANT

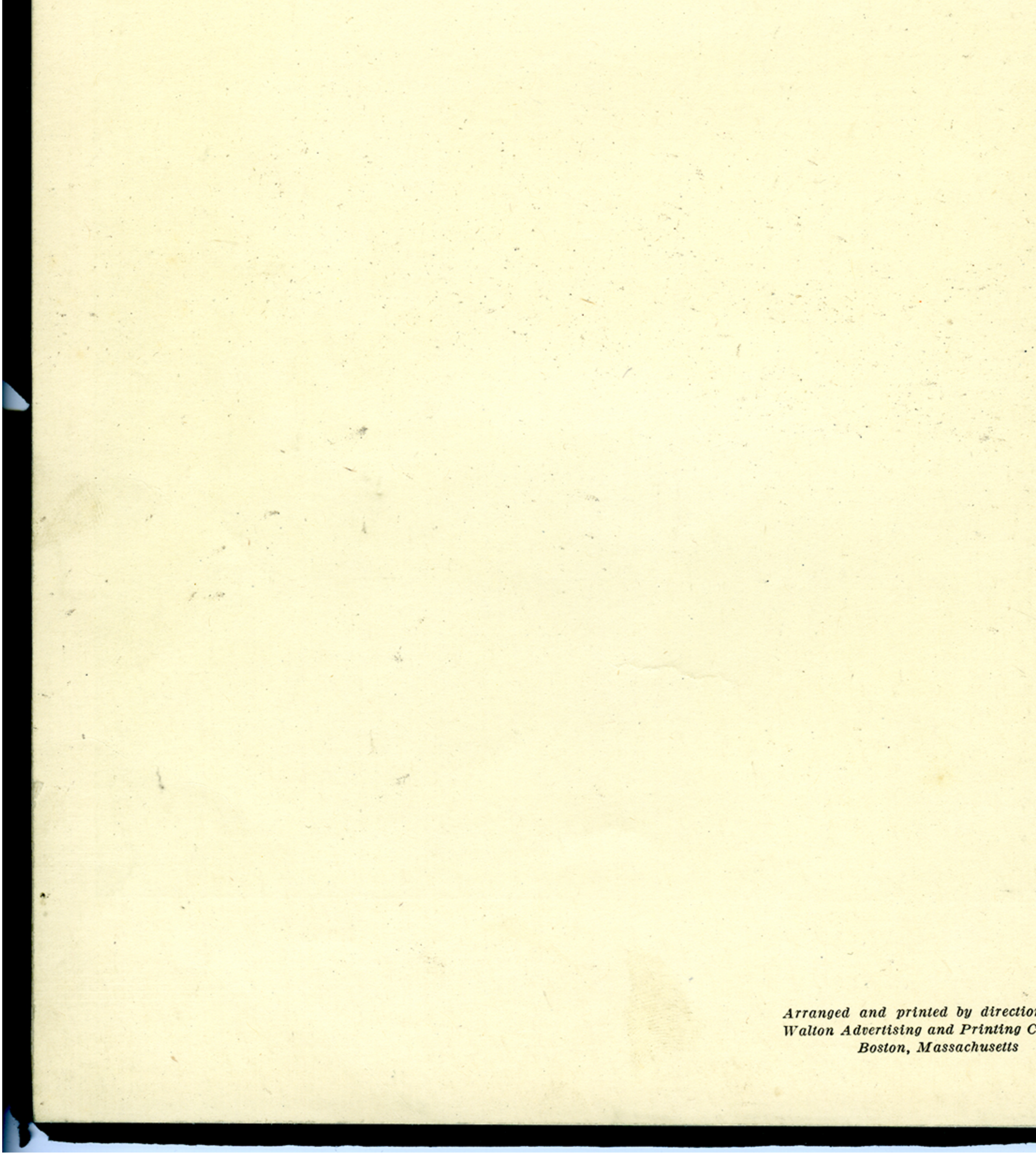
EQUIPPED
BELL
WITH
QUIPPED

SUBMARINE SIGNAL

E BELL INSTALLATIONS
C & NORTH SEAS
OCTOBER 1920
BMARINE SIGNAL CO
TON MASS U.S.A.




