

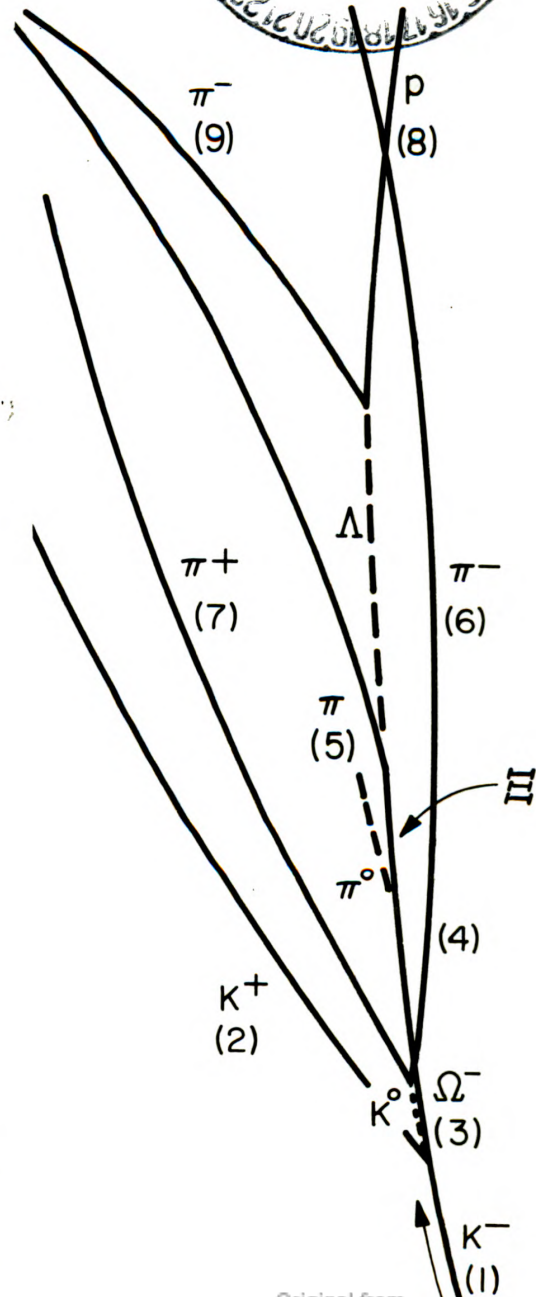
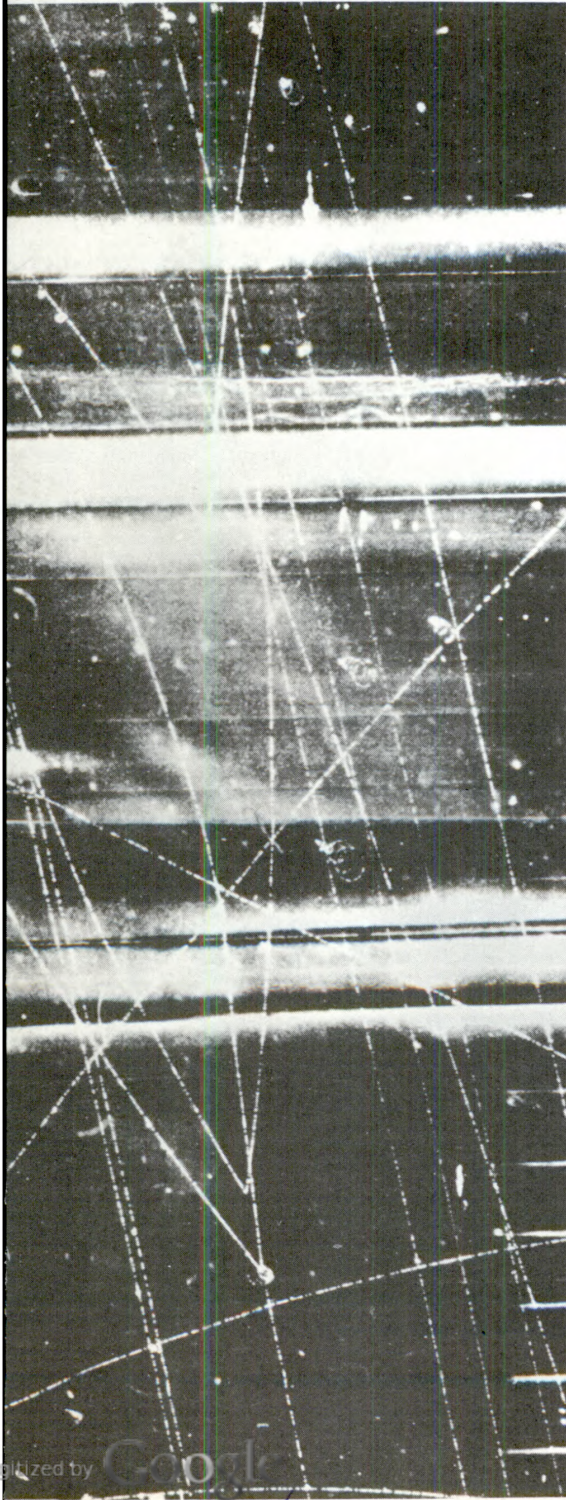
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NAVAL RESEARCH

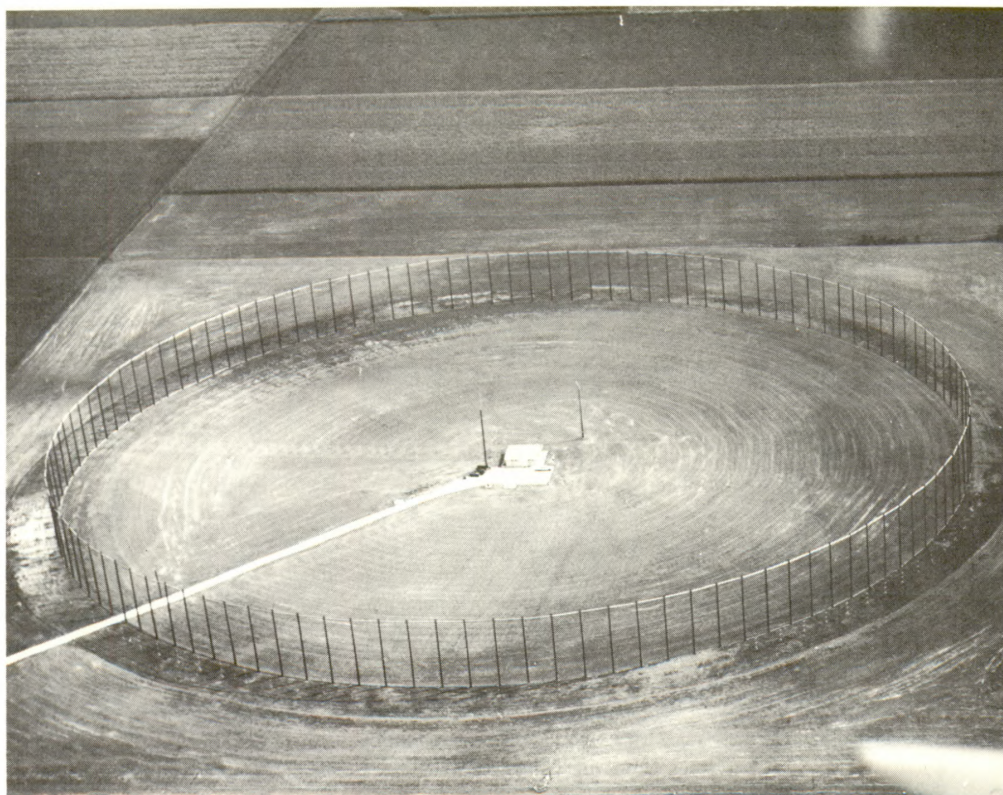
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REVIEWS

FEBRUARY 1965



Original from
UNIVERSITY OF ILLINOIS AT
URBANA-CHAMPAIGN



The 1000-foot-diameter radio direction-finding system at the University of Illinois.

Large, Precise Radio Direction-Finding System Developed for Navy

One of the world's largest and most precise radio direction-finding systems has been developed by the University of Illinois under a contract with the Office of Naval Research. The system can determine the direction from which a signal arrives within a one-half degree of accuracy.

Currently, the system is being used to acquire information concerning the properties of the ionosphere. In particular, it is hoped to understand the deviousness of the path of a radio signal through the ionosphere. Such factors as sun spots and moment-to-moment variations in the ionosphere often bend the signal by several degrees and, in extreme cases, by as much as 90 degrees, which makes it difficult to determine the location of the signal's origin.

Professor Edgar C. Hayden, who is in charge of the project, has reported that transmissions from Washington, D.C., have arrived at Illinois from the apparent direction of the North Pole. Deviations of 2 or 3 degrees are quite common, and variations of 30 degrees are not unusual.

The Illinois radio direction-finding system is an enlargement and improvement of the Wullenweber finder, which was developed by the Germans during World War II. Since 1946, Illinois engineers have greatly increased receiver sensitivity and directional accuracy, markedly reduced the effect of interfering stations on the same operating frequency, and developed the system as a research tool for probing the ionosphere. During this period, support has been provided by both ONR and the Bureau of Ships.

