AVAL RESEARCH

REVIEWS

VEMBER 1966

20th Year on the Frontier of Science

Ocean Wave and Current Generator Under Development for Classroom Use

A new training aid that will simulate waves, currents, tides, and other ocean surface and subsurface phenomena is being developed for use in classrooms for the Naval Training Device Center, Orlando, Florida. The training aid, called "Ocean Wave and Current Generator," will consist essentially of a glass-sided water tank, 13-1/2 feet long, 7 feet 9 inches wide, and 9 feet 7 inches high. A large, tiltable mirror mounted above the tank will enable students to study both surface and subsurface water action from a single viewing point.

Other important features of the training aid will be a wave generator and a control system by means of which an instructor can modify the phenomena he is demonstrating. These features will permit the generation, shaping, and damping of waves up to a scale height of 50 feet, the introduction of currents and tides, and the regulation of water temperature. The training aid is being designed also for operation in conjunction with various topographic models, such as of coasts, beaches, continental shelves, seamounts, and atolls, as well as with models of man-made structures, such as docks, piers, towers, and ships. The accessory equipment will include an insertable channel to be used with beach models to demonstrate water runoff and erosion caused by the surf; and a mobile hopper from which confetti can be dropped into the water to mark the directions of flow of currents. The hopper may be operated also to tow model boats through simulated seas.

A prototype of the Ocean Wave and Current Generator is now being built for NTDC by the National Engineering Science Company, Pasadena, California. The first operational units to be constructed are expected to be made available to such institutions as the Naval Postgraduate School, Naval Academy, and Naval Oceanographic Office.

A Reader for the Blind

Scientists at the Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts, have developed a computer-operated reading machine that converts printed letters to spoken letters. The printed message is inserted into a light-tight box, where it is illuminated by a flying-spot scanner of the type used in television sets. This scanner impinges a ray of light upon the printed letters, the reflections of which are picked up by a photocell that makes 34 "decisions" to describe the outline of the letter; these decisions, referred to as "bits," are forwarded to the computer, where they are compared with stored data. The computer then decides what the letter is and sends the corresponding signal to the audio component of the system, which produces audible tones that a trained hearer can synthesize into words and sentences to reproduce the message.

It is expected that the output of this machine, which is presently 30 letters per minute, will be stepped up to from 90 to 110 letters per minute. Eventually, the optical information will be converted to formants, consonants, and aspirates compounded to simulate the human voice, so that the output will appear as ordinary speech.

This very useful system represents one of the results of two years of research conducted by a team of scientists working on a program sponsored by the Office of Naval Research in cooperation with the Army and Air Force.

The Laser-Patent Controversy—The Story and Its Moral

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Significant scientific advances occur as the result of the probing by highly competent investigators into regions of increasing inventive potential. The breakthrough—that flash of genius which illumines the scientific horizon—requires both high intelligence and the inventive potential of the environment. The flash may startle with its brilliance, but in retrospect it is seldom surprising. The inexorable increase of the inventive potential effected by the persistent efforts of many individuals makes the flash inevitable, if not predictable.

Given the number of investigators in most scientific fields, it is hardly surprising that similar flashes frequently occur virtually simultaneously. When they do, they impose burdens upon a patent system extablished to protect an inventor's right to his concept. Most countries grant the patent monopoly to the first inventor filing a patent application. The United States is one major industrial country that grants the patent to the first inventor. It is relatively easy to determine who is the first to file a patent application, but it is often difficult to determine who is the first inventor. Legal controversies regarding the priority of rights are uncommon in other countries, but they form one of the fountainheads of litigation under the United States patent system.

The United States law provides the following:

> *A person shall be entitled to a patent unless... before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.*

There are two words in this provision that require further explanation. "Conception" means the complete performance of the mental part of the inventive act—the formation in the mind of the inventor of a difinite and permanent idea of the complete invention as it is to be applied in practice.

"Reduction to practice" may be either a "constructive reduction to practice," which is the filing of a patent application in the Patent

Office, or "an actual reduction to practice," which is the construction of a device embodying the invention and the successful operation of that device in the environment in which it is intended to be used.

The reports of the Supreme Court of the United States chronicle the attempts of "second inventors" to claim inventions which proved to be the basis of entire industries. The name of Daniel Drawbaugh is virtually unknown today, but in 1887 his claim of inventorship of the telephone impressed leading financiers of the country to such an extent that a corporation with capital of $5 million was formed to exploit his ideas.* Drawbaugh's attempt to prove priority of invention, although supported by 50 witnesses, failed, and he lapsed into obscurity along with his corporation.

The Laser Case

The basic patent on the incandescent lamp evoked similar argument. Edison was successful in establishing his inventorship, despite the work of Sawyer and Mann and of King and of Fox. Similar stories are associated with the invention of the electromagnetic induction motor (Tesla) and the air brake (Westinghouse). Of more current interest is the controversy over who invented the laser, which was settled on August 4, 1966, by the Court of Customs and Patent Appeals. The court determined that priority of invention was held by Charles H. Townes and Arthur L. Schawlow, who were the first to file a patent application on the device, and it thereby rejected the claim of R. Gordon Gould, who believed that his invention was first in this field.

Besides its obvious interest to the patent attorney and the historian, the laser case is of particular interest to the Navy because the Government had a royalty-free license under Gould's application. In addition, the case is a forceful admonition to researchers to keep laboratory records for patent purposes.

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*As reported in the Supreme Court report, 126 U.S. 1, 548, the following account appeared in the *Cincinnati Commercial*: "Special to the *Cincinnati Commercial,* Washington, D.C., July 21. An application for patent was filed today that in consequence of its vastness of interest as well as wealth of prospect renders it a subject of national interest. A company of leading businessmen has been formed that has bought up all of the telephone patents ante-dating those now in use and known as the Bell, Gray and Edison patents. The company is composed of leading businessmen from all parts of the country, Cincinnati being largely represented and interested. The cash capital of the company is $5,000,000 with headquarters in New York, and in about 60 days they will open up the telephone which will certainly result in the driving out of all telephones in the market save the ones they hold or else compelling the Gray, Bell and Edison Lines to pay the new company a munificent royalty. It appears from the testimony now on file and in the possession of the new company which is conclusive and exhaustive that the inventor of the telephone is a poor mechanic living near Harrisburgh, Pa., named Daniel Drawbaugh. Owing to his poverty he was unable to push his patent on the market. The new company have secured and are sole possessors of this invention ante-dating those now in use."

The facts are that Townes and Schawlow filed a patent application for the laser on July 30, 1958. Gould filed an application on April 6, 1959. The Townes-Schawlow patent was issued on March 22, 1960, shortly after which Gould instituted an interference proceeding to determine priority of invention. Gould had to establish at minimum that (1) he had conceived the invention sometime prior to the filing date of Townes and Schawlow and that (2) he exercised reasonable diligence in reducing the invention to practice commencing from a time just prior to the Townes-Schawlow filing date and extending to his filing date of April 6, 1959. The Court held that Gould failed to prove either a conception or diligence.

The claim which defined the invention in controversy read as follows:

> *A maser generator comprising a chamber having end reflective parallel members and side members, a negative temperature medium disposed within said chamber, and means arranged about said chamber for pumping such medium, said side members being transparent to the pumping energy and transparent to or absorptive of other energy radiated thereat.*

Gould's attempt to prove his conception of the invention was based essentially on nine pages of a notebook which had been witnessed in November 1957 by a notary public. The notary did not read the contents of the notebook and would not have understood them anyway. He testified that he specifically recalled the incident and that the pages were full at the time he signed each page on the margin. The notebook entries did not refer to the peculiar characteristics of the sidewalls of the device. It was essential, as the Townes-Schawlow claim states, that they be "transparent to the pumping energy and transparent to or absorptive of other energies radiated thereat." Gould contended that this was true by necessary implication. The Court held that the pages of Gould's notebook were susceptible to more than one interpretation, each of which was ostensibly plausible, and that the notebook, therefore, did not justify the conclusion that he had made his invention sufficiently plain to enable those skilled in the field to understand it.

Even though the Court felt that Gould's case must necessarily fail on the conception issue, it also discussed his proofs regarding diligence in attempting to reduce his invention to practice. Here, too, Gould introduced testimony of only a general nature. He said that he talked with various persons regarding his invention and gave a statement by his wife that he spent most of his time working on the laser and that he worked three or four times a week making calculations and reading the literature.

