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WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

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Reference No. 53-13

6 MILITARY DEFENSE OCEANOGRAPHY
conducted during the period
October 1, 1952 - December 31, 1952

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9 Periodic Status Report, 1 Oct - 31 Dec 52.
Submitted to Geophysics Branch, Office of Naval Research
Under Contract Nonr-769(00)(NR-083-069)

11 February 1953

APPROVED FOR DISTRIBUTION

[Signature]
Director

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JOB

The Contractor shall furnish the necessary personnel and facilities for and, in accordance with any instructions issued by the Scientific Officer or his authorized representative, shall conduct research studies on military oceanography in the Atlantic. This work shall include, but not necessarily be limited to, the following:

- (1) a study of subsurface warfare;
- (2) a study of amphibious warfare;
- (3) field laboratory liaison;
- (4) studies of problems pertaining to automatic instruments for recording and telemetering oceanographic data;
- (5) air-sea rescue studies and instrumentation;
- (6) development of underwater photography techniques.

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INTRODUCTION

The following reports for the final quarter of the year covering five projects under Military Defense Oceanography (Contract Nonr-769(00)) are submitted for record.

The development of two main objectives in the underwater camera work during the quarter were (a) the multi-flash tripod camera and (b) the catalog of bottom types. One member of the group was absent on a special assignment at the request of the Office of Naval Research.

The search and rescue buoy was subjected to its first transmission tests, its signals being recorded by an air plane. Beginning with the new year the work should enter a new and, perhaps, a more interesting field test stage.

The field laboratory liaison was more active during the quarter than usual. The sea trip of one of our staff on a submarine and the visit of two other members to the Key West Naval Base were conducive to a better understanding of field sonar problems.

The PBY-6A air plane on loan from the Navy was utilized on several projects. The tracking of a dry, cold air mass, and its changing character as it moved out eastward across the shelf to Bermuda, was probably the most spectacular and interesting operation.

The nature and scope of the development of automatic telemetering equipment is such that progress from quarter to quarter proceeds slowly. Tests indicate the soundness of the methods, and miniaturizing will follow when buoy installations are reached.

The largest outlay of funds and manpower during this quarter was devoted to the cruise of our research vessel ATLANTIS bringing back to Woods Hole a large amount of oceanographic data from as far south as Rio de Janeiro. The results are bound to add to our knowledge of subsurface waters where little information is available at this period of the year, and what furthermore will be added to our knowledge of waging successful subsurface warfare.

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UNDERWATER PHOTOGRAPHY

Introduction

During this quarter, Mr. Hammond was engaged in an underwater photographic field survey aboard the U.S.S. SHELDRAKE (AGS-19). His services were used by the Navy during most of October, November, and part of December.

Mr. Owen was busy at the laboratory in Woods Hole during this period, making only one short cruise in Narragansett Bay in December, upon Mr. Hammond's return.

Objectives, Work Accomplished

Except for the pressure-proof housings and a quadrupod assembly to contain the apparatus, the underwater time-lapse movie camera has been essentially completed. Mr. Hoadley is presently working on the assembly and it is hoped that initial tests will be run off the W.H.O.I. dock as soon as the case is completed. The housings will enable the time-lapse camera to operate ultimately in 300 fathoms. A vessel of fair size will be required to handle the complete camera, since it is estimated the total weight will be in the neighborhood of 1,000 pounds.

One fact must be realized in developing a camera that is supposed to record the transportation of bottom sediments. The water in shallow depths is likely to be prohibitively turbid during periods of fast currents or storms, just when these records would be most valuable. With greater depths, of course, this problem diminishes until, perhaps, at 200 feet, it becomes negligible.

Progress has been made on the assembly of the photographic catalogue of bottom types. Only the exact form of the report has to be decided. Approximately thirty photographs will comprise this report, which will probably be only preliminary. If interest warrants, the approach to this problem will be either broadened or modified.