— Continued on Page 14

Status and Potential of Research Ballooning

Henry Demboski

Physics Branch

Office of Naval Research

The earth's atmosphere, because of its anomalous, uncontrollable, and unpredictable variability, poses difficult problems in the pursuit of scientific and operational objectives in that medium. These problems are compounded by the fact that the atmosphere is neither isotropic nor homogeneous. Within certain limits, corrections can be made to overcome many of the problems. Beyond those limits, however, reliable corrections cannot be made. As a matter of fact, the most serious problem now existing in the operation of modern instrumentation and systems in the atmosphere is the uncertainty of the atmospheric effects. It is rather paradoxical, therefore, that many complex systems are carried to the operational evaluation stage before adequate thought is given to atmospheric effects. At that stage, the only recourse left is to try to minimize the uncertainties, which means prolonged evaluation testing.

Although our sensible atmosphere extends hundreds and perhaps thousands of miles into space, 50 percent of its mass is concentrated between sea level and an altitude of 3-1/2 miles; 90 percent is below an altitude of 10 miles; 99 percent is below 20 miles; and 99.9 percent is below 30 miles. It is apparent, then, that by utilizing vehicles capable of "leap-frogging" the main mass of our atmosphere, scientists can avoid most of the undesirable and/or undeterminable effects of the atmosphere on their experiments.

The concentration of practically all of the earth's sensible atmosphere within a relatively shallow layer makes the Skyhook balloon an attractive tool for conducting various types of scientific experiments for long periods of time in near-space conditions at almost any geographical location. The capability of the Skyhook balloon has been so highly regarded since its first use about 17 years ago that balloon development has been unable to keep pace with the rapid, continuous increase in scientific requirements. Balloon sizes and payload weights have increased by about two orders of magnitude. Balloons have swelled in volume from 10,000 to over 1,000,000 cubic feet. Scientific payloads have jumped in weight from less than 100 pounds to more than 10,000 pounds. And altitude requirements have been extended from around 100,000 feet to at least 150,000 feet.

As a result of these constantly increasing scientific demands, balloon capabilities have been taxed to the point that flight reliability is now approaching 50 percent. The high probability of loss or excessive damage to current sophisticated scientific payloads is becoming of greater concern to the scientist, and interest is increasing in obtaining balloons having a greater reliability. The mounting failure rate of balloons fabricated of polyethylene, the material most commonly used in the manufacture of Skyhook balloons, is related directly to increasing balloon size. The low tensile strength of polyethylene provides no safety factor for concentrated stresses induced by the unsymmetrical development of the gas bubble during the ascent of the balloon. Although the exact causes of the increased failure rate have not been determined, the low strength of polyethylene appears to be the most important factor precluding any significant increase in the reliability of balloons made of this material.

Polyethylene films of which Skyhook balloons are now being fabricated were developed originally for commercial purposes. Since the portion of these films used for balloon fabrication is extremely small compared with the total quantity used by industry, film extruding companies have no great incentive to improve film characteristics for balloon applications. Other films, such as Mylar and polypropylene, have been examined for balloon fabrication because of their high tensile strength. Unfortunately, these films are more difficult to seal and have very low tear resistance. A reinforced Mylar film has been developed, however, and is now in use for sophisticated flights in which the scientific payloads and scientific objectives justify the much higher cost of such balloons; the Stratoscope II balloon-borne telescope system exemplifies such a requirement. Extremely thin polyethylene film, approaching 1/10,000 of an inch in thickness, reinforced with nylon filaments, is being tested as a balloon material to carry moderately heavy scientific payloads (less than 500 pounds) to altitudes of 140,000-150,000 feet. Composite films of polyethylene and polypropylene laminates also are being tested and show great promise for improved reliability at economical costs. With the effort being made currently by all supporters of scientific ballooning to improve the capabilities of balloons, it can be assumed that in the future these vehicles will reach higher altitudes and carry more weight with greater reliability than they do at present. By the same token, it can be assumed that increasingly stringent scientific requirements will demand continuing developmental effort to insure the availability of reliable balloon systems.

The capability of Skyhook balloons was recognized quickly from operational as well as scientific aspects after the first ONR-sponsored flights of those balloons many years ago.

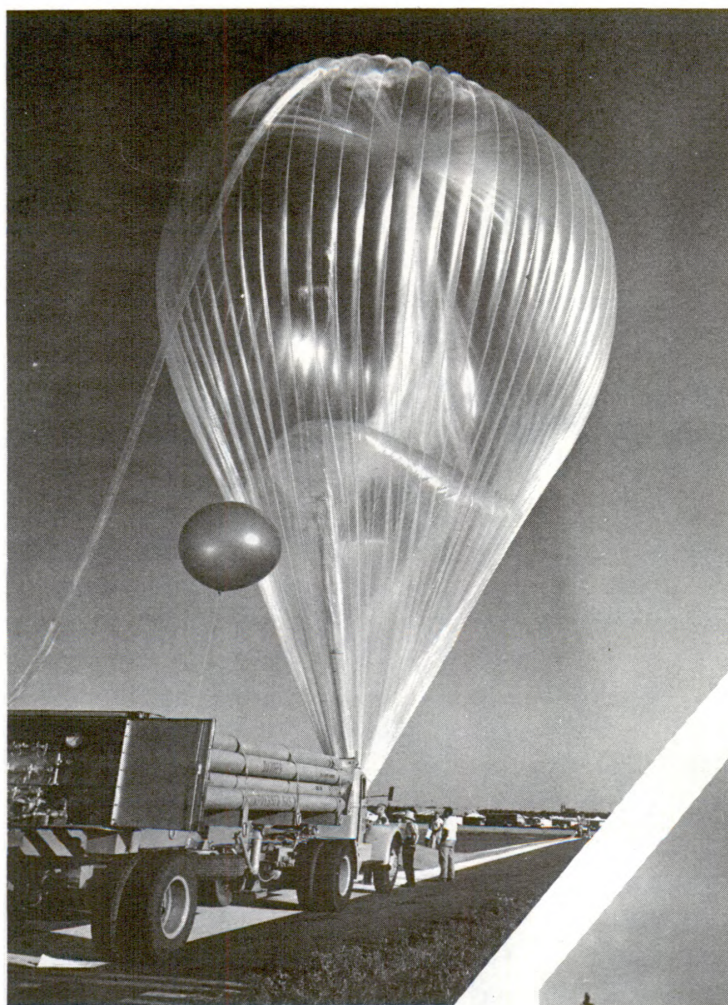
The Air Force now provides complete balloon launching, tracking, controlling, data collection, and recovery facilities for its in-house high-altitude research program, for its contractors, and for other organizations having programs of interest to the Air Force. Most of this service's programmed balloon flights are launched from Holloman Air Force Base, New Mexico, or Chico Municipal Airport, California. In addition, the Air Force has developed a mobile launch capability which permits balloon operation anywhere in the world.

The Weather Bureau carries out a continuing balloon program for the sampling of particulate matter in the atmosphere. Under this program, flights are launched at San Angelo, Texas, by the Weather Bureau, and at Mildura, Australia, by the Australian Department of Supply. Four samples of atmospheric particulate matter are required each month. Because of the failure rate of current balloons, eight or ten flights frequently must be made to insure that the four samples are obtained.

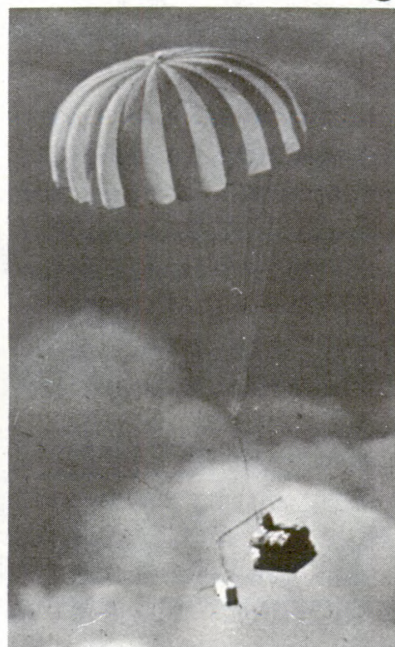
The National Center for Atmospheric Research (NCAR) has established a Balloon Flight Facility at Palestine, Texas, which has been in operation now for about two years. Complete launch, data-collection, control, tracking, and recovery facilities are available to civilian scientists and government agencies. Plans call for construction of a huge balloon-inflation structure to permit more orderly launch schedules to be kept. NCAR also operates a more limited balloon flight facility at Page, Arizona. This location is ideal for winter-time flights because of the extremely light ground winds and favorable float trajectories of that area. Such conditions permit static vertical launches, which are desirable for large balloons and scientific payloads because of the delicate handling and release operations involved. NCAR is currently managing a series of scientific balloon flights to be conducted from Hyderabad, India, in March 1965, in conjunction with the International Quiet Sun Year (IQSY).