Gould relied upon a second notebook for corroboration of his diligence. The book comprised more than 80 pages of description and analysis. It was not dated at every page but was witnessed by a Lawrence A. Willis on August 28, 1958, and Richard Dailey on December 1, 1958. Willis and Dailey did not testify in Gould's behalf. Nor were any other witnesses called upon to establish the authenticity of the signatures or dates. Disregarding the obvious deficiencies in his notebook entries, the Court pointed out that the notebook entries did not prove diligence during the critical period (commencing just before the filing of the patent application by Townes and Schawlow).

The moral of the story is that the value of significant inventions may sometimes be recognized only in retrospect. Therefore, each scientist should maintain complete, contemporaneous records of his work as protection against the day when the value of his work is recognized but his authorship is disputed.

What type of records are most helpful? If the record were solely for the scientist's personal use, the type of entry would be unimportant—it could be in code or in rhyme. However, the judge in a patent case may prove to be an unwilling cryptographer and a severe poetry critic. It would be better to follow a few simple standards in making notebook entries.

Building a Record

Inventors who attempt to work in complete secrecy usually find that the cloak they have drawn about themselves impedes their attempts to prove inventorship. Gould's work was initially shrouded with such secrecy that even his wife (a Ph.D. in biophysics) knew only vaguely what he was attempting to accomplish.

The notebook entries of the inventor often are relied upon to corroborate both the fact and date of the conception. Although the state of the inventor's mind at a particular time is as much a question of fact in a court of law as the state of his digestion, the courts are unwilling to give weight to an uncorroborated testimony concerning the fact of conception. Many reasons, all based on common sense, can be suggested for this rule which prevents the inventor from testifying about the mental picture of the invention which was known only to him. The mental concept must be presented in some tangible and understandable form if the inventor expects sympathetic treatment from the Patent Office or the courts. Several means of doing this exist in patent law and patent lore. In order of decreasing efficacy, they may be categorized as:

- Recording the concept fully and in as much detail as the inventor at the time is able to supply in a bound notebook; having a person with the training and experience to understand the concept read the notebook entries and sign and date each page.

- Describing the invention in a book or on loose sheets of paper and having the description notarized.

- Sending oneself a postcard describing the concept.

Gould chose the second method and was barely successful in having the court accept his entries. When this method of corroboration is relied upon, the description must be as complete as possible. The notary public must be able to testify that he remembers exactly the entries and that the pages submitted as corroboration of conception are exactly the pages he notarized and that, from his own personal recollection, the pages were so full that nothing was interlineated or inserted. Even though a notary public may testify to all of this, the creditability of his testimony will be decreased if the time lapse since the entries were made is long.

Sending a descriptive postcard to oneself is frequently the practice of the lone inventor who hopes to prove the date of the writing by the date of the postmark. However, there is nothing to prevent a person from sending himself a postcard with the message side completely blank to be filled in at a later date. The courts recognize this fact; accordingly, such an attempt at corroboration, however honestly made, is invariably useless.

The preferred mode is to fully describe the concept to a person capable of understanding it and to have that person witness and date the notebook containing a description of the concept. This witness should not be a coinventor or potential coinventor, since the corroboration by one coinventor of another is tantamount to an attempted corroboration by the inventor himself. If Gould had called upon a qualified person to witness his notebook, that person might have questioned him about the type of cavity required, in which case Gould might have said that it was obvious that the sidewalls must be transparent to the pumping energy and nonreflective of other energy radiated at the walls. There is little danger of compromise of the invention if the person witnessing it is friendly to the inventor. In addition, the witness would be dissuaded from attempting to steal the idea of the inventor, since by witnessing the notebook he acknowledges that the inventor communicated the idea to him on the date stated.

Few inventions burst forth from the inventor's brain fully formed, like Athene from the brow of Zeus. The inventor involved in an interference proceeding may therefore be called upon to establish the fact that he acted with diligence in attempting to reduce the invention to practice. He must show that the diligence persisted from sometime prior to the entrance of the opponent into the field until the invention was reduced to practice.

A properly witnessed journal-type record is virtually essential to show that diligence was exercised continuously during the required time span. Gould failed to keep such a record. Instead of a journal, he relied on a summary record. Gould's attorney admitted to the Court:

> *The notebook is not a journal but is rather a summary and a record of extensive analysis from which only the successful results are recorded in the notebook itself. The notebook is not dated at every page. It is known, however, that the first 23 pages were completed by August 28, 1958.*

The Court stated:

> *Exhibit 9 is also wholly insufficient to establish the continuity of activity required for reasonable diligence. The notebook is not adequate corroboration of diligence if it establishes in connection with other testimony* what *Gould did but not* when *he did it. We simply cannot ascertain from the notebook and testimony during what portion of the period from November 1957 to December 1958 the bulk of the work summarized in Exhibit 9 was completed. While we do not depreciate the amount of time complex theoretical work of the sort represented in the notebook might require, the total period of time sought to be blanketed by the notebook is great—on the order of 13 months—and we, like the Board, have no way of satisfying ourselves that unexplained lapses have not occurred.*

It is apparent that Gould wished to make the best record possible by entering in his notebook only the successful results and not those of experiments that failed or were only partially successful. Such selective recording delays the compilation of the record and does not add to the creditability of the notebook. This practice should be avoided. The scientist should also refrain from expressing value judgments in his notes, especially those which deprecate the work conducted. For example, if a test does not yield the result anticipated, only the fact of the result actually obtained should be recorded and not an expression of disappointment that another result was not obtained.

While it is not essential that entries be made in the laboratory notebook at the end of each day, it is obvious that the longer the time that is allowed to lapse between notebook entries, the greater the danger that the entries will not be useful in proving diligence. The Court observed:

> *Merely stating, for example, that he* [Gould] *took off six and one-half days in July, two days in August, and three days in September*

does not enable us to ascertain the extent of time gaps in his activities. The months of July and August bracketing Schawlow's entry into the field are critical to Gould's case and a lapse of nearly two months would result if 6-1/2 days were taken at the start of the period and two days at the end. The party chargeable with diligence must account for the entire period during which diligence is required.

Gould's entries were lacking at exactly the time which, in retrospect, his continuing diligence had to be proved if he was to succeed in his effort to establish priority. Subsequent events often make it essential that an inventor be able to convince the court that he was diligently working on the invention during a specific period, which may be only a matter of months or even weeks. A good laboratory notebook should contain daily, or at least weekly, entries describing the work which has been done on the project during the period covered.

Many inventors familiar with the broad language used by patent attorneys in drafting patent claims feel that to be too specific in the notebook is to prejudice their rights by limiting their invention. This is not so. A detailed record is much more useful than a collection of vague generalities. The patent attorney can be entrusted to draft patent claims commensurate with the scope of the invention and will not necessarily be bound by the specific experiments conducted by the inventor when these experiments indicate to him an invention of great scope.

After providing evidence of diligence and conception, the next and final step to be taken in the courtroom is to prove reduction to practice. Gould relied upon a constructive reduction to practice by filing a patent application. In many instances, the filing of a patent application is the only way an invention can be reduced to practice within a reasonable time. Therefore, when the inventor has sufficient data to prepare an invention disclosure, he should make the disclosure to his patent attorney. The diligence of the patent attorney in preparing the application will be ascribed to the applicant inventor. For example, Gould engaged a patent attorney to file his patent application in December 1958. The application was not filed until April 6, 1959. The Court acknowledged that this time period was reasonable in view of the fact that Gould's attorney was concurrently engaged in a 40-day patent infringement trial. Generally, if an attorney takes up a case in its regular order and prepares and files a patent application, his action in preparing the application will be considered duly diligent. He is not required to take the application out of turn in order to preserve the diligence of the inventor in establishing his constructive reduction to practice.

The reduction of an invention to practice is not a mental step but a "happening." Since it is not something in the mind of the inventor, it is proved in an entirely different manner from the establishment of a conception. The inventor who seeks to prove a reduction to practice by having competent parties witness his notebook describing such a reduction to practice will invariably fail.

The best rule in proving a reduction to practice is simply "seeing is believing." To establish the reduction to practice of a machine, for example, a machine incorporating the ideas of the invention should be constructed and operated in the presence of persons capable of understanding that operation. One should avoid disclosing only the successful result. If the alchemist succeeds in turning lead to gold, he will not convince the court of his reduction to practice by proving that he handed a witness some gold and told him that he had used his secret process to convert it from lead. He would have equally little success if his witness was able to testify that Mr. Alchemist took lead and performed a series of operations on it that resulted in the production of a yellow product which the alchemist said was gold. The way to prove actual reduction to practice of a chemical invention is for the witness to testify from his personal observations that tests were conducted with reactants known to him and that they yielded the results claimed. Although it is essential that the corroborating witness actually see and fully understand the activity purporting to be an actual reduction to practice, the reduction to practice should also be fully and completely described in the laboratory notebook and the signatures of the witnesses obtained. In the event of litigation, this record may be useful in refreshing the memory of those people who may be called upon to corroborate the reduction to practice.