SUBMARINE
BALTI
SUB
BOS
NORWAY
S
CHRISTIANIA
BERGEN
LAUSVIG
FREDERICK
KRAGEROE
EGGERSUND
CHRISTIANSAND
LAESO TRINDEL
KEY
SHORE STATION EQUIPPED WITH SUBMARINE BELL
BUOY EQUIPPED WITH SUBMARINE BELL
LIGHT VESSEL EQUIPPED WITH SUBMARINE BELL
THORRUM
N. DOGGER BANK
DENMARK
S. DOGGER BANK
AMRUM BANK
AUSSEN EIDER
AUSSEN JADE
ELBE I
BORKUM RIFF
NORDERNEY
WESER
BORKUM RIFF
HAAKS CHANNEL
HANBURG
EMDEN
BLEXEN
GRONINGEN
4°
6°
8°
10°
61°
60°
59°
58°
57°
56°
55°
54°
53°



Read more

Hull Number: SC 96

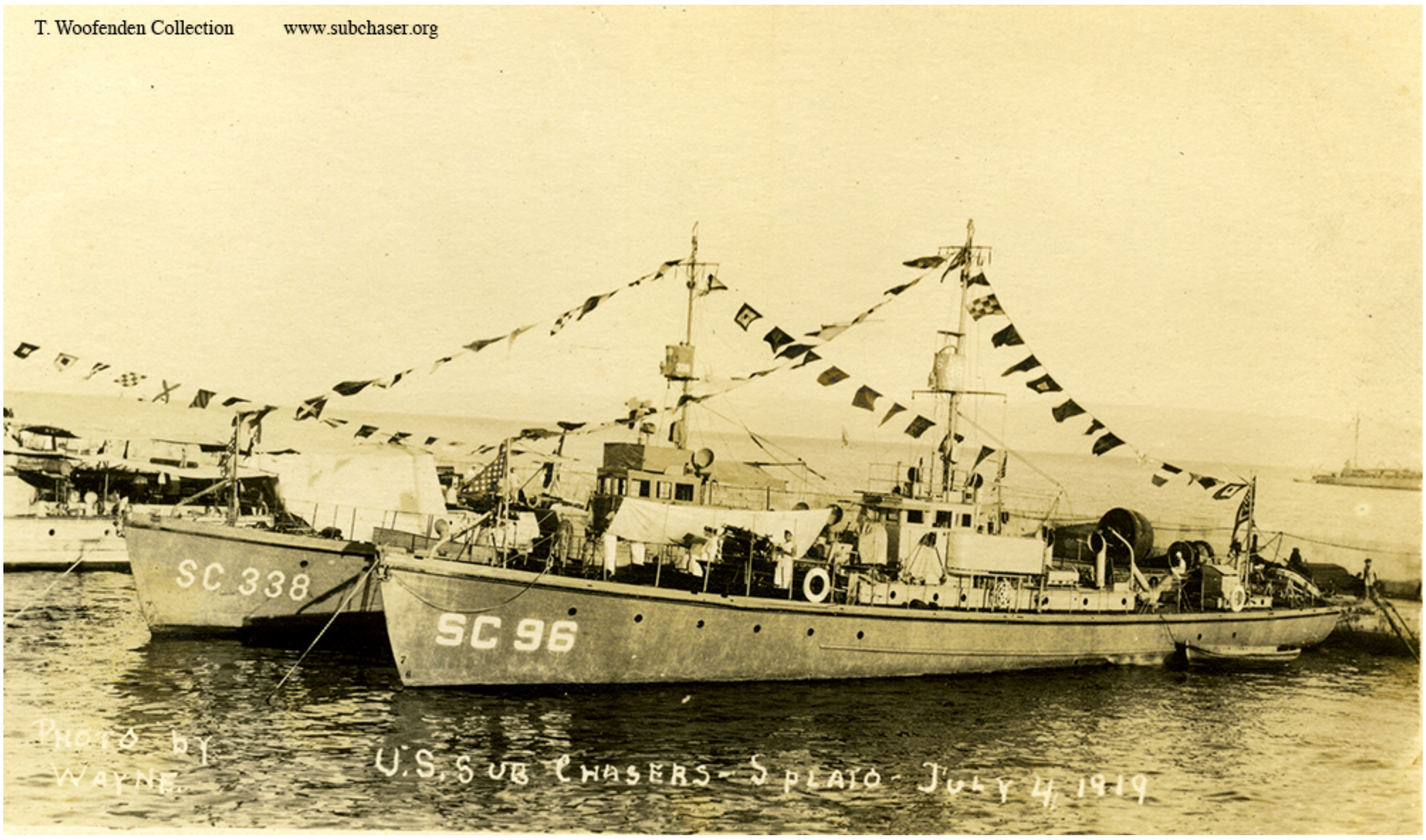
Submarine chaser SC 96 served overseas from Base 25, Corfu, Greece, under the command of Ens. P. Springer, USNRF.