The Office of Naval Research provides scientific balloon flight services for scientists sponsored by several agencies. Scientific objectives vary from astronomical observations conducted with remotely controlled balloon-borne telescopes to studies of galactic and solar particles and their atmospheric interactions utilizing nuclear emulsions, spark chambers, and scintillation counters. A large percentage of the ONR balloon flights are conducted at high northern latitudes because of the deeper penetration of high-energy particles there. Balloons are launched from the Fort Churchill Research Range, and the scientific payloads are recovered in the region around Lake Athabaska, Saskatchewan, Canada. Scientific flights for which locations are not critical are conducted from either Air Force or NCAR facilities.

Continuous coordination and liaison is maintained between the various scientific ballooning groups through visits, panels, and technical symposia.



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Balloon Launch and Recovery of a Scientific Payload

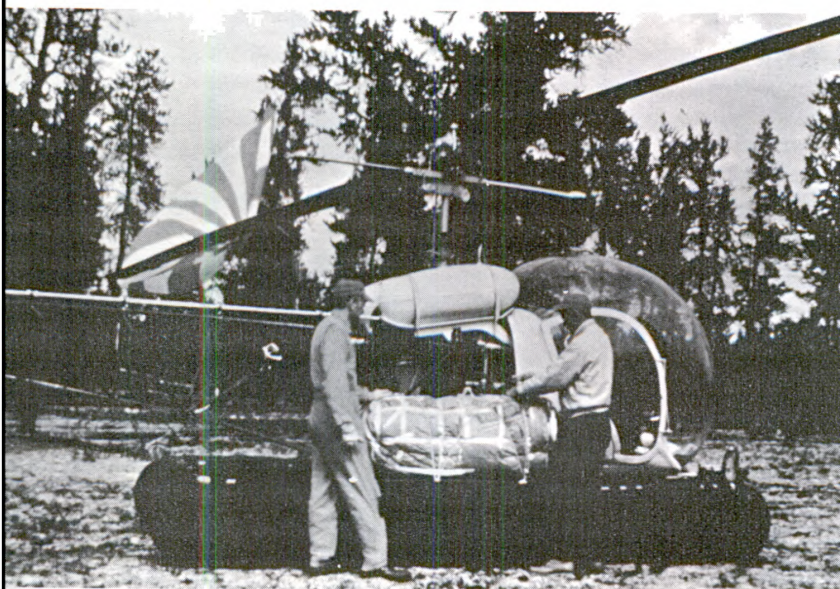
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1. A Skyhook balloon is inflated with helium in preparation for launching of instrument package on journey into stratosphere.
2. After reaching its assigned altitude and after completion of experiments, the scientific package separates automatically from the balloon and descends by parachute. Aircraft track its path to earth.
3. The payload, which dropped undamaged into a forest, is located by recovery team flown to the site by helicopter.
4. The package is loaded on helicopter for removal to the shore of a nearby lake.
5. At the lake shore, the package is loaded aboard a plane equipped with pontoons for shipment back to base of operations.

Pictures numbered 2-5 were taken in Saskatchewan, Canada, during the recovery of a payload launched by Skyhook balloon from Fort Churchill. Picture number 1, depicting the launch in this series, was taken at Sioux Falls, South Dakota, during Skyhook balloon operations in that region.



Research balloon technology is beset currently by material limitations and reliability problems. New and improved balloon materials are within the state of the art, however, and require only moderate funds to exploit. Higher balloon costs will no doubt result, but the unique and exclusive capability of Skyhook balloons to remain at high altitudes for long periods of time is so well established that their use for scientific and operational objectives cannot help but increase. With the current balloon capabilities, a typical ONR field operation, considering all needs, costs about \$100 per pound of scientific payload carried to an altitude of about 130,000 feet. What other system designed to meet scientific and operational objectives in the atmosphere provides so much for so little?



CAPT Thomas B. Owen, USN

Change of Command at NRL

CAPT Thomas B. Owen, USN, succeeded CAPT Bradley F. Bennett, USN, as director of the Naval Research Laboratory on February 5. CAPT Owen, formerly the Laboratory's director of support services, is a combat veteran who served aboard ships of the fleet from early 1941 until 1945. He is also the holder of a doctorate degree in chemistry, which he received from Cornell University. CAPT Bennett, the Laboratory's twentieth director, has retired from the Navy after 30 years of service.

The new director of NRL received the Silver Star Medal for action in the Battle of Tassafaronga. His ship, the heavy cruiser USS NORTHAMPTON, was sunk in the battle. About two years later, another ship he was serving on, the destroyer USS BUSH, was sunk during a kamikaze attack off Okinawa.

After the war, CAPT Owen was assigned to the U.S. Naval Postgraduate School for graduate study in electronic engineering. In 1947, he was selected by the Navy to attend Cornell University, where he received his doctorate degree in 1950. In 1951, he completed a year of postdoctoral work at the University of Amsterdam, the Netherlands. He completed the resident course at the Industrial College of the Armed Forces at Fort McNair, Washington, D.C., in 1962.

Other of his assignments include duty with the Office of Naval Research, the Long Beach Naval Shipyard, the Bureau of Ships, and the Deputy Director of Defense Research and Engineering.

Before coming to the Naval Research Laboratory as director of support services early in 1963, CAPT Owen was on temporary duty with the Assistant Secretary of the Navy for Research and Development.

In addition to the Silver Star, CAPT Owen holds the Bronze Star, the Asiatic-Pacific Campaign Medal with 12 battle stars, the Philippine Liberation Medal with one star, the Navy Unit Commendation Ribbon, and others.

Communication by Voice

John W. Black

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Communication by voice is relatively slow, permitting, at best, only from five to seven syllables to be uttered per second. It is readily masked by other sounds. It is restricted to listeners with normal or near normal hearing and to talkers and listeners who have a common language. Because of these conditions, much can go wrong with the transmission of messages by voice. Nevertheless, such delivery remains at the center of military communication—in discussions that involve policy, in bringing action to bear on observed targets, in coordinating team effort, and in reporting results. If the voice carrying the message is garbled, the communication will be wasteful, and it could have even disastrous consequences.

In the context of this discussion, which concerns an effort to achieve faultless voice communication, the clear message and the intelligible one are synonymous. They are messages that might be either written or repeated verbatim by a listener. For voice communication to be perfect, this property of the message must be assured even before the message is spoken. Thus, in providing for faultless voice communication in the Navy and elsewhere, it is crucial to select in advance, on the basis of demonstrated performance, (a) communication equipment of high intelligibility, (b) messages of proved intelligibility, (c) talkers who characteristically speak intelligibly, and (d) listeners who are skillful in receiving spoken messages.

Our effort to achieve faultless voice transmission has required, on the one hand, a group of speech and hearing specialists, whose task has been to measure the intelligibility of spoken words, and, on the other hand, various groups of human subjects, whose speech and hearing was to be analyzed.

A team of subjects consists typically of a dozen men. One day they compare alternative transmitters; another day, receivers. In rotation, they read lists of English words, 50 words to a list. For example, the first word might be *game*; the second word, *walk*; and the last word, *fall*. The items are spaced at 10-second intervals. As one member reads, the remaining 11 men write what they hear. The talkers normally speak into microphones, and the listeners hear through headsets. A continuous noise simulating the sound of an air-conditioning ventilator or the sounds heard in the cockpit of an aircraft is introduced into the communication line along with the verbal messages.

By following this procedure, at least four experimental findings have emerged:

- Clear evidence that one set of voice-communication equipment is superior to another in terms of transmitting messages correctly.

- A scaling of words in terms of receptability. For example, *football* is heard correctly by 95 percent of the listeners; *faith*, the least readily identified word, is heard correctly by 5 percent of the listeners. The other 598 words fall between *football* and *faith* on a recognition scale. The need for such a scaling of words goes back many years; during World War II, for example, the Armed Services requested lists of intelligible words and lists of words of high contrast—that is, pairs of words that could not be confused—for the voice transmission of military messages.

- Jones is 75 percent intelligible; Smith, 30 percent intelligible; the remaining 10 speakers are ranked between these extremes. Obviously, Jones is well suited to fill the talker's spot, and the phones should not be entrusted to Smith.

- Brown identifies 71 percent of the 550 words that he hears; Low identifies 37 percent. The remaining listeners fall between these extremes. Here, too, the differences provide a basis for selecting members of a communication team—that is, in terms of listening ability.

The last three findings are discussed in this article.

The Understandability of Words

There is a lawfulness about the intelligibility of messages. The intelligible word usually has more sounds and syllables than the less intelligible word. It is one that is spoken often rather than rarely. With respect to its phonetic composition, a word is the more intelligible for containing particular sounds; for example, the first sounds of the following words (isolate the first sound, which may be either a vowel or a consonant): *it, else, at, oil, out, but, key, go, show, chew, jump, no, me*; it is the less intelligible for including the initial sounds of *all, oak, pal, fee, theme, hill, and like*.

The garbled word is received poorly and may lead to wrong responses. Such misidentifications do not occur at random. Different listeners tend to make the same mistakes somewhat independently of who is speaking. Such behavior suggests that the listeners learn to hear speech sounds in a set way. However, in identifying words from acoustic clues, every listener makes judgments that come directly from his own experience. He originates his own errors.