A Cautionary Tale

The record which the Court of Customs and Patent Appeals had to interpret in the laser case was so fragmentary that the court had no alternative but to refuse to speculate concerning the proofs which Gould offered. It is impossible to state whether Gould's failure was caused by faulty record keeping or by the lack of something to insert in the record. Had he been successful in proving his conception, diligence, and reduction to practice, Townes and Schawlow would have had to prove their earlier claim and in the process might have established still earlier dates.

Gould was dubbed the "Candy Store Inventor" by the press—an anachronism, a garret inventor, a solitary investigator who had no sophisticated laboratory equipment at his disposal, no generous research budget, and, in retrospect, no available patent counselor—his sorest want. His failure in the patent contest may have been inevitable; it does not tarnish his skill as a researcher; what it does is provide a cautionary tale for others.

AGOR-14 and -15: First of a New Generation of Research Ships

Two new oceanographic research ships—the first of a new generation of the AGOR (Auxiliary General Oceanographic Research) series—are being built for use by the Scripps Institution of Oceanography and the Woods Hole Oceanographic Institution. The new vessels, which have been designated AGOR-14 and AGOR-15, will be about 245 feet in length, 46 feet at the beam, and have a full-load draft of about 15 feet. Construction of the ships is being supported by the Office of Naval Research.

A major feature of the new AGORs will be a propulsion system consisting of two cycloidal propellers, one located at the bow and the other at the stern. This system, which has been in operation in some European ships for more than 30 years, is being incorporated in oceanographic ships of the United States for the first time in AGOR-14 and -15. The cycloidal propeller consists of a variable number of vertically oriented, circulating blades. The blades can swivel individually in any direction. By changing the orientation of any or all of the blades, the pilot can maneuver the ship in forward, reverse, and sideways directions, or he can hold it in a fixed position, even in winds as high as 35 knots and in very rough seas.

The propellers, which will be the ships' sole source of propulsion, are to be driven by a slow-speed 2500-horsepower engine located amidship. By means of the power generated by this engine, the vessels will be able to maintain a speed of 12 knots over a cruising range of 10,000 miles. Single-lever, or joy-stick, control at the bridge will determine both the direction and magnitude of thrust. Because of the control capability provided by the cycloidal propeller system, a rudder is not required.

Both vessels will be equipped with underwater observation ports and lights, an uncontaminated sea-water circulating and sampling system, small- and medium-size cranes, and a bathythermograph winch. In addition, each ship will have an internal well through which multi-ton transducers can be lowered into the ocean for the study of acoustic transmission phenomena or through which drilling operations can be conducted.

Another major feature of the new ships will be the allowance for laboratory space in accordance with the so-called "optional equipment design concept." Aboard oceanographic ships now in operation, scientists can perform only those tasks that can be accommodated by the ships' permanent laboratory installations. New missions have to be preceded by extensive re-outfitting, which means that valuable time is

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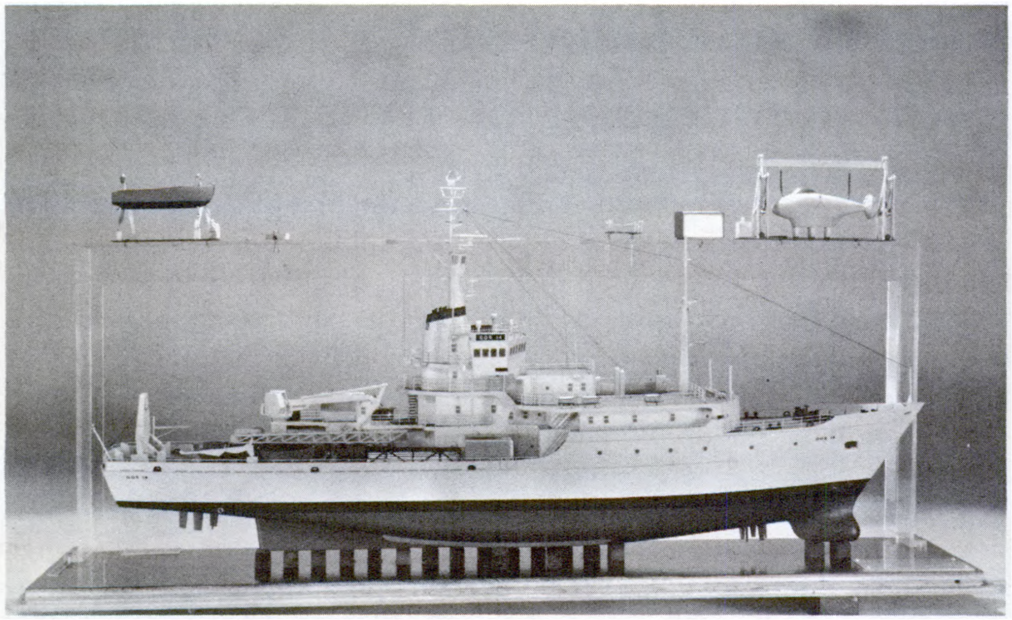
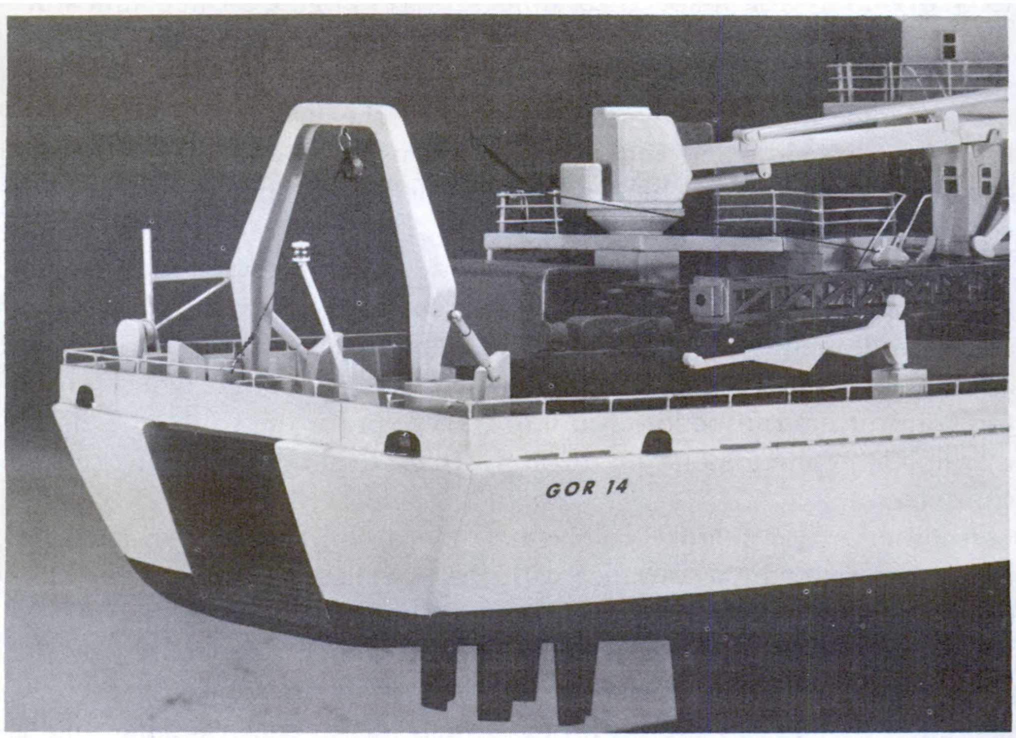


A model of AGOR-14. The vertically oriented cycloidal propeller blades are mounted on the ship's bottom near the bow and stern.

A close-up view of the stern of a model of AGOR-14. The opening and ramp at the stern and the "horseshoe" support above them will be used for loading purposes. The stern cycloidal propellers are in view beneath the ship.



consumed. According to the concept embodied in AGOR-14 and -15, the laboratories will be set up in mobile vans. Scientists will be able to outfit and equip these vans on shore, long before the ship aboard which they are to be installed has arrived in port. When the ship docks, the vans that were in use during the voyage just completed can be removed quickly and the new vans installed, ready for operation, without delay. The variety of laboratories that can be placed aboard the new AGORs is limited only by the number of vans the ships can carry. The experimental capacity of each ship thus will be broadened significantly over that of older research ships.