This is the hull depicted in the Glencoe chaser model, although the other hull marking depicted in the model -- "AV" -- almost certainly was never used on this chaser.

Shown in the photo set:

Subchasers SC 338 and SC 96 at Spalato (Split), celebrating American Independence Day, July 4, 1919.

Photo Set - click to view large versions:



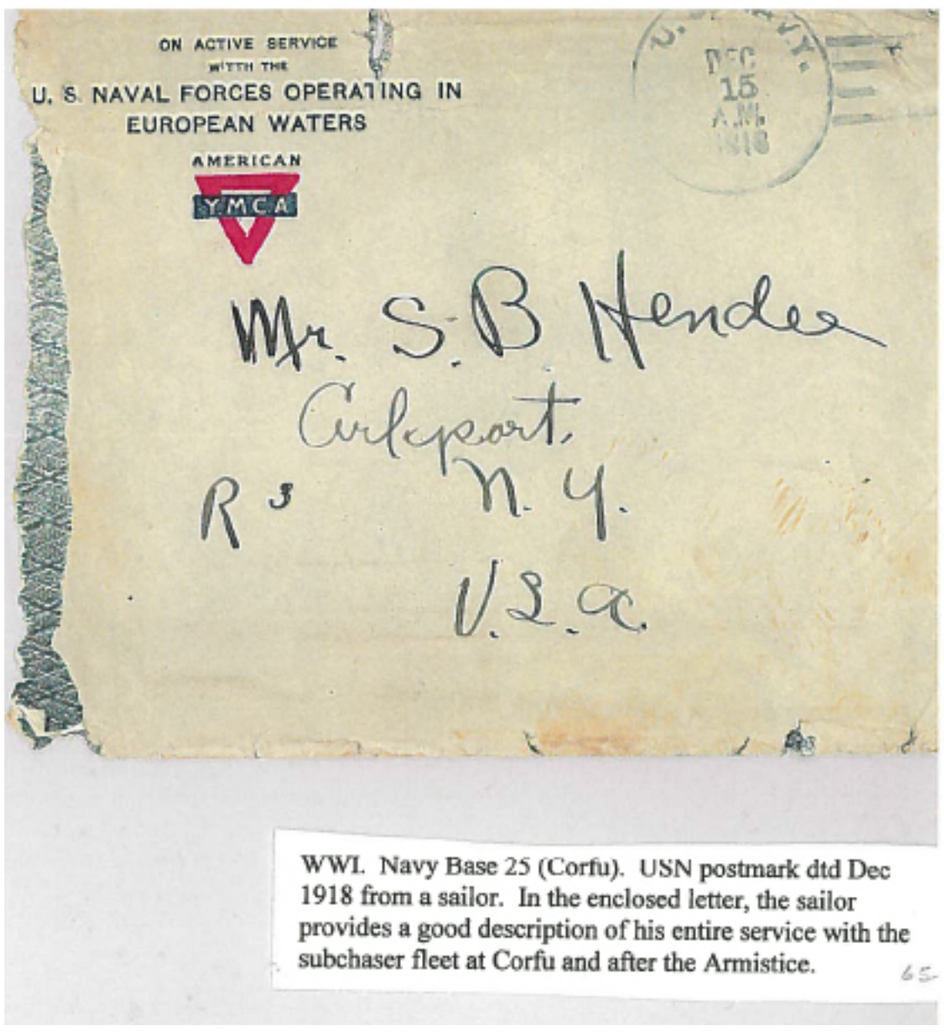
Read more

Daniel K. Hendee Letter - SC 78

Thanks to Doug Webb for submitting scans of this letter written by SC 78 crewman Daniel K. Hendee, to his family.

Hendee describes events during the overseas journey, including a periscope sighting off Gibraltar, and enemy planes flying overhead shortly after their arrival at Base 25, Corfu.

Photo Set - click to view large versions:



WWI. Navy Base 25 (Corfu). USN postmark dtd Dec 1918 from a sailor. In the enclosed letter, the sailor provides a good description of his entire service with the subchaser fleet at Corfu and after the Armistice.

D.R.Thursby

Dec 12, 18—

Dear folks at home—

At last we are allowed to write a bit about where we have been during the past 9 months and where we think we are going—tho not there—so stand by.—It was on a Sunday the last day of March that we, 15 strong, including 3 tugs and a light cruiser put out of New London, and 4 days later we were tied up in the Magistics Dock yard at Irelands Island in the Bermudas. Oh but it was rough the first two day. And you may well imagine that the green islands and the warm climate well paid us for our [illegible] stomachs. We didn't get a chance to see much of the place and we were not quite ready to leave on a Sunday, two weeks from the day we left New London

Here in Bermuda we picked up some more chaps that left New London, a few more ships and a supply ship with fuel gasoline and stores. making a convoy of 37 strong. and on April 27 after 12 & 12 nights of steady chugging by our 4 cylinder standard engine. which we got to notice only when they stopped. and they did occasionally we tied up in the harbor of Ponta Delgada on the island of St. Michael in the Azores. and we were a dirty and hungry bunch. The natives had only a flourishing business in Pineapples & oranges of which there were plenty. we also found a restaurant called the U.S Restaurant. Here we could get steak eggs and shawbacks for a moderate price. You may well believe this place was well patronized the natives sure gave us the glad hand. partly on account of our belief of us spending money in circulation and partly for the credit of a U.S