Dr. William S. Butcher has lent his assistance in this project, and has suggested the following outline on which the catalogue might be based:

Underwater sound is scattered by

1. Roughness of surface of bottom sediments, varying with
 - a. grain size directly
 - b. blanketing by fine sediment
 - c. mass obstacles
 - (1) linear structures--ripples, etc.
 - (2) non-linear structures--pockmarks, borings.
 - d. gross slope changes; i.e., continental shelf slope.
2. Non-sedimentary structures
 - a. Benthos
 - (1) botanical growth
 - (a) zoological growth
 - b. Nekton--fish

Development and construction of camera and diving equipment. We plan to construct a deeper (3,000 fathom, plus) pressure case for the stereoscopic underwater camera and electronic flash light, incorporating perhaps a rectangular window which will not restrict the view of the two lenses. The Rolleidoscope camera used has proved very satisfactory and we have purchased a spare.

The repeating electronic flash camera, firing at 45-second intervals to 5,000 feet, has been further improved. In addition to making changes in the electronic circuit, more dependable wet cell batteries have been substituted, enabling operation for about four to five hours. For longer periods of operation at the expense of convenience, a separate battery case for a still larger battery has been built.

We hope to eventually develop a repeating camera which could be successfully used in 3,000 or more fathoms. The problem to overcome concerns a way of knowing the location of the camera in relation to the sea bottom to an accuracy of only a few feet. At the present time, it is practical to make only one exposure per lowering at this great depth.

A single-shot non-stereoscopic camera, capable of descending to 3,000 fathoms, with either electronic or flash bulb light source, is almost completed. The camera is an improvement over the original Ewing Argoflex camera and is intended to help build a reserve of underwater cameras at W.H.O.I. The design may be duplicated with greater ease than the forerunner. Our last camera of the original Ewing type was lost from the U.S.S. SHELDRAKE.

Experiments are being made with relatively small dry battery powered electronic flash units which may entirely eliminate the use of ordinary flash bulbs in our underwater photography, except in case of equipment failure.

The need is becoming greater for an underwater camera of practical design which will take reasonably clear photographs in turbid water. To a certain extent, a wide angle lens camera may be placed close to the sea bottom in fairly dirty water, but much photography should be done where the Secchi disk reading may be only a few inches, or less. One method, used with some success by the Fenjohn Underwater Photo and Equipment Company, consists of placing a glass-bottomed tank of clear water (piped from the surface) in front of the camera window.

The Institution has purchased and received delivery of the new German Robot Star underwater camera, which was ordered last June. This fills the need for a hand camera which an aqua-lung diver may take down to 100 feet. Fifty-five exposures and focussing and f-stop adjustments can be made by the diver without returning to the surface. We hope to accomplish much of our shallow water photography with the Robot, where the suspended cameras shoot "blind". A Weston Master II light meter has been enclosed in an aluminum and lucite box, and flash will eventually be used where natural illumination is insufficient.

A pressure-proof housing has been made for the aqua-lung diver's watch, which is one safety measure in judging the amount of air remaining in the bottle.

Navy aqua-lung training. On December 13, Commander F. D. Fane, Underwater Demolition Unit One, visited W.H.O.I. to discuss mutual interests in shallow water photography, and guidance in a training program for W.H.O.I. personnel in the expert use of the aqua-lung.

Commander Fane advised us to go ahead on the possibility of attending the Little Creek Center, which is closer and has the advantage of learning in the Virgin Islands. In any case,

he would be pleased to offer training with him at Coronado or Hawaii.

Also, arrangements are being made to attend the submarine escape training tank in New London, Connecticut, in order to familiarize some members of the project even further with this medium and its problems, both physiological and psychological.

The following are people involved full or part time under this contract in underwater photography during this quarter:

David M. Owen	Research Assist. in Oceanography
Willis T. Hammond	" " " "
Lloyd D. Hoadley	" Assoc. " Engineering

Publications and Reports

Reference No. 52-91, Hydrographic Survey of the Boston Area, Bottom Photography (Cont'd.), by Wm. S. Butcher, D. M. Owen, and W. T. Hammond. November 1952. (Confidential).