AGOR-14 and -15 are to be outfitted with special equipment designed to meet certain special requirements of the two institutions which will operate them. AGOR-14, which will be operated by Scripps, will have a winch capable of towing the Institution's Floating Instrument Platform (FLIP) at speeds greater than eight knots. The ship assigned to Woods Hole, AGOR-15, will have equipment capable of transporting and servicing deep-submergence research vehicles, such as ALVIN, the Institution's research submersible. The operations of both FLIP and ALVIN are supported by ONR.

The Defoe Shipbuilding Company of Bay City, Michigan, will build the two AGORs at a cost of $11,764,280. The ships are expected to be operational in 1968. The contract was awarded by the Naval Ship Systems Command.

Magnetoelectric Effect Discovered in Ferromagnetic Crystal

The fundamental magnetic properties of spin-ordered materials are under investigation at NRL. These studies aid in achieving a better understanding of the basic phenomena associated with such materials and provide the necessary prerequisites for many practical applications, such as nonreciprocal microwave ferrite devices (rotators, isolators, limiters), transformers, and computer magnetic cores.

Magnetoelectric (ME) effects, which have been under investigation only since 1960, are somewhat different from the more usual crystalline electrical or magnetic properties. If an ME-active single crystal is introduced to a magnetic field, the crystal will be electrically polarized; and if it is introduced into an electric field, it will be magnetically polarized. These phenomena present the possibility of a new class of circuit elements.

All previous ME experiments in magnetically ordered substances have been confined to chromic oxide and titanium oxide, both of which are antiferromagnetic. Dr. George T. Rado, Head, Magnetism Branch, NRL, has experimented with single crystals of a gallium-iron-oxygen compound ($Ga_{2-x}Fe_xO_3$), which is both ferromagnetic and piezoelectric. The linear effect which he has observed is an order of magnitude greater than any previously reported. He also discovered a non-linear ME effect, unknown in any other material.

In recognition of the research conducted on ME effects by the Magnetism Branch of NRL and the theory that the Branch developed to explain them, the eleventh annual E. O. Hulburt Award of the Naval Research Laboratory was presented, on July 5, to Dr. Rado.

A Defense Against Shark Attacks

Lightweight Screen Developed to Protect Downed Pilots

Since World War II, marine investigators have been searching for ways to prevent attacks by sharks against men who have had to abandon their aircraft, boats, and ships at sea. What has been sought is a device that is effective against all of the two dozen or so species of sharks that are considered dangerous to man. Most of these sharks live in tropical and semitropical waters, including the area of Australia, the West Indies, and South Africa.

In the past, sharks have been of little danger in the waters bordering the United States. For example, a report prepared in 1958 noted that in the previous 40 years there had been only 24 attacks by sharks along the eastern seaboard, of which only 12 were fatal. During World War II, however, Navy aircrews and shipboard personnel deployed in the tropical and semitropical Pacific encountered sharks frequently when they were forced to abandon their aircraft or ships. For them, sharks were both a physical and psychological hazard. It became obvious that some type of repellent was needed to protect Navy men from shark attacks and to bolster their morale against the prospect of such attacks.

Work was initiated at the Naval Research Laboratory in 1943 to produce a satisfactory shark repellent. A series of experiments led to a chemical preparation composed of 20-percent copper acetate and 80-percent nigrosine dye. Copper acetate was included because it hydrolizes readily in sea water to form substantial quantities of acetic acid, which was believed to be repugnant to the shark's sense of smell. The nigrosine, a black dye, provided a means of hiding a man from sharks. This repellent, known as "Shark Chaser," was compressed into a 6-1/2-ounce cake and included in the survival equipment of Navy pilots. Although the Shark Chaser performed well in tests, its effectiveness in service did not prove to be as satisfactory as had been anticipated.

In 1958, a new group, called the Shark Research Panel of the American Institute of Biological Sciences, was formed with the support of the Office of Naval Research. One of the functions of this panel, which is still in existence, is to appraise the effectiveness of anti-shark measures and the use of chemical and physical repellents. It conducted a series of tests on the Shark Chaser and discovered that in sea water the copper acetate did not convert to appreciable amounts of acetic acid, which was

*This article is based in large part on a report of tests conducted for the Shark Research Panel by Albert L. Tester, Gareth J. Nelson, and Charles I. Daniels of the University of Hawaii.

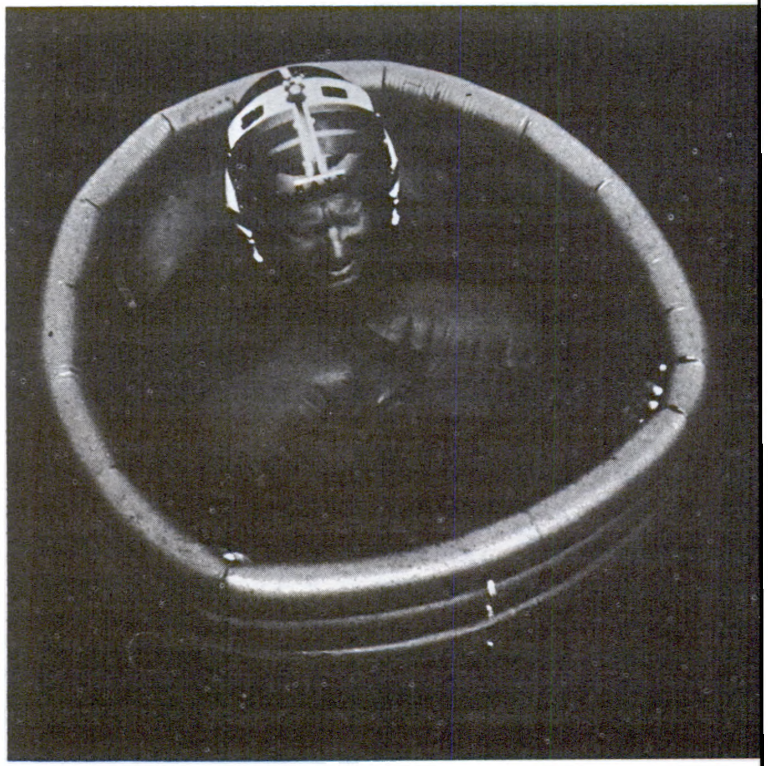
supposed to drive sharks away. In fact, the cloud of nigrosine dye was more effective in repelling sharks than the copper acetate.

This clue that a man can be protected if he is effectively screened from a shark has led to the development of a new shark deterrent which has passed in amazing fashion the tests so far conducted on it. The deterrent, designed by Dr. C. Scott Johnson of the Naval Ordnance Test Station's Marine Biology Facility at Point Mugu, California, consists of a plasticized black bag five feet in length and from two to three feet in diameter. Attached to the top of the bag are three inflatable cuffs, or buoyancy rings, colored international orange for visibility. These rings are fitted with mouthpieces by means of which the swimmer can inflate them with little effort. When packed, the screen, or bag, is carried easily on a life jacket. Once in the water, the swimmer, supported by his life jacket, detaches the screen, fills it with water, crawls inside, and inflates the three rings. One special advantage of this type of protection is that if the man is wounded, blood and odors, which attract sharks, are not released into the ocean. Another advantage is that the bag helps keep its user warm by conserving body heat. In addition, the man is relieved of the mental and physical strain that accompanies the expectation of a shark attack.