One fortunate consequence of making "errors-in-common" is that the most frequent mistakes (wrong words) can be printed along with the

right word to set up a multiple-choice answer form for measuring intelligibility. A listener only needs to indicate which of the printed words he believes he hears. Machine scoring follows, and the tiring and unreliable scanning and marking—akin to a teacher's scoring of spelling papers, but expanded manifold—can be avoided. A careful check of the responses to *grew*, spoken and heard many times, might show that while 50 percent of the listeners heard it correctly, 20 percent of their peers wrote *groove*, another 10 percent wrote *glue*; and 6 percent wrote *group*. The second most frequent error, *glue*, is made one-half as frequently as the first; the ratio of the third to the second error response is greater, 0.6. If these four words then are made optional choices on a multiple-choice answer form, the ratios among the errors continue to obtain. (See Figure 1.)

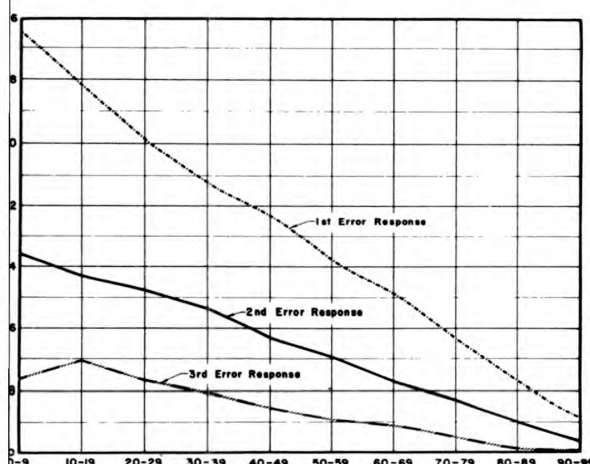


Figure 1 — Graph showing relationship of errors made by groups of individuals tested in their understanding of spoken words. "1st Error Response" refers to word most commonly substituted for correct work; "2nd Error Response," to next commonly substituted word; and "3rd Error Response," to third most commonly substituted word. Irrespective of the intelligibility of words, the value of the second most frequent error response is one half the value of the most frequent error response, and the ratio of the third to the second is greater than one half.

Another lawfulness emerges from measurements of intelligibility: the recognizability of a word is somewhat predictable. Obviously, the intelligibility of the individual sounds of speech can be computed. Consider the example given in the preceding paragraph: *grew* (50 percent), *groove* (20 percent), *glue* (10 percent), *group* (6 percent), and infrequent, scattered responses (14 percent). The four most frequent responses to the stimulus *grew* contain an initial sound [g] and the vowel sound [u]; thus, both of these sounds are at least 86 percent intelligible. All of the sounds of *grew* are in *groove* and some are in each of the other two words. If the stimulus were a nonsense syllable, the relation between the single sounds and the syllable would be simple: the joint product of the intelligibility of the separate sounds would serve as a predictor of the intelligibility of the syllable. With words, such an analysis leads to the unrealistic outcome that longer words are predicted to be less intelligible than shorter ones. What is actually the case is that the intelligibility of a word can be equated reasonably well with the product of the intelligibility values of its first two sounds. This does not mean that other

sounds of the word contribute nothing to its intelligibility or that all of the potential contribution toward intelligibility, carried in the first two sounds, is utilized.

The identification and misidentification of the word have been related in these paragraphs to the phonetic content of the word, particularly, and to the word's length and probability of occurrence. However, other factors are involved. In the circumstance of the preceding paragraph, if one should hear the message "the word is *grew*, not *groove*" the combination would yield approximately 70 percent correct identification; that is, 50 percent (*grew*) plus 20 percent (*groove*). Possibly, if the message were "the word is *grew*, not *groove*, and not *glue*" the reception would be approximately 80 percent correct.

Another way to improve the intelligibility of a word is to put it in context. The word then becomes more than the sum of its phonemes, and its length is of relatively little consequence. How much improvement? How much context? By context, we do not necessarily mean discourse or sentences. Meaningful sentences, of course, increase the intelligibility of the member words. "Mary *grew* radishes" would never be misinterpreted as "Mary *groove* radishes." But, even a low-order approximation of English syntax provides sufficient context to improve intelligibility. For example, if the word preceding and the word following a test item "fit" the test item, that item is more intelligible than it would be in isolation, irrespective of the nonsensical character of the group of words. Thus *grew* is progressively more intelligible in these successive messages, which were presented at random to panels of listeners: (1) "*grew*"; (2) "*grew* not *groove*"; (3) "were they *grew* some little"; and (4) "little Mary *grew* some radishes."

Much lawfulness contributes to the listeners' correct and incorrect identifications of verbal material.

The Communicators and Their Language

The 12-member crew from which measures of intelligibility were obtained was described as serving rotationally as speakers and listeners. Each man's functions were both oral and aural, comparable to those of both the sender and receiver of a communication team. Importantly, the two functions are closely related. The data we obtained for young foreigners who are speaking English in an American university provide a convincing illustration. Although such students are very carefully selected for enrollment in American universities, there is marked disparity among them in their ability to cope with English, both in speaking and listening. The following experiment makes this disparity evident.

Twenty-four Hindi, 24 Spanish, and 24 Japanese speaking students in an American university were tested for listening comprehension.

Based on this test, each group was divided into upper and lower halves, and the performance of the two subgroups was observed and compared. All of the students read multiple-choice intelligibility tests on which test words were arranged in groups of three, preceded by an identifying phrase, such as "Number one airport bark tassel," ("Number one" being the identifying phrase and "airport," "bark," and "tassel" being the test items). A group of words arranged in this fashion was spoken as though it were a continuous sentence, one "sentence" each 10-seconds. All of the acoustic material was recorded. Subsequently, three sets of measures were obtained from the recordings, two from responses of panels of American listeners and one from a meter for detecting and measuring the durations of pauses.

Statistical analysis of the measures revealed the following facts: (1) In each language group, the half consisting of the better listeners was also the half consisting of the more intelligible speakers. (2) In each language group, the poorer listeners exhibited more foreign dialect than the better speakers. (3) In each language group, the better listeners, when speaking, spent more time making the sounds of speech and less time pausing than did the poorer listeners. The interdependence of speaking and listening abilities demonstrated in this experiment is in keeping with a theory held currently which relates speech perception to speech production. Essentially, according to this theory, called the motor-behavior theory, the sounds which a person does not readily produce orally, he cannot readily perceive aurally, and vice versa.

According to our present understanding, there seems to be little relationship between the motor-behavior theory and the idea that there is a human repository for vocabulary and language structure. In order to support his own theories of information transfer, communications-theorist Claude Shannon developed a method applicable to tests of the motor-behavior theory in language. An early modification of his letter-predicting technique permits the investigator to provide the correct response in the event the experimental subject gives an incorrect one. The subject may progress at a fairly rapid pace in the following manner:

The predictor (subject) might say...	The investigator would say...
1. <i>t</i> (he might be thinking of <i>the</i>)	wrong, <i>h</i>
2. <i>a</i> (he now knows the first letter is <i>h</i> ; he is thinking possibly of <i>half</i>)	wrong, <i>e</i>
3. space (he assumes the word is <i>he</i>)	right
4. <i>a</i>	wrong, <i>l</i>
5. <i>e</i> (he is thinking of <i>let</i>)	wrong, <i>o</i>

6. <i>s</i> (he is thinking of <i>lost</i>)	right
7. <i>t</i>	right
8. space	right
9. <i>h</i> (he is thinking of <i>his</i>)	wrong, <i>t</i>
10. <i>h</i>	right
11. <i>e</i>	right
12. space	right, etc.

The outcome of the letter-predicting procedure would seem to relate to one's knowledge of English vocabulary and syntax.

In one test utilizing this technique, three groups of students were asked to predict four English phrases and sentences: 25 native students in an American university, 25 Italian students who were sufficiently confident of their mastery of English that they had applied for scholarships to American universities, and 25 Yugoslavian students who had studied English for 8-12 years in school. The results indicate that a relatively small advantage was held by the students to whom English was vernacular. Indeed, similarities of the letter-predicting responses of the three groups are striking, not at all in keeping with the disparities that are common in the aural perception and oral production of American speech in such groups of students. (See Figure 2.)