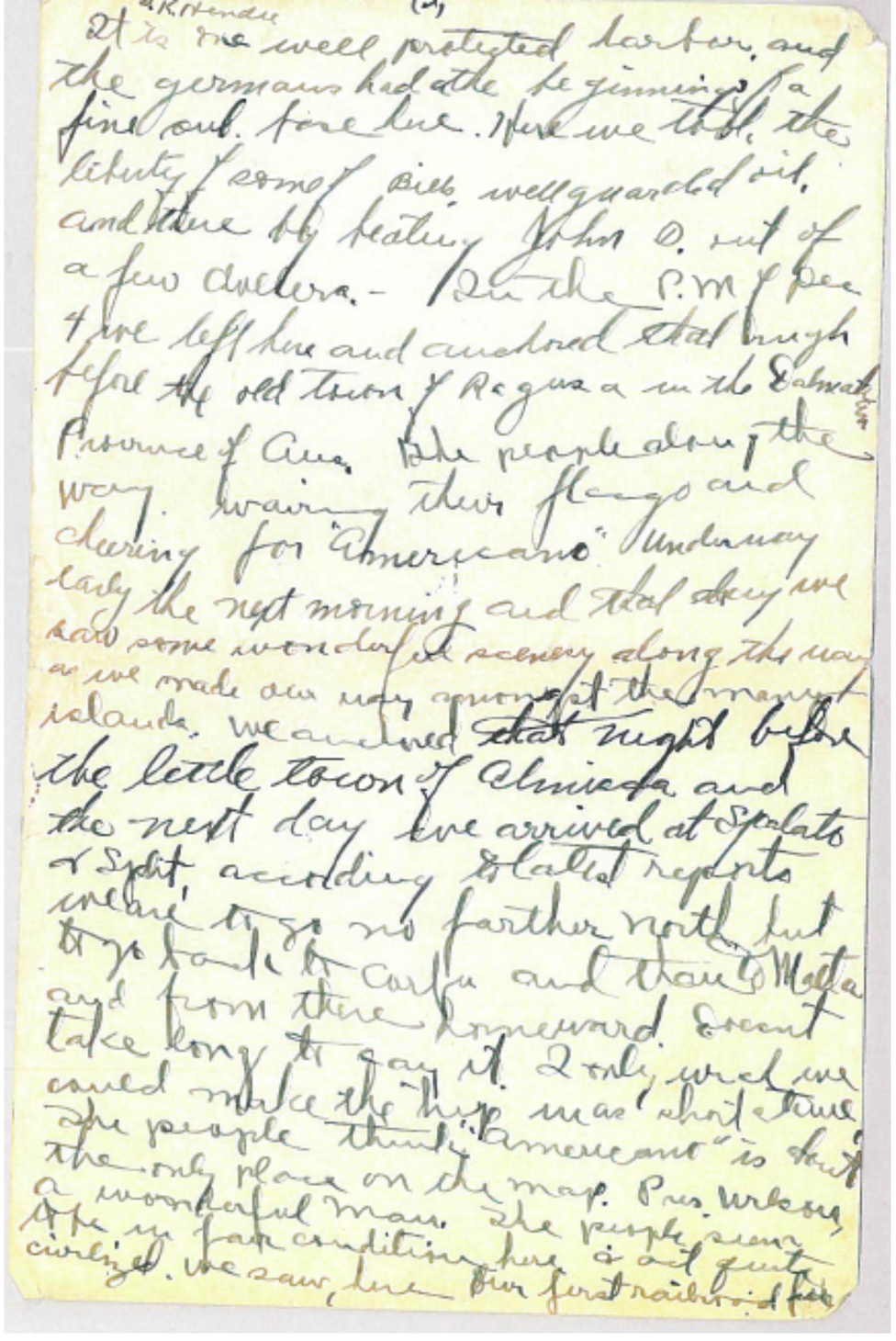
Collier that had previously driven
off a german submarine that
was shelling the Toconi. Here
in port a Delgada we found the
Leondas and more chasers. — On May
7, 45 strong we started out on
a 700 mile trip. and May 13 we
were tied up under the towering
rock of Gibraltar and all her guns.
According to the reports of some
of the chasers this last trip would
not be called uneventful, for
a periscope was reported as
being seen. one night a couple
of torpedoes were sighted, or a
wake similar to the one of a torpedo
was seen. We lived thru the
fright however and came to port
all safe and sound. The day before
we were preparing to leave here
a couple of subs. were sighted near
Gib, and the chasers were sent
out to hunt. We were on this