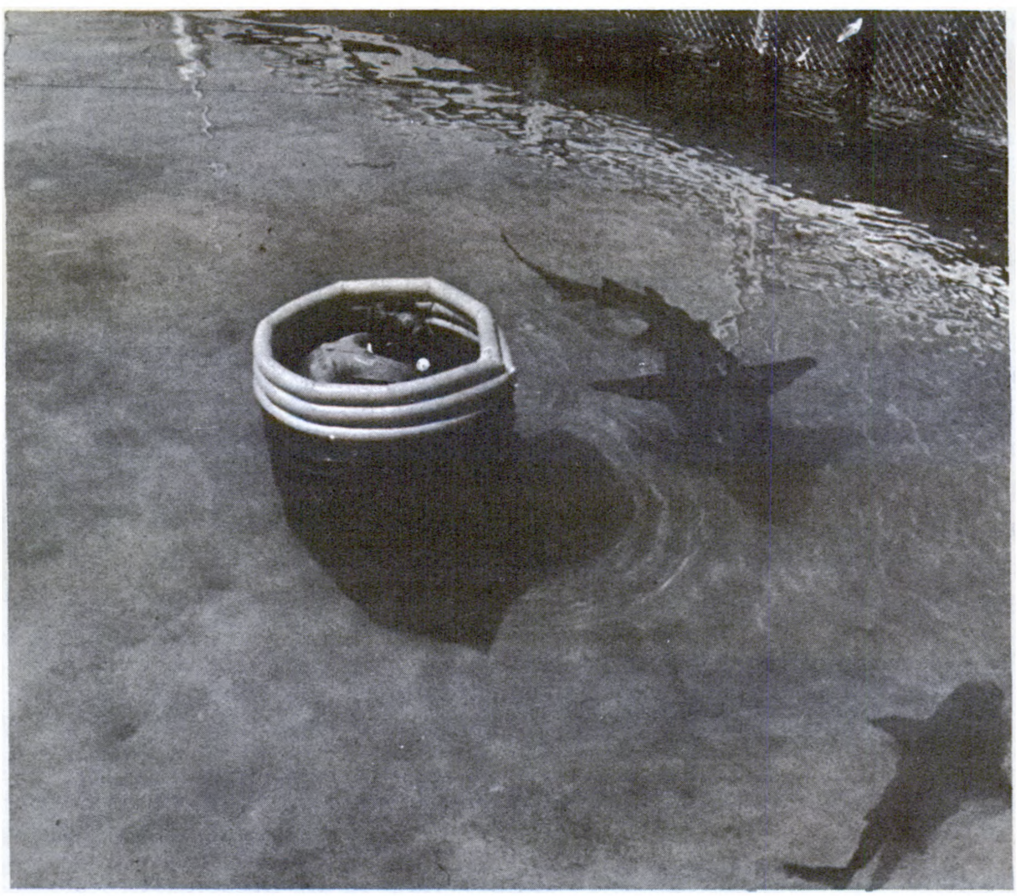
Many tests were conducted on the shark screen for the Shark Research Panel during 1966. The scene of one of them was a large pond at the Hawaii Institute of Marine Biology. Two grey sharks were used, one about six feet and the other about seven feet in length. They had been in captivity for six years and were active, healthy specimens. In order to make the tests as realistic as possible, the sharks were starved for approximately two months before the tests were conducted.

The pond contained a channel along which the sharks usually swam slowly back and forth. From a 16-foot-high tower that overlooks the channel, an observer watched the sharks and recorded their activity. Simultaneously, another observer diagrammed the movements of the sharks. Two bags of the same size but made of different materials were used. One bag was pink and made of lightweight, smooth, plastic-like material. The other one was silvery gray and made of lighter weight, fabric-like material. The pink bag was translucent and the gray bag, opaque. Each bag, in turn, was filled with water and anchored in mid-channel.

Before the introduction of the bags to the water, the sharks rarely swerved from a straight course down the channel, and they tended to swim in mid-water or near the bottom. When a bag was first placed in the channel, the sharks veered as many as 15 feet away from it. Later, they approached to a distance of about 10 feet from the bag. Still later, they sometimes passed beneath the bag but never closer to it than about 4 or 5 feet. The sharks seemed to be quite wary of the presence of the



Experimenters, afloat in the shark screen, expose themselves to potential shark attacks during recent testing of the deterrent. The screen, actually a plasticized bag about five feet high and three feet wide, is supported by three inflatable buoyancy rings. The bag and rings fold into a small package that can be attached to a pilot's life jacket.



bag, particularly the larger shark, which avoided the general area of the bag.

The next phase of the test was to throw pieces of cut fish, or chum, from the observation tower as close as possible to the bag. The sharks were attracted immediately by the splash of the chum, approached the area with dorsal fin above the water, and excitedly circled the bag in a feeding frenzy. Generally, they would take the chum when it was at least a foot away from the bag. However, when the piece of fish was less than one foot away, a shark would dash in on a collision course with the bag, but then would veer abruptly away at a distance of about one foot without taking the bait. On one occasion, a shark actually rammed the bag with its snout and then circled closely, attempting, unsuccessfully, to devour the bait.

In other experiments, fish were tied to a line and dangled against the side of the bag both before and after chumming. In both cases, the sharks sensed the odor, surfaced, and excitedly circled the bag but did not approach closer than two feet. At no time did their bodies come in contact with the bag. The action soon died down, and the sharks then ignored the bag. When chum was added to the water, the sharks immediately became excited, circled the bag, and fed voraciously on the chum. They also approached close enough to take a few of the fish attached to the bag, but apparently only those that had drifted farthest away. While doing so, their bodies and fins frequently brushed against the side of the bag. This action as well as the collision mentioned previously caused some damage to the bags. It was judged, therefore, that the fabrics were too flimsy for use under rugged survival conditions.

A second series of tests was conducted this past summer on free-living sharks at the Eniwetok Marine Biological Laboratory, on Eniwetok Lagoon, Eniwetok Atoll. Observations were made from a barge that was equipped with an underwater viewing chamber which placed an observer six feet below the water surface. Plasticized bags of eight different colors, including black and white, and a green bag covered on the outside with silvery foil were tested. Three species of sharks commonly appeared during the observation periods—the whitetip shark, the blacktip shark, and the grey shark.

One of the problems that arose in conducting these experiments was devising a method of luring the sharks from the bottom of the lagoon, where they habitually stayed. The most successful technique was to attach whole fish to a line or place them in a wire basket, lower the fish to the bottom, then gradually raise them as the sharks became interested in feeding. Once the sharks were near to the surface, chum was thrown into the water near the bags.

During the first week of these experiments, it became apparent that most of the sharks induced to come to the surface were not noticeably attracted or repelled by any of the bags, regardless of their color. For the most part, their attitude was one of indifference. In general, sharks would not approach within one foot of a bag except to eat chopped fish. On those occasions, they did not hesitate to approach the bags. The grey sharks, which appeared to be the most agressive species, approached the bags more frequently than either the whitetips or the blacktips.

Sometimes, contacts occurred between sharks and bag—either brushes with the body or fins or bumps with the snout. Rarely was a shark seen to attempt to bite a bag, and when he did, he often failed to make contact. On a few occasions, sharks did bite the bag on one corner along the bottom edge. However, no teeth marks or visible damage were noted later when the bags were examined. The bumping of the bag seemed to be an exploratory procedure on the part of the sharks. In any case, anything they might have learned from the bumping did not stimulate them to attack the bag.

One interesting experiment was conducted in an illuminated area at night with one black and one white bag. Under these conditions, the behavior of the sharks changed radically. More than 25 of the animals surfaced and swam in the area of the bags, attacking several dead fish dangling at the water surface. The number of approaches to and contacts with the white bag increased so rapidly that they could not be counted. However, no contacts between sharks and the black bag were observed.

Finally, one of the experimenters entered a bag while it was in the water and sharks were in the area. One grey shark brushed the bag, but the contact was not felt by the person inside. The experiment lasted about 20 minutes without further incident. (During other tests, a large number of men entered the bags and exposed themselves to potential shark attacks; in each case, no injuries or serious damage to the bags occurred.)

The conclusion reached was that the plasticized bag is "far superior" to the Shark Chaser or any other chemical repellent or electrical device tested previously for protecting persons from shark attacks. Even when motivated by food, the sharks did not attack the bag (except for its bottom corners). This held true even when the bag was occupied by a person.

The bags tested in the lagoon, in contrast to those tested in the pond in Hawaii, were sufficiently strong to resist damage when hit or brushed by sharks. They also were constructed of material strong enough to withstand the strain of a person entering them and moving around inside. The strength of the material is vitally important, for if a hole or rip develops, not only will odors be dispersed into the surrounding water but the bag will become flaccid and more susceptible to damage from shark contacts. The experimenters recommended, therefore, that the bag have a round bottom, preferably without seams. Such construction would prevent sharks from obtaining "bite holds" on the bottom corners of the bag. Although the bags tested at Eniwetok were not damaged, they might have been torn or perforated by more agressive shark actions.

Black bags are recommended because of their low reflectivity. Relatively few approaches to and no contacts were made with the black bag during the daytime and evening tests. The greatest approach rate and contact rate were recorded for the highly reflective silvery bag.

The Office of Naval Research has recommended an immediate production of these shark protective screens. It is believed that the screens can be produced easily at a cost of less than $10 each when manufactured in large lots. The material used should be lightweight, strong, snag resistant, and mildew and decay proof; such material is available commercially. An additional recommendation is that a strap be placed within the bag to support the weight of the swimmer in the event he becomes unconscious or sleepy.