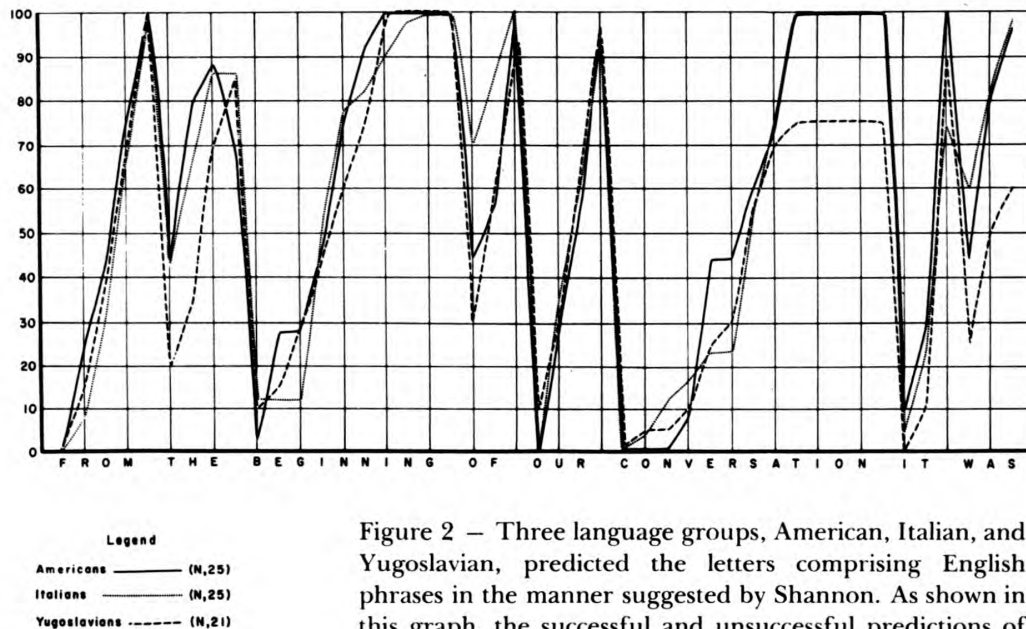


Figure 2 — Three language groups, American, Italian, and Yugoslavian, predicted the letters comprising English phrases in the manner suggested by Shannon. As shown in this graph, the successful and unsuccessful predictions of the three groups are comparable.

Improving the Operators

Could the flaws of the communication network in which a 12-man testing crew operates be mended? The misunderstanding of words was attributed to the code, the talker, and the listener, not to any weaknesses in the line. Obviously, improvements are feasible. A relatively intelligible code or language would exploit the better part of phonetic intelligibility, and it would utilize context and probable words and avoid bizarre signals and rare words.

Training that focuses upon intelligibility elicits in the second or third session a common-sense behavior that was learned in childhood and is often drawn upon in later life after repeated failures in communication: loud talk and clear articulation. Importantly, a person can be his own teacher of intelligibility. Utilizing the now familiar multiple-choice intelligibility test phrase, "Number one airport bark tassel," young Mr. Mumbler sits in a small booth, faces a panel, and reads aloud *number one airport bark tassel*, which appears in an open window above a tele prompter. Mumbler has scarcely finished reading when he hears a similar message, *number ten group flicker beef*. A second window above the teleprompter presents visually three columns with four words in each and permits the subject to select, by pushing an appropriate button, one word from *group*, *troop*, *coop*, *fruit*; one word from *flicker*, *quicker*, *slicker*, *liquor*; and one word from *beef*, *beast*, *beat*, *beam*. If he selects the correct responses, a numerical score, cumulative for the entire exercise, flashes in front of him. The machine is programmed to present one frame of verbal material after another. Successive lights prompt the subject to push a sequence of buttons that brings into view new material for reading and that is synchronized with the recordings of phrases with which he was tested earlier. (See Figure 3.)

Mumbler hears and talks alternately. The words that he hears now are the ones he spoke a few moments ago, *number one airport bark tassel*, and the voice is his. Time and preoccupation have taken a toll: his memory helps him very little, if any. Mumbler's articulation is so poor he must now almost guess what he just heard himself say from a recording that was made only four or five minutes previously. Then he presses a button for a score; he was wrong! He cannot understand himself! This is challenging. He draws upon his lifelong experience in talking and listening; he talks louder and clearer. He tends to improve in his ability to understand himself. He is talking better. It could be that he is only paying attention and memorizing what he says in order to use this memorized version when the time comes. But we know that is not what has happened, because a recorder was put into the system, and Mumbler's recorded speech was played back to a panel of listeners. They, too, recognized the latter part of his exercise to be more intelligible than the earlier part.

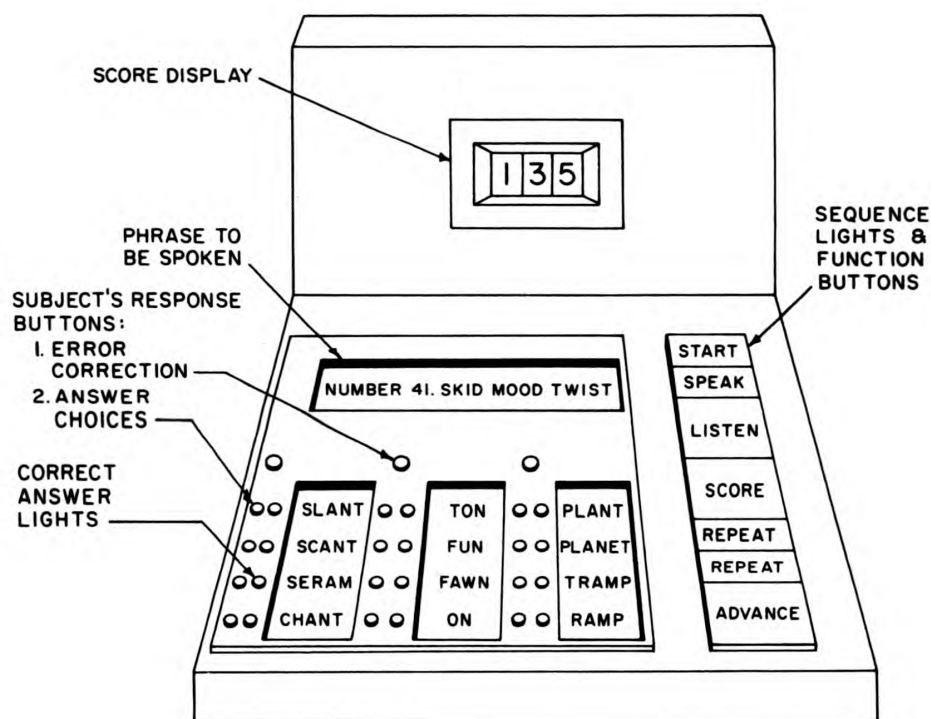


Figure 3 — The panel of a device for self instruction in intelligibility.

The ability of men to speak and hear words intelligibly upon the first utterance of the words, particularly when the men are transmitting or receiving Naval or other military messages, is obviously vital. The experimental procedures discussed in this article reveal not only the weaknesses of voice communication, but also techniques which might be utilized to overcome them. Through the careful engineering of messages and the training of oral-aural communicators, first-time high intelligibility can be achieved. Especially important to the training sessions conducted to achieve high intelligibility is the provision of a means whereby the communicators learn to recognize their own inadequacies so that they can help themselves to become intelligible.

—Continued from front (inside) cover

The present system covers a circular area nearly 1,000 feet in diameter. Around the perimeter of this area is a 65-foot-high circular screen composed of 960 vertical wires. The screen is supported by 120 poles of the same height. Surrounding the screen is a circle of 120 vertical antennas, each 16 feet high, connected by individual cables to a radio receiver inside the circle.

This instrument can scan the horizon as many as 900 times a minute. Information is displayed on a cathode-ray tube similar to a radar scope. In addition, the directional information on radio signals can be transferred to teletype tape for transmission to distant points for analysis by a computer.

Some Experiments in Marine Biotelemetry

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The dolphin, an air-breathing marine mammal, is an excellent subject for specialized investigations of physiological responses which occur in mammals, including man, in the marine environment. However, the techniques and equipment necessary for measuring these responses, particularly at considerable ocean depths and pressures, are not available at present. For this reason, Professor Baldwin is attempting to devise telemetering devices which convey physiological information from the subjects to observers at the surface. His studies, some of which are described in this article, have been supported by the Office of Naval Research, the Army Research Office, and the Air Force Office of Scientific Research.

In the summer of 1964, Kenneth S. Norris of the University of California at Los Angeles released two mature dolphins in the open ocean in order to conduct physiological and hydrodynamic studies of these mammals, which were trained to return from their natural environment on command of the investigator. The event represents a pioneering effort to obtain detailed information on the physiology and behavior of marine animals with the aid of telemetric instruments.

Norris' experiment was undertaken to determine the maximum swimming velocity of dolphins in both rough and quiet water and the depth to which these air-breathing mammals can dive. While the results have yet to be interpreted fully, the inferences are that a single dolphin, *Tursiops gilli*, attained swimming velocities of about 15 knots in both the open ocean and in quiet water without causing wave action. Another species, *Steno bredanensis*, dove to a depth of 125 feet before the test was interrupted by the arrival of several large sharks. Perhaps this short experience highlights both the potential of such work and our ignorance of the difficulties we face.

Marine biotelemetry offers the hope that observations of the physiological ecology of sea animals may be made accurately in realms that are beyond the range of the human senses. While the link between the observer and the observed animal is not as tenuous as it is in many space experiments, the medium of the deep sea is almost as foreign to our knowledge, at this time, as the medium of space. Nevertheless, exciting progress has been made in recent years in obtaining first-hand observations of living creatures in the ocean depths—for example, by the building of protective “cocoons” around observers and the lowering

*Research Associate in Zoology, University of Arizona.

of elaborate instruments. Many such procedures are still expensive or difficult to carry out successfully, however, so alternative methods of obtaining the information are being studied. One of these approaches involves the use, as "observers," of certain marine animals whose physiology and sensory skills are comparable to those of the human. It should be possible to monitor remotely the physiology of an air-breathing marine animal, such as the dolphin, and develop an understanding of its reactions and adaptation to high pressure and cold temperature in the real environment beyond the laboratory.