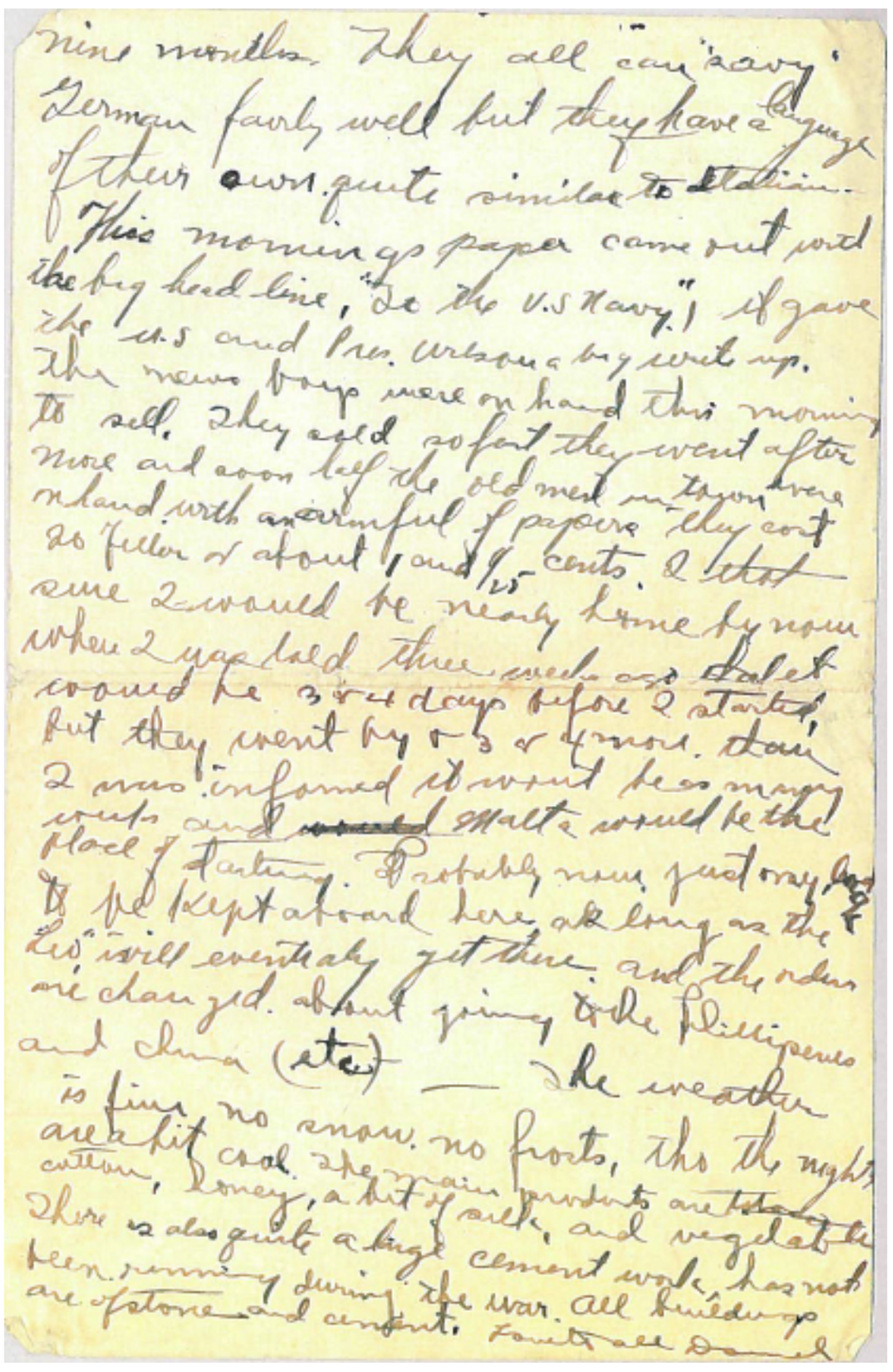
U.S. Navy
trail but being like a young
pup we lacked experience and
lost them that with other traits
to the unit I consider 22, 7 & 8.
did not make a touch. meanwhile
however, was the cause of a submarine
putting into a Spanish port in
a crippled condition, also a signaling
system was discovered, whereby
between some one on the Spanish
shore and the submarines were were
on this hunt for a part of two days
and a night. then we were called
in and prepared for sea again
and the next day we set out for
a rather 6 days trip. On May 25
we were in the harbor of Valetta
of the island of malta. — Here we
went into dry dock and got a general
overhauling for we were going to
a place which had not all the modern
conveniences. on June 2nd 9 chasers
18 included left malta ahead of
the rest of convoy to make ready at
our destination, the coming of
the rest. — On May 4. we left