High-Pressure Testing Viewed on TV

Through the use of a specially adapted camera, the Naval Oceanographic Office's Instrumentation Testing Division is now able to monitor, by closed-circuit television, the effects of ocean pressures on instruments being evaluated in its high-pressure test chamber. The chamber accepts instruments as long as eight feet and subjects them to pressures equivalent to those of any ocean depth (see *Naval Research Reviews,* August 1966).

The camera, which weighs about 20 pounds and measures 6 by 8 by 18 inches, is attached to the outer surface of the cylindrical test vessel. Through a lucite window, it views the interior of the vessel and relays a picture to a TV monitor. Investigators thus can visually observe the performance of instruments being tested and can evaluate that performance in terms of manufacturers' claims concerning the pressure resistance of their products.

Symposium on Military Oceanography

The Fourth Annual Symposium on Military Oceanography, which will be sponsored by the Naval Oceanographic Office, will be held at the Naval Research Laboratory on May 10, 11, and 12, 1967.

The purpose of the symposium, as it has been in previous years, will be to provide a meeting at which scientists, engineers, and military personnel in the field can present papers, exchange information, and discuss problems concerning military oceanography. All sessions will be classified. The call for papers and applications for invitations will be issued in December.

Information concerning the symposium may be obtained from the Office of the Oceanographer of the Navy, Building 200, Navy Yard, Washington, D.C. 20390.

Zetes North Pacific Expedition

One of the most arduous voyages ever made by a Scripps Institution of Oceanography ship ended on August 8 when the research vessel ARGO docked at San Diego after a 17,000-mile, seven-month voyage to the far reaches of the North Pacific. When she tied up, ARGO had traveled more than a quarter million miles for the Institution—all since the summer of 1960—but those logged this year in the North Pacific were the most difficult of all for ship, crew, and scientific party. While traveling those miles, ARGO encountered gale-force winds of 70 knots, waves 40 feet in height, continuous bad weather during February and March, ice floes, and low temperatures that froze the sea spray and coated her decks and gear with ice.

Under different circumstances, such conditions were familiar to the ship's captain—Alan S. Phinney—and to the expedition's chief scientist during the North Pacific leg of the voyage—research oceanographer Joseph L. Reid. During World War II, Phinney was a Merchant Marine officer on the run to Murmansk, Russia, and Reid was a naval officer on a destroyer escort in the North Atlantic.

A fortunate aspect of the Zetes Expedition was that of the 31 crew members who sailed from Scripps in January, 27 completed the entire voyage. On some voyages of this length, a turnover of crew members as high as 25 percent has occurred. Furthermore, no time was lost from scientific investigations, and only a day and a half was lost in sailing time—when a crew member had to be taken into port for hospitalization.

Captain Phinney served as ship's master throughout the expedition, and William C. King and Eugene M. Trease alternately assumed the duties of chief engineer.

The expedition was divided into seven segments under the leadership of five chief scientists, each of whom arranged time to pursue his own research interests. The following breakdown describes each leg of the expedition, names its chief scientist, and briefly describes the type of investigations undertaken.

San Diego to Kodiak

During this first leg of the expedition, Dr. John A. McGowan, an associate professor of oceanography, directed a study of marine life bordering the 40th parallel. For thousands of miles across the Pacific north of the 40th parallel the ocean teems with millions of marine organisms in hundreds of forms. South of the 40th parallel, as if one drove suddenly from a lush rain forest onto California's Mohave Desert, the ocean becomes virtually a "submarine wasteland." Studies of the hundreds of ocean samplings and net tows of marine life taken during a crossing of this boundary between areas of marine abundance and scarcity should help to show what causes this biological phenomenon. The results, obtained under winter conditions, will be compared with those obtained in the summer of 1964 during Scripps' Ursa Major Expedition in the same general area.

Kodiak to Hakodate, Japan

The purpose of this segment of the trip, which was directed by Joseph L. Reid, Jr., who coordinated the arrangements for the entire expedition, was to observe winter conditions in the upper mile of the ocean in the northwestern pacific, the western Bering Sea, and the Sea of Okhotsk. Winter was the time chosen for the voyage because no oceanographic vessel had ventured there before during that season. Wind speeds as great as 70 knots and waves as high as 40 feet were experienced. Near the coast of Kamchatka, the air temperature fell to 16°F. Ice formed over much of the ship, and a great deal of sea ice was encountered, especially in the Okhotsk Sea.

The principal subject of study in these areas was the circulation of the ocean water—that involving both horizontal currents and the vertical exchange of surface water with deeper water. The southward flow near Kamchatka (the Kamchatka Current) was found to be about 25 million tons per second, three times that of the flow in summer and about a third as great as that of the Gulf Stream. In winter, the Kamchatka Current is one of the greatest currents in the world, carrying a vast quantity of cold water southward from the Bering Sea into the Pacific Ocean. The vertical exchange of water was found to be remarkably small. Unlike the North Atlantic and Antarctic regions, where surface water is cooled and made dense enough to sink more than a mile downward, the North Pacific surface water does not sink more than a few hundred feet in winter.

Hakodate to Tokyo, Tokyo to Honolulu, and Honolulu to San Diego

Victor Vacquier, a professor of geophysics, directed three segments of the expedition: Hakodate to Tokyo, Tokyo to Honolulu, and Honolulu to San Diego.

Hakodate to Tokyo. American and Japanese scientists took extensive measurements of the heat flow from the earth's interior into the ocean and made surveys of the earth's magnetic field at seven seamounts scattered over an area of about a million and a half square miles east and south of the coast of Japan. Preliminary findings of the magnetic surveys tend to show that the seamounts have moved over the ocean floor from the locale of their formation millions of years ago. Investigations in the area east of Japan indicated a normal, or slightly below normal, heat flow when compared with the heat flow of the ocean as a whole. This discovery contrasts significantly with heat-flow measurements taken in 1963-64 by Japanese scientists on the bottom of the Sea of Japan. That area, between Japan and the mainland, has a much higher than normal ocean-bottom heat flow. The high average heat flow indicates considerable deep-seated activity beneath the Sea of Japan, while the near-normal heat flow east of Japan suggests this large area is much less active.

Tokyo to Honolulu. Scripps technicians took a number of heat-flow measurements and made several hydrographic casts.

Honolulu to San Diego. ARGO personnel made numerous heat-flow measurements, took a number of gravity core samples from the ocean floor, as well as a number of water and air samples, and they made magnetic and bathymetric surveys of several seamounts.

Japan-Bonin Trench

On the 800-mile journey to the Japan-Bonin Trench and return to Tokyo, scientists from Scripps and from Japanese universities conducted investigations under the direction of Dr. Claude E. ZoBell, a professor of microbiology. These investigations involved collecting deep-sea sediment samples from depths greater than 30,000 feet to learn more about the occurrence, characteristics, and biochemical activities of bacteria at great ocean depths. Subsequent studies of the samples may disclose the basis for obtaining new antibiotics from deep-sea bacteria. Further examination is expected to illustrate in what fundamental respects deep-sea bacteria differ from surface-dwelling bacteria, which, like man, cannot tolerate high pressures. The role of marine bacteria in the "nitrogen cycle" in sea-bottom muds also is being investigated by the Japanese scientists who were aboard ARGO. Results of their work aboard ship already have revealed the presence of ocean-bottom nitrates that previously escaped detection in sediments at great depths.

Waters North of Hawaii

At Hawaii, ARGO rendezvoused with the Scripps research vessel, HORIZON, and the University of Hawaii's ship, TERITU, to form a team to conduct a detailed geophysical survey of the area north of Hawaii that had been chosen as the drilling site for Project Mohole. To determine the depth of the boundary between the earth's crust and mantle, ARGO and TERITU made recordings of sound waves from 2300 large underwater blasts, fired from HORIZON, over a 10,000-

square-mile area of the Hawaiian Arch, the low sea-floor rise north of the Hawaiian Islands.

In addition, ARGO and HORIZON took sediment samples, recorded the thickness of sediment on the sea floor, and made detailed measurements of the heat flow through the bottom in a search for signs of new volcanic activity near the active volcanoes of Hawaii (indications of such activity were not found). This work was done as part of a program started last March by Scripps, the University of Hawaii, Oregon State University, and the University of Wisconsin. The studies are being conducted from the research ships HORIZON and TERITU, Oregon State's YAQUINA, and from Scripps' manned buoy, FLIP.

Support for the scientific investigations conducted during the Zetes North Pacific Expedition was provided by the National Science Foundation and the Office of Naval Research.

New Technical Director Appointed at David Taylor Model Basin

On October 17, Dr. Alan Powell was appointed to the position of Technical Director, David Taylor Model Basin. He had been employed at the Model Basin as Head of the Acoustics and Vibration Laboratory since January 1965.