The study of other marine animals offers interesting possibilities, also, and should produce many new insights into the ways those animals have solved problems that are subjects of current research interest. A few of the more obvious questions biologists are pondering are how do whales extract fresh water from saline water for drinking, how do many migratory animals navigate in the trackless regions of the sea, and how do seals and whales solve the problems associated with deep diving. The sensory skills of marine life are extremely varied, and their study should teach us much about visualization without light and sight.

The Sensory Systems Laboratory, Tucson, Arizona, has been concerned with the development of experimental techniques in which instruments are attached to freely moving aquatic animals. A system for injecting olfactory attractants (fish fluids) into the nostrils of a shark was developed and tested in the summer of 1963 at the Cape Haze Marine Laboratory, Sarasota, Florida. The objective was to determine the ability of the nurse shark, *Ginglymostoma cirratum*, to detect weak stimulants against a natural background, and to learn whether this animal employs its nostrils to localize the source of an odor. Two hypodermic syringes were mounted on the body of a shark in such a way as to inject the test fluid into its nostrils at a known flow rate and at a predetermined concentration. The first ultrasonic transmitter applied to this experiment was suitable for remote off-on control of the syringes in relatively small enclosures or ponds. More recently, small battery-operated transmitters have been constructed that permit control to be effected at ranges in excess of 1,000 feet in the open ocean.

A photograph on page 19 shows the receiver portion of the system being mounted on a large nurse shark in the initial feasibility studies. In this case, the receiver and syringe assembly are being attached to the body surface with quick-setting adhesive. Fortunately, the nurse shark is relatively lethargic and survives for considerable time when removed from sea water.

Recent experiments with ultrasonic telemetry have led to the ability to record electrocardiogram (EKG) signals from freely swimming mammals. Records have been obtained from the harbour porpoise (*Phocaena phocaena*), the Greenland seal (*Phoca groenlandica*), the Pacific white sided dolphin (*Lagenorhynchus obliquidens*), the pilot whale (*Globocephala*

malaena), and man. A photograph on page 18 shows an EKG transmitter that has been attached, by an elastic strap, to the Greenland seal. Silver-silver chloride electrodes in small suction cups are placed in the vicinity of the heart to obtain a differential input. The system provides an excellent electrocardiogram. The record is free of drift and is uncluttered by extraneous signals representing muscle activity associated with swimming and breathing.

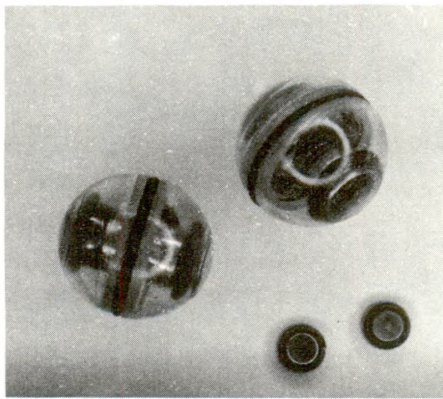
Surface detection of voltages associated with heart action in cetaceans was much easier to achieve than was expected originally on the basis of experience with man. The skin of these animals is unusually smooth, and the small suction cups prevent the shorting effect of the high conductivity of sea water. Bradycardia, or slowing of the heart rate, which occurs in all diving mammals investigated to date, including man, was demonstrated with the telemetry system. The instrument is suitable also for studies of fish when needle electrodes are substituted for surface electrodes.

The EKG transmitter employs frequency modulation of a 50-kilocycle carrier. This modulation technique was selected to eliminate multipath propagation problems in the transmission of accurate analog data. A high impedance input circuit results in considerable reduction of the problems usually associated with surface movement of the electrodes on the body. Small mercury batteries provide about 8 hours of operating time at 70°F. Transmission ranges of 70 to 100 feet are obtained in the open sea, but considerable distortion of the sound field is caused by the high reflectivity of air in the lungs. No loss of signal has been observed in large tanks or aquaria where reflection of sound energy occurs at the sides of the enclosure. The companion FM receiver provides high gain and selectivity in the 45- to 55-kilocycle band. A beat-frequency oscillator is used to obtain an audible signal so that data may be recorded on magnetic tape.

Records were obtained for two hours while the Greenland seal was swimming freely in its tank, apparently completely at ease. Dolphins and some seals show an initial fear reaction when the ultrasonic transmitter is placed in their vicinity, but they seem to accept the device once they become accustomed to the ultrasonic signal.

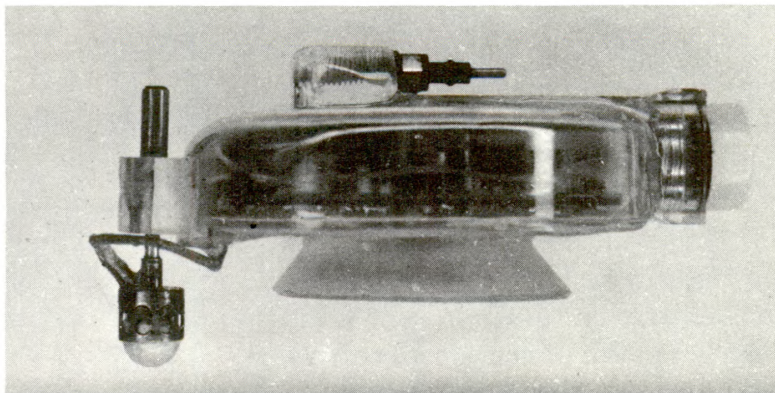
Several of our experiments have been concerned with the measurement of maximum or typical depths to which air-breathing marine animals dive. Mr. Gerald Kooyman of the University of Arizona has employed small recorders, 2-1/2 inches in diameter, to measure both the time and depth of dives of the Weddell seal in the antarctic. Data have been obtained showing that these animals are capable of reaching depths of 1428 feet during dives lasting 28 minutes. Recovery of these recorders is possible when the experimenter selects a breathing hole in the ice to which the instrumented animal must return.

Additional preliminary information on depths to which seals dive was obtained during the 1964-65 antarctic expedition with a small



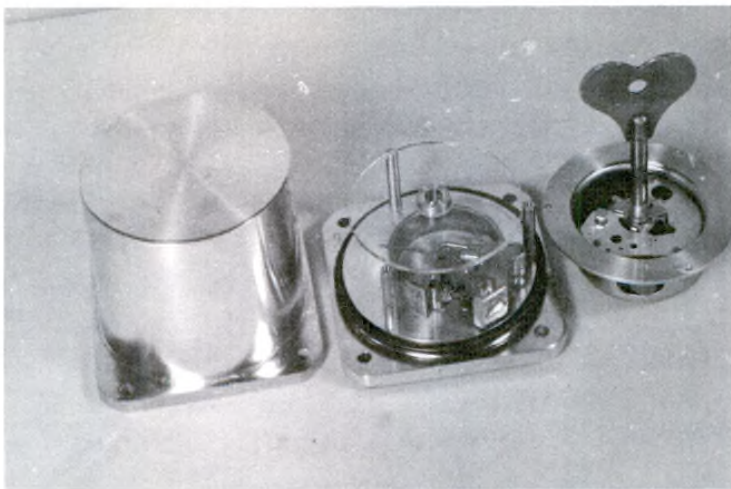
In a large tank about to be filled with water, a Greenland seal (*Phoca groenlandica*) awaits a study of heart action to be conducted while the animal swims freely. Measurements are obtained by an electrocardiogram transmitter, which is held in place on the seal by an elastic strap.

Neutrally buoyant transmitters designed to measure properties of fluid media. The larger spheres are less than an inch in diameter.