AIR-SEA RESCUE STUDIES AND INSTRUMENTATION

Objectives

The chief aims of the O.N.R. buoy development work this quarter have been to design an improved transmitter circuit based on the new Raytheon CK-6147 tubes, to obtain maximum range tests of buoy signals from this type of transmitter, and to arrive at more definite electronic specifications essential for furthering the design of the complete buoy assembly.

Work and Accomplishments

Having had repeated failures and burnouts of the standard UHF tubes used in the first two transmitter models built at W.H.O.I., the project obtained in October 1952 an order of the new Raytheon CK-6147 tubes, and a new circuit employing the latter tubes exclusively was presently constructed. This third transmitter model represents an appreciable increase in operating efficiency and has allowed the elimination of one stage of radio frequency amplification. To date the new tubes have given excellent results.

After making thorough sensitivity tests of the PBY's recently installed AN/ARC-27 radio equipment, we began tests of the buoy's new transmitter as received by this plane. In the first flights no signals were received by the PBY owing to a very slight frequency difference between the signals and air-borne receiver when set at 243 megacycles. It seemed almost certain that the crystals used in the buoy's transmitter were at fault.

The manufacturer of these crystals (James Knight Company of Sandwich, Illinois) was consulted and confirmed our belief, based on the preceding quarter's experience, that precise frequency operation with overtone crystals is much affected by circuit type and values. The company recommended a specific oscillator design, one which had been perfected after many months' work for a Signal Corps transmitter and caused least frequency change of the crystal. They informed us that their manufacturing technique was capable of producing highly satisfactory crystals for this design.

It was decided to place an order for a number of these special crystals anticipating adoption of the recommended circuit. A subsequent change to this type of oscillator design for the O.N.R. buoy transmitter has proved encouraging. Using this oscillator and one of the recommended crystals already on hand, it was found that the buoy signals could be transmitted exactly on the frequency required by the PBY's receiver.

As this resolution of our difficulties was not reached until mid-December, we have been able to make during this quarter only two of the flight tests needed to establish typical ranges of the buoy transmitter under several sea states as received by the plane at different altitudes. And other work involving buoy transmissions and the plane's AN/ARC-27 has had to be postponed to the new year.

On 29 December 1952 the first range results were secured. The transmitter buoy was set adrift in Buzzards Bay near Cleveland Ledge Lighthouse. The PBY flew over the buoy and proceeded on a straight course for Point Judith, permitting a clear, over-water path for signal reception. On this flight an altitude of 600 feet was maintained for 12 miles when the signal became faint. The plane then went to 1,000 feet and held the signal until 20 miles from the buoy. Climbing to 5,000 feet, the plane received the signal well until 28 miles from the buoy, but at 36 miles it could still be heard. Sea conditions were slight during this test. On the following day in moderate seas in the same area substantially the same results were obtained from the buoy. Experimental work was begun at this time to develop a satisfactory method of recording.