Dr. Powell came to the Model Basin from the University of California at Los Angeles, where he was Professor of Engineering. He is known widely for his work on the complex phenomena of acoustic fatigue, aerodynamic boundary-layer pressures, jet and rocket engine noises, turbulence effects, vortex sounds, and edge tones.

He was educated in Great Britain, receiving his Ph.D. at Southhampton University. In September 1956, he came to the United States as a Research Fellow in Aeronautics at the California Institute of Technology. That same year he received the Biennial Award of the Acoustical Society of America in recognition of his outstanding contributions to theoretical and applied acoustics through the publication of about 100 papers.

Dr. Powell is an Associate Fellow in the Royal Aeronautical Society, Associate Member of the Institution of Mechanical Engineers, a Fellow in the Physical Society, Fellow in the Acoustical Society of America, Associate Fellow of the Aerospace Sciences, and member of the American Society for Engineering Education and the Honorary Engineering Fraternity, Tau Beta Pi.

Glossary of Oceanographic Terms

Two hundred and four pages of oceanographic terms and definitions, ranging alphebetically from "abioseston" to "zooplankton" have been published in a hard-cover book by the Naval Oceanographic Office. Included in the new book, called "Glossary of Oceanographic Terms," is a list of sources from which many of the words and their definitions were taken. Some of the terms that appear in the glossary have only a vague relationship to oceanography, but are defined because of their scientific association with the subject.

The "Glossary of Oceanographic Terms" may be purchased for $2.25 per copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

On the Naval Research Reserve

Research Reserve Assistants Meet at Omaha

On September 27-28, 1966, Reserve Assistants from ONR Washington and ONR Branch Offices met at Omaha, Nebraska, for a two-day conference. The conference was held at Headquarters, Naval Reserve Training Command, with CAPT H. K. McWilliams, MC, USNR, Assistant for Research Programs, serving as liaison officer.

The conference was convened by CAPT D. J. Marker, USNR, Special Assistant to the Chief of Naval Research for the Research Reserve, and attended by the following Research Reserve Assistants: CDR D. M. Aulick, USN, ONR Boston (1st, 3rd, and 4th Naval Districts); Miss E. F. Kehoe (Commander, USNR), ONR Washington (Training Officer and Assistant for the 5th and 6th Naval Districts); CDR J. W. Tilford, USNR (8th and 9th Naval Districts); and LCDR T. J. Kennedy, USNR (11th, 12th, and 13th Naval Districts). Also in attendance was LT L. R. Dunne, USNR, representative of the Fourth Naval District.

RADM D. C. Lyndon, USN, Commander, Naval Reserve Training Command, welcomed the conferees. He emphasized the role that Research Reservists might play in public affairs to make known the Navy's research interests. CAPT D. W. Davis, USN, Deputy Commander, Naval Reserve Training Command, followed with a briefing on the mission and functions of the Command.

LCDR W. Warnecke, USNR, of the Reserve Officer Recording Activity, spoke on the work of RORA and discussed in detail the service it

At work at the Research Reserve Assistants Conference are (standing, left to right) CDR Aulick; LCDR Kennedy; and CDR Tilford; and (seated, left to right) LT Dunne; CDR Kehoe; CAPT F. B. Guest, USNR, Director, Performance and Officer Training Department, NRTC; CAPT McWilliams; and CAPT Marker.

performs to both the Navy and Naval Reservists by recording accurately credit for participation in Naval Reserve activities.

Matters of concern to the Research Reserve program were discussed in following sessions. These topics included mobilization plans, organization and quality of units to meet mobilization requirements, recruiting, training program, publicity, award program, and fitness reports. Participating in these discussions were cognizant officers from the Naval Reserve Training Command staff. During fall visits to Research Reserve units, Reserve Assistants will discuss appropriate topics with unit members.

A luncheon held on the last day of the conference at the Birchwood Club was attended by many officers from the Naval Reserve Training Command. On that occasion, CAPT Davis presented certificates to the conferees designating them "Admirals in the Great Navy of the State of Nebraska."

Training Program of NRRC 3-4

Rochester, New York, the hub of a complex of industrial and academic research activities, is the stimulating environment from which NRRC 3-4 taps its exciting training programs. Although the company is small, having a total complement of 16 officers, it has not been restrained from obtaining speakers who are experts in their various branches of science, nor from arranging excellent field tours. Recently the company toured the Obenbach Seismic Observatory. On an earlier occasion, it toured the Mees Astronomical Observatory in Naples, New York.

The diverse professional interests of the group and a keen awareness of world problems as well as those directly related to Naval research provide an atmosphere for dynamic sessions in which everyone participates. The pros and cons of new and challenging concepts and ideas directed toward today's most crucial situations and discoveries are earnestly debated, providing much enlightenment. The present schedule is an excellent example of this stimulating diversity.

Mr. George Keene of Eastman Kodak Company will "kick-off" the new quarter with a lecture on the "Use of Color Films in Astrophotography." He will be followed by Mr. Richard Crooker, of Eastman Kodak, who will discuss "Titan Missile Sites."

In weeks to come, LCDR W. R. Smith, USNR, Commanding Officer, NRRC 3-4, will speak on the critical question, "Why Viet Nam?" Mr. Dennis Smith, of Eastman Kodak, will present an intriguing lecture on "Programmed Learning," and LT Dave Hopkins, NRRC 3-4, will speak on a subject of interest to everyone: "Oceanography: Science of Survival."

In addition, the company will tour the Rochester Gas and Electric Company with Mr. R. Conversi, of the Company, and learn of "Power Electricity and Gas Production."

During the past quarter, NRRC 3-4 initiated a program involving all of its members in which Navy tactics are reviewed by studying famous Naval battles. Part I was conducted by LT R. B. Taylor, USNR, a former commanding officer of NRRC 3-4, who discussed the tactics of both the U.S. and Japanese Navies at Leyte Gulf and drew fundamental analogies with British tactics at Trafalgar. In the present quarter, LT J. L. Wheeler, USNR, NRRC 3-5, will preside over "Famous Naval Battles, Part II."

The success of the NRRC 3-4 training programs can be gauged best by the enthusiasm of its members. It has been exemplary in the past and is expected to remain that way in the coming quarter.

Research Reserve Statistics

The following figures were compiled from data submitted in the annual reports forwarded by Reserve Research companies for fiscal year 1966:

	Number	Percent
Companies	94	
Members	1870	
Ready Reserves		87
Standby Reserves		13
Attendance at drill meetings (median percent)		85
Earned satisfactory Federal year		86
Selected for promotion	173	
Received active duty for training	923	50
Captains	120	
Commanders	227	
Lieutenant Commanders	371	
Lieutenants	176	
Lieutenants (JG) and below	29	
Completed correspondence courses		52

Change in Date for Research Reserve Seminar

The convening date for the new Research Reserve Seminar at Argonne National Laboratory, Argonne, Illinois, originally scheduled for May 1, 1967, has been changed to April 24, 1967. This change was required because quarters will not be available in early May.

Horizons in Oceanography Seminar

In August, 76 Research Reservists attended a two-week marine-sciences seminar, the second of its kind to be held in New England, at the University of Rhode Island, Kingston. The first of the pair of seminars was held at Quonset Point. At the University, the Reservists and their families received a warm welcome and were provided with excellent dormitory and dining facilities.

The speaker's roster, which reads like a "who's who" in the marine sciences on the East Coast, included contributors from the University of Rhode Island, Charles Fish Marine Laboratory, Woods Hole Oceanographic Institution, Harvard University, Lamont Geological Observatory, Benthos, Inc., New England Aquarium, Alden Hydraulics Laboratory, University of Bridgeport, Ocean Systems Development, Inc., and the Office of Naval Research.

Tours were made to the Naval Submarine Medical Research Center, Naval Underwater Sound Laboratory, Quonset Point, Naval Construction Battalion Center at Davisville, Rhode Island Reactor, Northeast shellfish Sanitation Research Center, Narragansett Marine Laboratory, and two destroyer units assigned to Destroyer Development Group Two.

A good insight was obtained into the broad spectrum of activity in the marine sciences and related subjects taking place in New England.