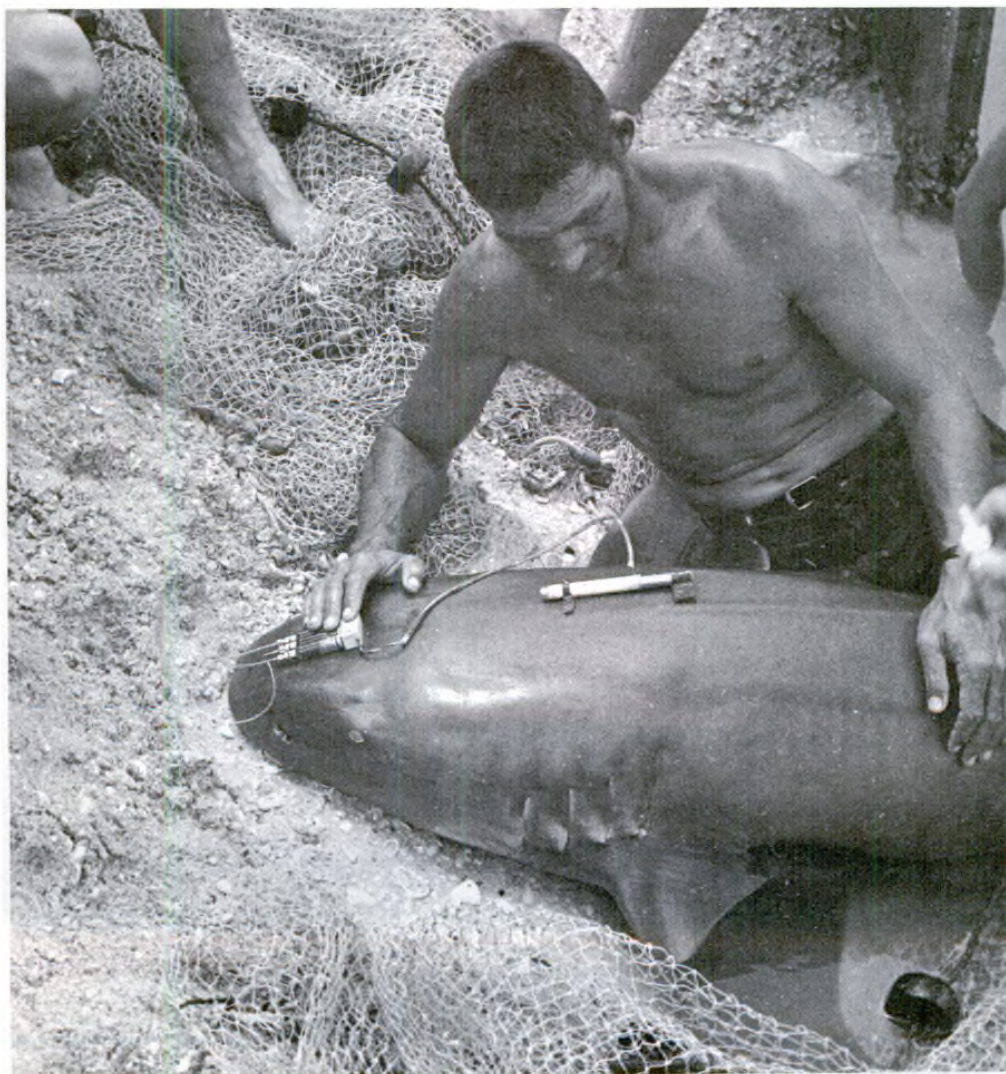


An instrument design for the detection of sound transmission generated by dolphins. The spherical hydrophone is held in contact with the body of the animal by a suction cup. The unit is about 5 inches long.

Components of an experimental depth-time recorder. The device was designed for attachment to the Weddell seal.



A remotely controlled ultrasonic receiver and syringe assembly are attached to a nurse shark in preparation for studies of olfaction.



ultrasonic transmitter. This device transmits an ultrasonic tone (45 to 55 kilocycles) that is proportional to the depth at which it is carried by an animal, and it enables one to track the animal during a dive by means of a directive hydrophone array. Some 50 dives have been recorded with this device, the deepest of which was to about 1000 feet. In another dive, the Weddell seal was tracked while swimming between breathing holes in the ice cap one mile apart.

Radio-frequency transmission through water and biological material is a valuable means of obtaining data when bandwidth requirements are large and the range required is low. A transmitter developed for use in dental research was introduced into the stomach of a 7-1/2-inch bass and was retained by the fish for about 2 hours. Continuous transmission was received from the device through about 14 inches of fresh water. The transmitter consisted of a radio-frequency oscillator (125 megacycles) operated with a single mercury cell. These devices weigh as little as 0.86 grams and transmit for about 5 days.

The preliminary experiments described here led to the design and construction of an FM radio-frequency transmitter for the detection and transmission of dolphin acoustic activity in studies of the animal's ability to communicate and echolocate. The transmitter unit, which is about 3 inches in diameter, adheres to the body of the dolphin (*Tursiops truncatus*) by means of a suction cup and thus allows the investigator to locate sources of sound energy on the surface of the body. Transmission from individual animals in the same enclosure may then be separated for acoustical and behavioral analysis. The transmission range in sea water at these frequencies is extremely limited (approximately one foot) and it is inversely proportional to the salinity of the medium. Signals can be obtained from the bottom of an 8-foot-deep fresh water pond with the same device.

The telemetry of environmental data is expected to be of value also in ecological studies. Preliminary efforts to design equipment for such studies have been directed to small neutrally buoyant transmitters for measurement of the properties of fluid media. These transmitters are contained in small spheres, about one inch in diameter. Our current investigation deals with an analysis of the accuracy with which such transmitters can be located in two dimensions in moving fluids. Similar units have been designed to monitor temperature and pressure in such an environment.

In summary, marine biotelemetry is an experimental technique that is only just beginning to receive recognition. It offers an unusual opportunity to conduct experiments in natural environments that should lead to a fuller understanding of the sensory and regulatory physiology of animal life. It should also give us the ability to monitor aquatic microenvironments of living systems without disturbing those characteristics which may be important.



A Navy plane skims low over ARLIS II. In the background is a row of the island's rocky hills.

ARLIS II Traverses Greenland Sea

ARLIS II, a drifting arctic ice island on which the Navy operates a scientific laboratory as part of its arctic research program, has begun an historic transit of the Greenland Sea. The ice island's course southward toward the Atlantic Ocean will permit the study of an area which surface ships have never penetrated in winter and only rarely in the summer months. As of February 12, the 3-1/2 mile long by 1-1/2 mile wide island was located at 78° 31.5' N. latitude and 8° 15' W. longitude, about midway between the northeastern coast of Greenland and the northwestern coast of Spitzbergen.

The scientific station is maintained and supported by the Office of Naval Research through the Arctic Research Laboratory, Point Barrow, Alaska, which is operated for ONR by the University of Alaska. Its normal complement is 12 to 15 scientists and support personnel. (See *Naval Research Reviews*, Sept. 1961 and Feb. 1963).

ARLIS II, which stands for Artic Research Laboratory Island II, is a chunk of fresh-water (glacial) ice, from 40 to 80 feet thick, covered in many places with large piles of glacial debris.* It was discovered (or perhaps rediscovered, as an island answering its description was sighted on several occasions in the past, even by Admiral Peary in 1909) by Max Brewer, director of the Arctic Research Laboratory, in May 1961. The island was then drifting with the surrounding pack ice about 130 statute miles north of Point Barrow. Since then, it has followed a meandering path and is now about 1400 miles northeast of the point where it was first manned.

Even to the most discerning observer, ARLIS II looks remarkably like a snow-covered land mass. Its gently rolling topography differs markedly from the surrounding pack ice, whose perfectly flat surfaces alternate with heaps or ridges of blocky, broken ice. From "dunes" of glacial debris, the island's surface slopes gently downward to the pack ice of the ocean. At some places along the periphery of the island, the "coastline" is smooth like a beach, and in others, it is rugged, as the result of blocks of ice being pushed up on "shore". In the summer, a river, muddy with glacial silt and pebbles, cascades off the edge of the island to the pack. The piles of glacial debris, ranging in size from large boulders to fine silt, probably represent a terminal moraine that was deposited originally on some ice shelf in the Canadian north. These rock piles look very much like mountains, because of the faulty depth perception and lack of perspective which so commonly afflict observers in polar areas.

Only once before has a manned drifting ice station traversed the Greenland Sea. This station was the Russian NP-1, which made the trip in 1937-38 when instrumentation and techniques for making meteorological and oceanographic studies were primitive compared to those in use presently. NP-1 was an ice floe, which is smaller and less stable than an ice island. Only one other ice island has ever been inhabited by the United States for arctic research, and that one is Fletcher's Ice Island, or T-3, which is also operated by ARL for the Navy. It is now drifting between Point Barrow and ARLIS II. The Russians, who occupy two drift stations currently, NP-12 and NP-13, which are ice floes, have manned one ice island in the past.

The drift of ARLIS II through the Greenland Sea provides this country with the first opportunity to study in detail this relatively unknown geographic area. The Greenland Sea is particularly significant to the Navy, because it provides an important deep-water access route for submarines into the Arctic Ocean. It is also important scientifically,

*A discussion of the origin and structure of the island appears in the *Journal of Glaciology*, Vol. 5, No. 37, Feb. 1964. The report, entitled "Ice Lithologies and Structure of Ice Island ARLIS II," was prepared by David D. Smith on the basis of a study supported by ONR.

because it includes the broad transition zone where cold arctic waters and warmer Atlantic waters are known to mix.

Five research programs are in progress currently aboard ARLIS II. One program, conducted by the Naval Oceanographic Office as part of its ice prediction and forecast mission, involves the measurement of ice strain and ice formation and observations of the drift of pack ice. A program of geophysical investigations, including gravity measurements, is being carried out by the University of Wisconsin's Geophysical and Polar Research Center. A program in arctic marine biology, including the taxonomy and ecology of marine organisms, is being undertaken by the University of Southern California. Another program concerning meteorology and sea ice physics, in which surface weather observations are made on a three-hour schedule, and celestial navigation is applied to determine the daily geographic position of the station, is being conducted by the University of Washington. In addition, the University of Washington is now conducting a program for measuring currents. A team of Japanese oceanographers from Hokkaido University is engaged in studies in physical and chemical oceanography.