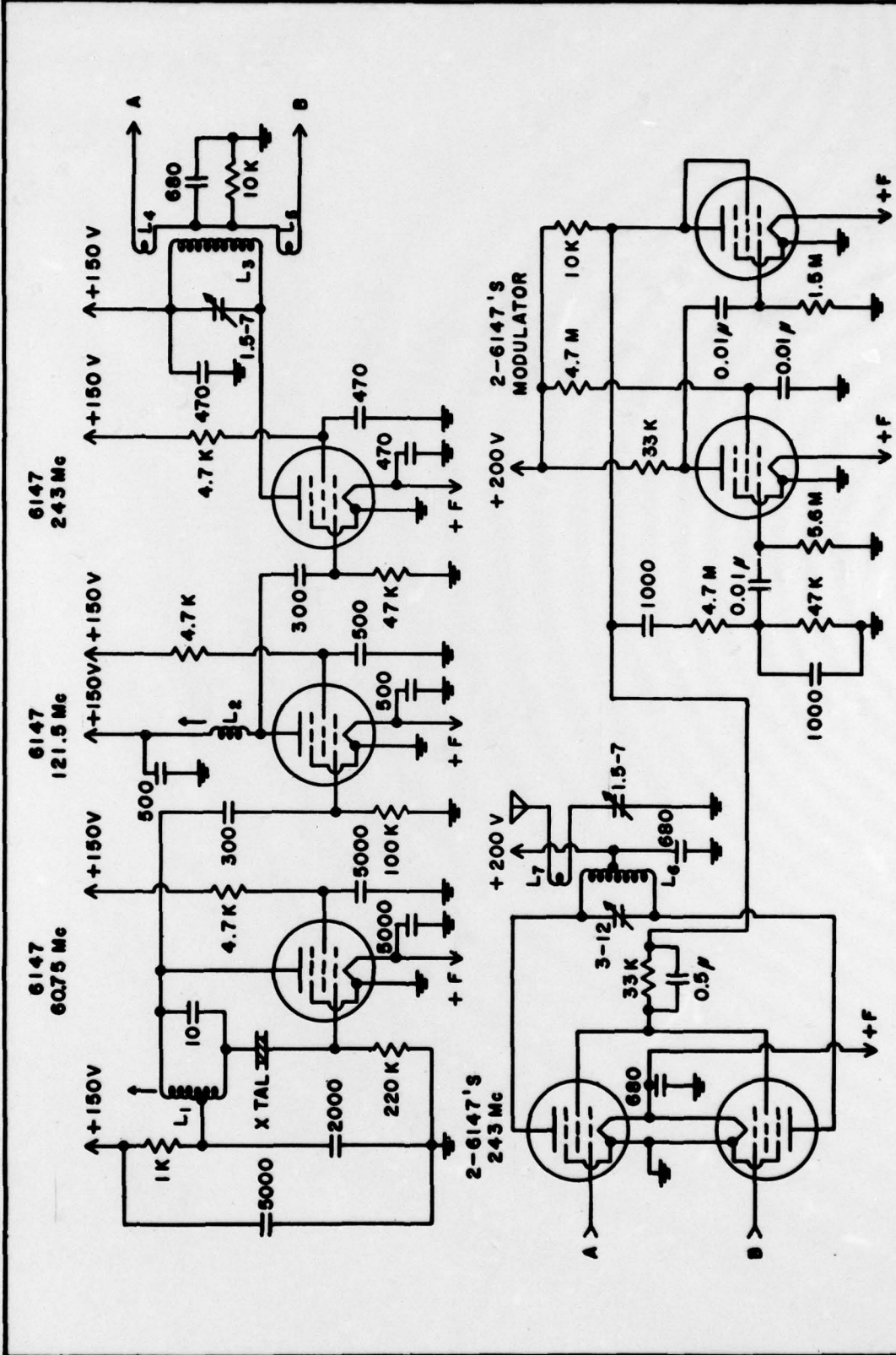
A circuit diagram of the present transmitter is reproduced here. It is based on the new CK-6147 tubes. The crystal oscillator circuit is a modified Hartley design with a series-type, crystal feed-back path. Modulation is of the clamp-tube type, with one section of the oscillator being used as the clamp tube. This system of modulation represents an economy of power required by the modulators, as well as a decrease in weight through the elimination of transformers. The power output is 100 milliwatts at 243 megacycles 60% modulated at 600 cycles.

Tests of new communications and locating aids. In reference to the over-water series of high-frequency radio propagation tests of a simulated Crash Locator Beacon desired by the Wright Air Development Center, our Institution has now submitted, as requested, a proposal for providing facilities for this work in local Massachusetts waters during June 1953. The equipment to be tested is classified as "Restricted".

Through the courtesy of certain naval officials the project leader recently had the privilege of witnessing tests of instruments developed for purposes rather similar to those of the search and rescue beacon being undertaken at Woods Hole. Notes on the subject equipment and tests are summarized here for what informational value they may have for the Office of Naval Research.