presented our selves before the city of Corfu on the island of Corfu. Here we were met by a couple of U.S.N officers who had come over land with 9 radio men. So we found our mooring buoys all ready for us in a little bay about 4 miles N of Corfu, latter became known as american bay. The next day 4 austrian planes sailed over Corfu and what was to become the busy base 25. They just came to observe I guess for they dropped nothing and were soon on their way back, midst the bursting shells from the French anti air craft guns, nor they never came again. So here we were with 5000 miles behind us a journey of 45 days and 31 days of actual sailing. On June 4 the fog came in and that which was a desolate point of land with nothing but olive trees and rocks. came to be one of the busiest places, [illegible] a lifetime, this side of Berlin.

[illegible]

No time was lost in sending the chasers out on the barrage, the hunting or fishing place, which was the narrowest place between Italy, Otranto and these islands. Conditions were soon made so warm for the sub. that the hunting trips became monotonous, the hun dared not to run the gauntlet. June the 17th I took my bag and baggage to the Leonidas. and it has been my home ever since. On the night of thanksgiving day we pulled up our mud hooks. set out for Brindisi Italy. most of the chasers had gone before to several town on the eastern shore. We anchored at Brindisi the night of the 29 and the next we started across for Cattaro in Austrian territory but very near the dividing line of Montenegro we anchored in this harbor at two P.M. Dec 1, we stayed here nearly three days. went ashore and visited the people. they all looked [illegible] but war weary and quite pleased





Read more

Hull Number: SC 374

Two photos of submarine chaser C52 (initially SC 374, built at Hiltebrant Dry Dock, Kingston, New York; sold to France) in Paris.

Thanks to Benoît Dehaine for submitting the photo scans to The Subchaser Archives.

Photo Set - click to view large versions:

Read more

Hull Number: SC 201

Submarine chaser SC 201 at Hampton Roads, VA. Collection 2013.65, National WWI Museum.

SC 201 was assigned to the Fifth District (Norfolk), and would have performed patrol duties . This might explain the missing Bearing Indicator; or possibly the boat simply hadn't been fully fitted out, yet. *Thanks to the National WWI Museum for submitting the photo scan to The Subchaser Archives*.

Photo Set - click to view large versions:

Read more

Rum Runner: Flor del Mar

Photograph of a subchaser post-war, abandoned and set on fire by rum-runners during Prohibition.

Press photo caption on reverse reads: "The charred converted submarine chaser Flor Del Mar, set afire by escaping crew after the craft was overtaken by the patrol boat Legare in Long Island Sound, at anchor at the Coast Guard Station at New London, Conn. Five coast guardsmen were held following a fight in a rooming house, in which, police say, they admitted that the liquor drunk at the place was stolen from the craft's cargo." Datestamp is 12/21/29.

Photo Set - click to view large versions:

Read more

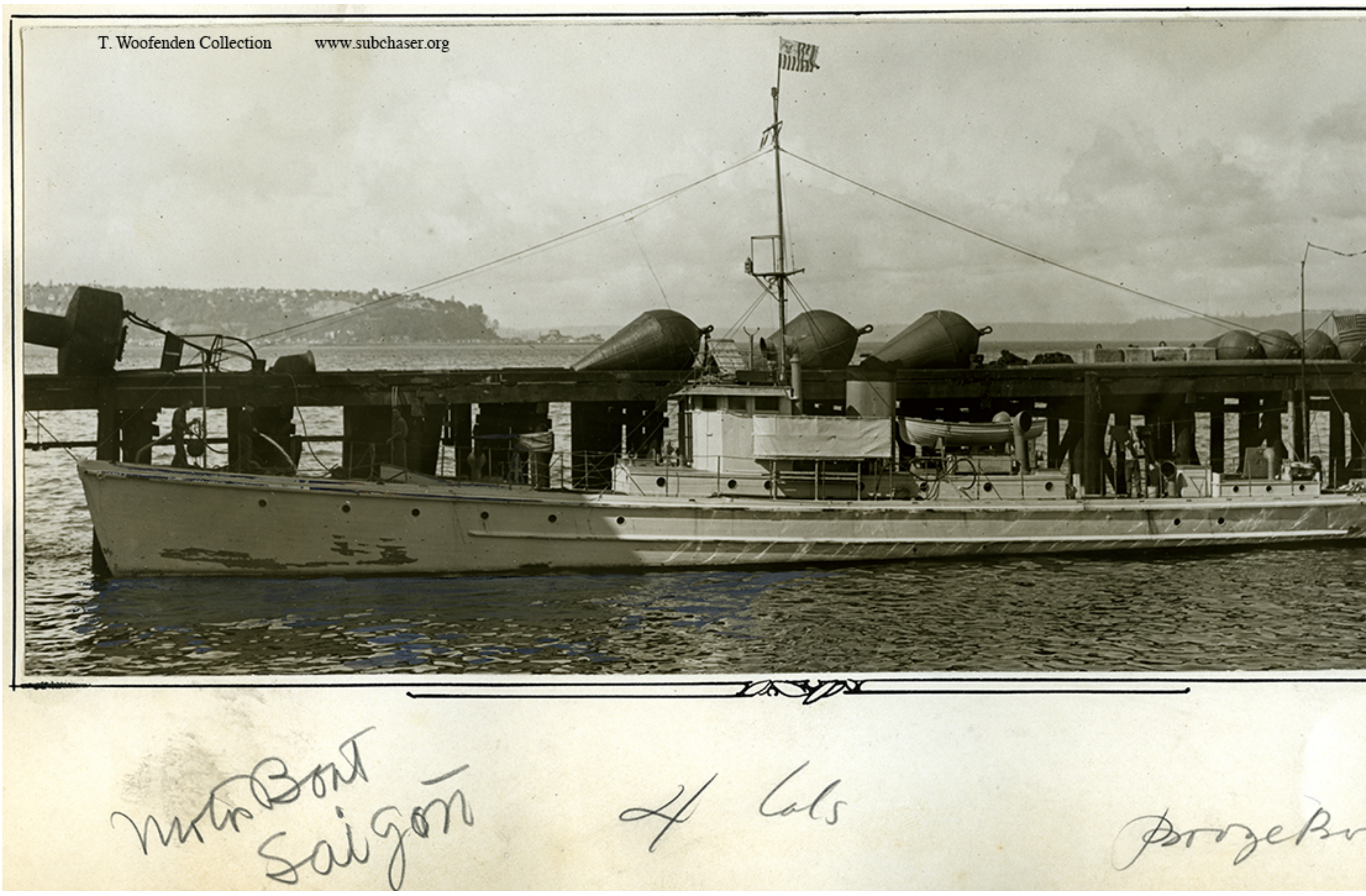
Hull Number: SC 335

A post-war photograph of a submarine chaser, as the Coast Guard cutter *Cygan*. T. Woofenden Collection.

A date stamp on the back reads, May 9, 1923, and a newspaper article attached to the back of the photo (unattributed) reads:

> Latest addition to the local Coast Guard fleet, and specially designated to the work of chasing liquor smugglers, the subchaser Saigon arrived in Elliot Bay last night and today was being overhauled at her moorings at the Bell Street Terminal of the Port Commission.

Photo Set - click to view large versions:



Read more

Battle Formation

Photo captioned "Battle Formation of Sub-Chasers" -- although the chasers appear to be moving in column formation, which would be for regular travel. The most typical hunt formation was three chaser units moving abreast.

Photo Set - click to view large versions:

T. Woofenden Collection www.subchaser.org

Read more

« first ‹ previous 1 2 3 **4** 5 6 7 8 9 … next › last »

Share Tweet Share Email Pin G+

About This Site | Submissions | Signal Light Books | Contact Us | Monthly Newsletter

Search

Subscribe to *The Subchaser Archives Notes*, the mothly newsletter of The Subchaser Archive. Sign up.