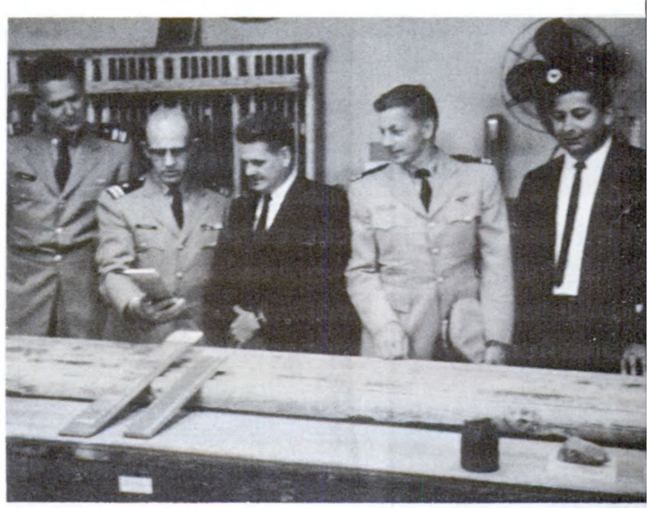
A Day at Lamont

Members of Naval Reserve Research Company 3-7, Scotia, New York, visited the Lamont Geological Observatory, Palisades, New York, for a full day of briefings on marine geophysical and oceanographic research programs being pursued at the Observatory. Dr. J. L. Worzel, Associate Director of Lamont, and Dr. R. S. Stevens, ONR Scientific Liaison Officer to the Observatory, arranged a complete program to indoctrinate the Reservists in many of the latest developments in marine research and their naval applications. The program was well received by the visiting group.

NRRC 3-7 was officially welcomed by Dr. Stevens, who summarized several of the major contributions made by Lamont scientists to underwater acoustics, marine geophysics, and oceanographic instrumentation. In addition, he described the ONR-sponsored marine research programs at the Observatory and introduced speakers, all specialists, who gave both informative and interesting talks on parts of the programs in gravity, seismic refraction and reflection, physical oceanography, magnetics, Arctic Ocean research, and marine geology.

Dr. Worzel met with the Reservists and discussed Lamont's extensive ocean-bottom coring program and conducted the group on a tour of the core "library," which contains about 4000 long cores of bottom samples from all of the world's oceans. These cores, collected principally from the Observatory's two research ships, VEMA and R. D. CONRAD, are subjected to methodic lithological, micropaleontological, acoustical, and mass physical property analyses in support of the Observatory's dynamic research programs in marine geophysics and geology.

Of particular interest to the group was a lecture by Dr. Kenneth L. Hunkins of Lamont on the broad scope of marine research being conducted by his research team on Fletcher's Ice Island, also referred to as T-3. T-3 is an 8- by 4-mile and 100-foot-thick ice island that has been drifting almost constantly in the Arctic Ocean. It first came under surveillance in 1947, and it was used as an Air Force station until 1961. After drifting aground in the autumn of 1961, it was abandoned. In 1962, T-3 drifted into deeper water, and in the spring of 1962 it was reoccupied by Navy-sponsored marine scientists. Since then, the overall administration has been provided by the University of Alaska under a contract with the Office of Naval Research. (See "Arctic Basin Research," *Naval Research Reviews,* October 1966.)



Dr. Worzel, Associate Director of Lamont, describes a long core obtained from the Indian Ocean. Left to right: LCDR Fred G. Bailey, LT Lawrence C. Pedersen, Dr. J. Lamar Worzel, LT Richard A. Siergiej, and Dr. Richard S. Stevens.

ELEVENTH NAVAL DISTRICT REPORTS

Reservists Visit NCEL

CAPT J. D. Kuser, USN, Director of the ONR Branch Office, Pasadena, California, gave the welcoming and keynote address to a large group of Research Reserve officers who convened recently at the Naval Civil Engineering Laboratory, Port Hueneme, California, for a one day seminar. The subjects which were covered in this interesting session were the Structural Research Program, Deep Ocean Engineering Efforts, and Amphibious Warfare Developments. The featured speaker was Dr. Warren Shaw, Director of the Structures Division at the Laboratory.

A luncheon given at the Port Hueneme Officers Club and a tour of the NCEL facilities completed the day. NRRC 11-8, Point Mugu, under the command of CAPT M. Hudson Fields, USNR-R, was the host company and was in charge of all arrangements and planning.

Eleventh Naval District Research Reservists inspect ocean-bottom core samples during a one-day seminar conducted recently at the Naval Civil Engineering Laboratory.

Reservist Takes Active Duty Training in San Diego

ENS Roger G. Bland, MSC, USNR-R, a member of Naval Reserve Research Company 11-7, Tucson, Arizona, recently performed his first active duty for training as a Naval officer in San Diego, California. CDR Richard B. Woolley, USNR-R, a member of San Diego's NRRC 11-5, in cooperation with the Commandant, Eleventh Naval District, and the Director of the ONR Branch Office, Pasadena, arranged the complete and comprehensive training schedule.

Highlights of ENS Bland's duty included indoctrination briefings and tours of the Naval District headquarters; Naval Hospital, San Diego; Operational Test and Evaluation Force, Pacific; Scripps Institution of Oceanography; Naval Amphibious Base, Coronado; Naval Training Center; Navy Electronics Laboratory; and visits to USS CANBERRA (CAG-2), USS HULL (DD 945) and USS TICONDEROGA (CVA-14).

A laboratory technician explains method of introducing blood samples into multiple-factor blood analyzer to ENS Bland and CDR Woolley during a visit to the Naval Hospital, San Diego.

The Naval Analysis and Naval Applications Groups of the Office of Naval Research have been consolidated to form a single Naval Applications and Analysis Group. Through this consolidation, conceptual analysis and application feasibility studies will more effectively complement each other and thereby contribute in larger measure to ONR's research and development missions.

U. S. GOVERNMENT PRINTING OFFICE : 1966 O - 238-037

ALUMINAUT Recovers Lost Buoy System

A sunken buoy system consisting of a cable and five current meters for measuring water movement was recovered recently from a depth of 3150 feet by scientists from the Naval Oceanographic Office by means of the deep-submersible ALUMINAUT. The array disappeared a year ago when its buoy broke loose, causing the cable to drop to the ocean floor.

The recovery technique utilized required that one end of a 2000-foot coil of salvage line be attached to the keel of the 51-foot submersible and that the vehicle carry the line to the ocean bottom. By means of the ALUMINAUT's mechanical arms, a hook at the other end of the line was placed under the cable. The coil was then dropped, and the submersible ascended, unreeling line from the coil and, subsequently, pulling up the array. The cable and the instruments attached to it were in near perfect condition despite the long period of time they lay on the bottom.

The Reynolds Company's aluminum-hulled undersea craft found the lost array in the darkness of the ocean depths by means of special floodlights. Within two hours of the time the search began, ALUMINAUT's observers had spotted the cable and had determined its position. In spite of troublesome currents and sharp variations in the terrain, the entire operation was carried out in a short period of time.

International Symposium on Modern Optics Rescheduled

The seventeenth in the Polytechnic Institute of Brooklyn series of annual international symposia, entitled "Symposium on Modern Optics," has been rescheduled to coincide with the 1967 International Convention of the Institute of Electrical and Electronics Engineers. It will be held at the Waldorf-Astoria Hotel in New York City from March 22 to 24, 1967.

Developments in optical masers, quasi-optics, and coherence theory are contributing to the creation of a new modern optics. This year's symposium proposes to map out the domain of this new science. The laser has brought a host of problems pertaining to the nonlinear optical properties of materials within range of solution. Emphasis will fall in areas such as holography, spatial filtering, information processing, and electrodynamic measurement, in which several novel aspects of the subject, physical and theoretical, converge. In the tradition of past symposia, the meeting will provide a review of the present status of modern optics as well as a forum for discussion of the latest advances of interest to engineers and physicists.

The symposium is organized, as it has been in other years, under the sponsorship of the Microwave Research Institute of the Polytechnic Institute of Brooklyn, the Air Force Office of Scientific Research, the Office of Naval Research, and the Army Research Office.

Correspondence relating to the symposium should be addressed to the Symposium Committee, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N.Y. 11201.

A national effort now being made to define the requirements, scope, and methodology appropriate to the utilization of spacecraft for the observation of ocean phenomena was augmented recently by the initiation of a study that will cost about $99,000. A contract for the study was awarded by the Naval Oceanographic Office to Western Development Laboratories, Philco Corporation, Palo Alto, California.

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NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington, D.C., 20390. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

Editor: RICHARD D. OLSON

NAVSO P-510

Artist's concept of a new Navy shark deterrent. The deterrent, actually an opaque plasticized bag supported by buoyancy rings, is shown here protecting its occupant from visual and olfactory detection by two curious sharks. Before performing its life-saving function, the bag is attached in a compact package to the user's life jacket. See article beginning on page 12. Drawing by James C. Koukos, Office of Naval Research.