During September-October 1952, a series of tests were made at the Naval Air Test Center, Patuxent River, Maryland, of the unclassified "Radio Rescue Beacon" and associated receiving-homing equipment developed by a British company, Ultra Electric Ltd. of London. A somewhat detailed description of this locating system as it had been developed by the autumn of 1951 was included in our Periodic Status Report No. 3 (W.H.O.I. Ref. No. 52-18).

The operating frequency of the British beacon has recently been changed to 243 megacycles and a two-way voice communication facility has been added, making the weight of the unit 2 pounds 9 ounces. The power source is Ruben Mallory mercury cells, providing 20 hours' operating life for beacon signal and about 15 hours for speech. Unlike the Navy's AN/PRC-17 (the new emergency transceiver issued for life-raft use), the British beacon signals cannot be utilized by the Navy's new radio receiving and homing instruments (AN/ARC-27 and AN/ARA-25), but require installation of additional antennae, wiring, and specialized instruments on the search plane or vessel. However, in a number of clearly important respects the British system and equipment have definite advantages over the AN/PRC-17, while the much smaller and lighter British beacon can be



CIRCUIT DIAGRAM OF UHF SUB-MINIATURE TRANSMITTER USING NO. 6147 TUBES

3RD INSTRUMENT BUILT OCTOBER-DECEMBER 1952
 AT WOODS HOLE OCEANOGRAPHIC INSTITUTION

CONTRACT Nonr - 769 (00)

O.N.R. DISTRESS BUOY PROJECT

worn as an item of personal equipment (for attachment to life-jacket) or supplied simply as an item of life-raft equipment.

Since the ranges obtained on the particular flight tests observed by Mr. Pingree of W.H.O.I. do not seem to be fairly representative of the average performance of the British equipment, the reader is referred to the complete Pawtuxent test data in an official BuAer report to be published in 1953. However, it may now be noted that the over-water ranges commonly obtainable with the Ultra beacon are much superior to those which can be achieved with the AN/PRC-17, while the visual presentation of the information needed for homing on the British beacon, as well as the degree of homing accuracy permitted by the British system, are outstanding features. As now designed, both the British equipment and the AN/PRC-17 depend for their emergency use on conscious survivors and their rational, timely participation.

Future Plans

During the coming quarter a series of flight tests will be needed to establish typical ranges for the transmitter under differing weather and sea conditions, as well as to determine the antenna pattern and check further the effect of the new type of pneumatic gear and case on transmission. It is hoped that the results of these tests plus some special work on keyer and oscillator will enable us to bring the development of the transmitter unit to a close. When any final revisions of the transmitter have been made, it will then be worth while to secure the most compact, effective arrangement of its components.

With transmitter reduced to minimum bulk and weight, and with power requirements and best power source established, it then becomes possible to undertake the design and construction of a prototype buoy assembly. To date much of the mechanical engineering work has necessarily been exploratory or tentative, and it seems probable that several months will be needed to achieve the desired results in terms of the concepts and features which are now indicated. With a first prototype buoy proven satisfactory for sea use, the equipment will then require drop tests.

FIELD LABORATORY LIAISON

Objectives

The purpose of field liaison is to bring the research and development work being carried on for the Navy at Woods Hole into closer relationship with naval operating units through the means of visits of our staff members to such commands. This work has been extended to the assignment of Woods Hole personnel to act as consultants and advisors on certain high-priority field work for the Navy, or other organizations working for the Government. The costs are almost wholly confined to transportation.

Work and Accomplishments

Mr. W. E. Schevill and R. H. Backus, Research Associates in Oceanography, in November attended the Gulf and Caribbean Fisheries Institute meetings in Miami, Florida. The purpose of attendance was to learn to what extent, and with what results, commercial and Government fisheries agencies are making use of sound equipment as an aid in the capture of fishes and in fisheries research. Preliminary evaluation suggested that this country is less active than Europe in the use of sound equipment for this purpose.

At Key West, Florida, Mr. Schevill and Mr. Backus visited VX-1, SurAsDevDet, Fleet Sonar School, and Submarine Squadrons FOUR and TWELVE. At SurAsDevDet, Captain Momm and Lieutenant Tyler discussed sonar problems and arranged for a visit to U.S.S. WILKIE (EDE-800). At VX-1, profitable time was spent discussing air-borne and submarine sonar in general, and target classification in particular, with Lieutenant Commander W. G. Stearns, Lieutenant G. I. Dumas, and Lieutenant Bruce Weart. A demonstration trip in a helicopter proved very interesting.

At the Fleet Sonar School, Commander J. R. English, Lieutenant Commander C. E. Miller, and Lieutenant P. W. Michaels discussed the problems of sonar targets and their classification. Noted was the great progress which is being made in this subject. Of particular interest was a draft manual for sonar men which has been prepared by Lieutenant Commander Miller.

During the months of November and December, the Institution furnished a staff member, Mr. Hammond, who was trained in the use of the underwater camera, to demonstrate the use

of the camera actually in the field and to train naval personnel in the use of the underwater camera. Mr. Hammond participated in Project JEZEBEL, making underwater photographs and assisted in giving instruction both in underwater photography and bottom coring to other members of the expedition.

Also in November, a member of the Woods Hole staff accompanied a submarine group when it carried out, among other exercises, certain acoustic field investigations in the North Atlantic. During this period, opportunities were accorded for exchange of information of technical nature between the research laboratory and operational naval personnel. The technical reports of this research are being reported and charged under the appropriate naval contract.

OPERATION OF AIRCRAFT IN OCEANOGRAPHIC RESEARCH

Objectives

The PBY aircraft during this quarter was utilized to a high degree, with its time being distributed among various projects.

Work Accomplished

In October the plane was used to make a thermal survey of the Gulf Stream in the vicinity of Cape Hatteras. During November, flight tests were made of automatic radio transmitter buoys in the Buzzards Bay area, and the tracking of the northern edge of the Gulf Stream south of New York by means of an air-borne radiation recorder.

The first of a series of flights in a Polar-Canadian air mass was initiated in late November when the PBY followed just behind a cold front from Woods Hole to Bermuda. The excellent results obtained from this flight are being reported under Contract N6onr-27702.

In December, a British-built air-borne sea and swell recorder was installed in the plane, and preparations were made to commence evaluation tests early in January.

AUTOMATIC INSTRUMENTS FOR RECORDING AND
TELEMETERING DATA

Unattended instruments (radio-ranging buoys). The circuit for the phase-difference radio-ranging link to be used with freely drifting buoys has been reconstructed for further tests. It is noted that this more finished version of the circuit operates with a more favorable signal-to-noise ratio, and for that reason triggers more reliably when interrogated. This present apparatus has not been miniaturized for adaptation to the dimensions of a buoy capsule, nor has power consumption been a major concern. Both considerations have been kept in mind, however, and it is believed that miniaturization can be accomplished and power requirements met in straightforward ways. There may be continuing uses for the existing 110 volt, 60 cycle apparatus in connection with two-ship or ship-aircraft operations in which the position of one with respect to the other is of importance.

The problems of transmitting oceanographic data in code and by means of timed CW tones are being studied, as are the problems of separately triggering and identifying each of several buoys in a field. While there are many methods possible, attention is given only to those which will be relatively unaffected by noise or chance signals on the interrogation frequency.

OCEANOGRAPHIC STUDY OF SUBSURFACE AND
AMPHIBIOUS WARFARE

The ATLANTIS Cruise #181 from Rio de Janeiro, Brazil, to Woods Hole, covered a total distance of 7,200 nautical miles. A study was made of the Brazil Current between Rio de Janeiro and Recife. Fourteen sections were made across the Guiana Current on the leg from Recife, Brazil, to Port of Spain, Trinidad. One section was made across the eastern end of the Antilles Current and four stations were occupied in the deep western basin of the North Atlantic south of Bermuda.

Bathythermograph observations were made hourly generally to a depth of about 800 feet. These data fill in an important gap in our over-all distribution of observations in the North Atlantic. The instruments used were in poor shape, so that a careful check of the data and recalibration of the instruments will be necessary before the bathythermograms are processed. These data showed that in the area off the coast of South

America between Rio and Recife there are no major temperature changes such as are found in the Gulf Stream System in comparable northern latitudes. Insofar as such data can be used to indicate the current pattern, they did show numerous relatively weak currents and countercurrents in this region. In the Guiana Current area along the northeastern coast of South America, the most striking feature of the bathythermograph data was the stratification within the thermocline layer as indicated by step-like traces. This same phenomena was observed during the trade wind cruise of last spring. After the bathythermograms from this cruise are processed a chart of the temperatures at a depth of 200 meters in the North Atlantic will be produced.

Sixty-eight stations were occupied on the cruise where temperature, salinity, oxygen, and phosphate samples were obtained by the Nansen bottle method. On eighteen of the stations total phosphate and total nitrate samples were taken, where the depth of the sea permitted all stations went to over 2,000 meters. Nineteen stations were to depths over 3,000 meters; the deepest cast made went to 5,460 meters. One bottle and two thermometers were lost when they struck bottom. In general the gear worked well though some difficulty was caused by the mercury sticking in several unprotected thermometers. These station data fill a gap in our knowledge of the density and chemical structure of the Atlantic especially in the Guiana Current area. Since this current crosses from the southern to the northern hemisphere, variations in the density pattern along its course should be of particular interest. The outstanding feature of the thermal structure in this area is an isothermal layer averaging about 200 meters thick lying beneath the thermocline at depths between 10 and 15 hundred meters. Occasionally a slight temperature inversion occurred within this layer.

Some fifty observations were made with the geomagnetic electrokinetograph on the first leg of the cruise. Sponge rubber floats were attached along the cable in order to keep both electrodes at the surface of the water. The action of the floats appeared satisfactory but where a float was situated within a few inches of the after electrode the bending action was too abrupt and broke the cable. On several occasions pieces were torn out of the floats by fish. Attempts to repair the cables and electrodes were unsuccessful and after two observations north of Recife the instrument was secured. The observations obtained south of Recife showed a series of relatively weak currents and countercurrents.

Unfortunately, the new pitometer which was shipped to Rio was not tested and put into working order until after the G.E.K.

was secured. Navigational evidence was used to determine the direction of the surface currents and then the pitometer was towed upstream. The wire angle which developed, in the horizontal plane, frequently indicated a change in current direction with depth. At one station the direction of the surface current was extremely doubtful so the pitometer was towed in a large circle, the ship changing course 15° every five minutes. All these observations were made in the Guiana Current area. The results are not satisfactory but time did not permit more extensive work with the instrument.

Because of the failure of the trawl winch only one bottom core was obtained on the first leg of the cruise. The winch was repaired in Recife and nine cores were obtained during the remainder of the cruise, six in the Guiana Current area and three in the deep basin south of Bermuda. Except for the one failure of the winch the equipment worked well. Some difficulty was experienced in determining when the bottom was reached on those occasions when the tension change was damped by the Carbon 14 sampling can.

Three samples of bottom water, for Carbon 14 analysis, were brought to the surface. In each case the sampling can was leaking. Twice the clamp at the bottom of the can was torn loose. On two other occasions the can failed to close.

Throughout the cruise the ENM with the hull-mounted sounder and the EDO with the towed sounder were in operation. On numerous occasions there appeared to be more than a fifty-fathom difference in the records obtained by the two instruments. On various occasions one or the other instrument was undergoing repairs. These data have been turned over to the Lamont Geological Laboratory which will in turn pass them to the U. S. Navy Hydrographic Office. The only unusual feature noted on the cruise was a 45-fathom bank discovered at $22^{\circ}25'$ south, $37^{\circ}35'$ west. The charts used aboard ship indicated depths of 2,000 fathoms at this place. The ATLANTIS made two traverses of the bank and a bottom sample of coral was obtained.

After Recife, SOFAR bombs were dropped at regular intervals until the ship reached Bermuda.