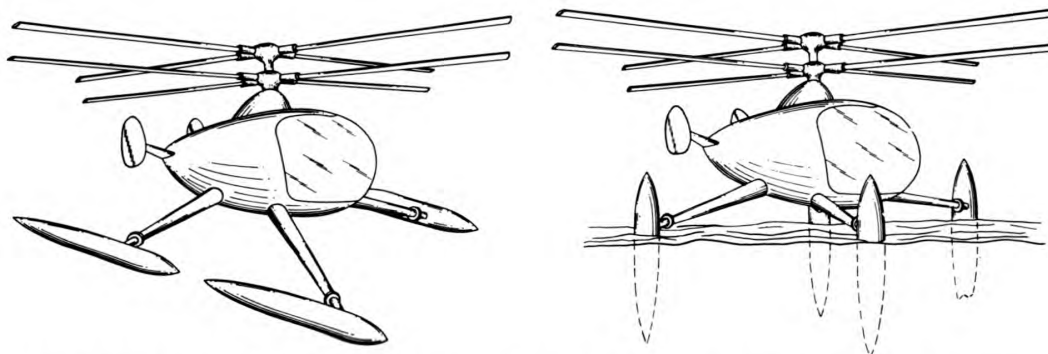
In addition to the above, two new programs are being activated on the station to exploit the drift through the Greenland Sea. These investigations will be of ocean-bottom heat flow and of a new, precise very low frequency (VLF) navigation system. More accurate information on the station's daily progress will be needed since ARLIS II is expected to move considerably faster than it has during its previous wanderings. The Russian NP-1 was reported to have traveled at an average speed of 20 miles per day during the latter part of its transit of the Greenland Sea. Based on the experience of NP-1, ARLIS II may have to be evacuated by April.

The basic mission of the Arctic Research Laboratory is to accomplish those programs of basic and applied research which contribute to successful Navy operations in arctic and sub-arctic regions. The temporary occupation of drift stations makes it possible to extend its research hundreds of miles into the Arctic Ocean Basin. For example, ARLIS II spent a period of its drift in the eastern hemisphere, which provided the Navy with its first opportunity for detailed studies in this region.

The fundamental knowledge of arctic environments that is being gained through this research will contribute to such Naval objectives as improvement of under-ice sonic and electromagnetic communications, navigation, detection and surveillance systems, including through-the-ice communications; the marking out of major access and egress routes for nuclear submarines in the Arctic Basin; improving methods of submarines surfacing through sea ice; developing techniques for construction on permafrost terrain; weather and ice forecasting; and gaining experience in naval operations in the arctic.

Inventions

Tilt Floats for Helicopters and Seaplanes



Views of an amphibious helicopter landing on the ocean with its floats in normal, horizontal position (left) and at rest on the water with its floats in vertical position (right).

The development of anti-submarine-warfare technology and the increased emphasis on air-sea rescue capabilities have pointed up the need for aircraft that can land upon the open sea and hold a stable position there while conducting operations.

While hovering, a helicopter is sufficiently stable to enable sonar gear suspended from it to function effectively and to enable people to be picked up from the water. However, in the process of holding a stable position, a large amount of fuel is consumed, thus limiting the range of the aircraft. Fuel consumption is reduced greatly, of course, if the helicopter lands on the water, but then the plane's stability is reduced by the action of the waves and wind, especially if the height of the waves is greater than 3 to 5 feet or the velocity of the wind is greater than 7 to 10 knots.

In view of these difficulties, Eugene H. Handler, of the Bureau of Naval Weapons, conceived a tilt-float pontoon system that enables a helicopter or seaplane to maintain good sea-keeping characteristics while floating on the ocean surface. The concept, disclosed in U.S. Patent No. 2,973,169, provides for tiltable or retractable pontoons. Vertical positioning of the floats acts to minimize the effects of the wind and sea state upon the aircraft, thus allowing on-the-sea operation, which otherwise might not be possible.

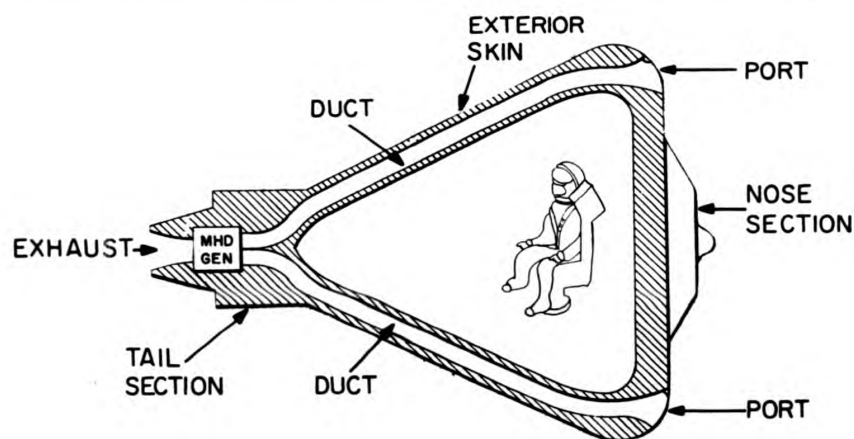
Operational tests of aircraft provided with tilt floats have been conducted in both the Atlantic and Pacific Oceans. A float-equipped DSNI helicopter tested by the Gyrodyne Company in Long Island Sound demonstrated good sea-keeping characteristics. On the Pacific coast, the sea-keeping characteristics of a PBM equipped with the floats was compared with those of a PBM not so equipped. The stability

of the plane riding on the new floats was so superior to that of the other plane that the Convair Corporation is now working toward the development of a float that is both retractable and inflatable.

Power Source for Spacecraft Reentry Operations

A simple, lightweight, efficient, and fail-safe power source intended to actuate instruments during the reentry into the atmosphere and the landing of a manned spacecraft has been invented by E. A. White, Jr., of the Naval Ordnance Laboratory, White Oak, Maryland. The invention bears U.S. Patent No. 3,156,433 and is entitled "Magnetohydrodynamic Generator."

For its operation, the magnetohydrodynamic generator utilizes the gas through which the spacecraft passes in the atmosphere. As the vehicle plummets earthward, the gas adjacent to it, particularly that flowing over the nose section, is heated and ionized. This ionized gas enters a number of ports back of the nose section, moves through a system of ducts, passes into the generator, and is exhausted finally at the tail of the vehicle. While passing through the duct system enroute to the generator, the gas is accelerated still further as a result of the proximity of the ducts to the outside skin of the vehicle, which is heated to a very high temperature by the flow of hot gases over it. Upon reaching the generator, the ionized gas passes an electrode and a magnetic field system, which cause the desired current to be produced.



Schematic view of a manned spacecraft, showing location of MHD generator, ports, and duct system. The invention is applicable to other spacecraft configurations also.

On the Naval Research Reserve

SIXTH NAVAL DISTRICT REPORTS

NRRC 6-6 Receives Award

On November 16, 1964, the first place plaque award for the Sixth Naval District for fiscal year 1964 was presented to Naval Reserve Research Company 6-6, Chapel Hill, N.C., by CAPT R. W. Warner, USN, head of the Department of Naval Science at the University of North Carolina. During the competition period every officer in the 31-member unit earned a satisfactory year of Federal service, and 65 percent of the membership participated in active duty for training.



CDR Marvin E. Woodard, USNR (left), immediate past commanding officer, NRRC 6-6, receives the Sixth Naval District award from CAPT Warner (right). Other officers shown are CDR W. A. Stockdale, USNR (second from left), commanding officer, Naval Reserve Training Center, Durham, N.C.; LCDR Adger Wilson, USNR (center), present commanding officer, NRRC 6-6; and CDR F. H. Langdon, USNR (second from right), Fifth and Sixth Naval District Research Reserve liaison officer.

Research Reservist Honored

LCDR Glenn M. Gray, USNR-R, a member of Naval Reserve Research Company 6-1, Atlanta, Georgia, was honored in September by the Society of Experimental Test Pilots at its national convention in Los Angeles, California. He was awarded the plaque for the most outstanding paper, entitled "The Progress of the XV-4A Hummingbird," presented at the meeting. In civilian life LCDR Gray is employed by the Lockheed-Georgia Company, where he has been the test pilot of the experimental "Hummingbird" aircraft, a vertical take-off and landing vehicle.



LCDR Gray, of NRRC 6-1, displays his award.

15th Annual Nuclear Sciences Seminar

The Fifteenth Annual ONR Nuclear Sciences Seminar was held at Oak Ridge, Tennessee, November 30 through December 11, 1964, with Naval Reserve Research Company 6-3 serving as the host. The seminar was sponsored by the Office of Naval Research in conjunction with the Atomic Energy Commission and the Oak Ridge National Laboratory. The 57 participants included 45 Naval Reserve and 12 Army Reserve officers. LCDR James N. Robinson, USNR, served as seminar chairman.

The seminar was opened officially with welcoming remarks by LCDR Robinson. Greetings from the commandant of the Sixth Naval District

were extended by CDR J. A. Scholes, USN, executive officer, NROTC Unit, Vanderbilt University. CAPT L. B. Melson, USN, director, Naval Applications Group, ONR, reviewed recent significant Naval research and development accomplishments. In addition, he gave an illustrated presentation on the Navy's SEALAB I underwater experiment. Other opening-session talks were given by Dr. R. B. Martin, representing the manager of the Oak Ridge Operations Office, USAEC, and Dr. W. G. Pollard, executive director, Oak Ridge Institute of Nuclear Studies.

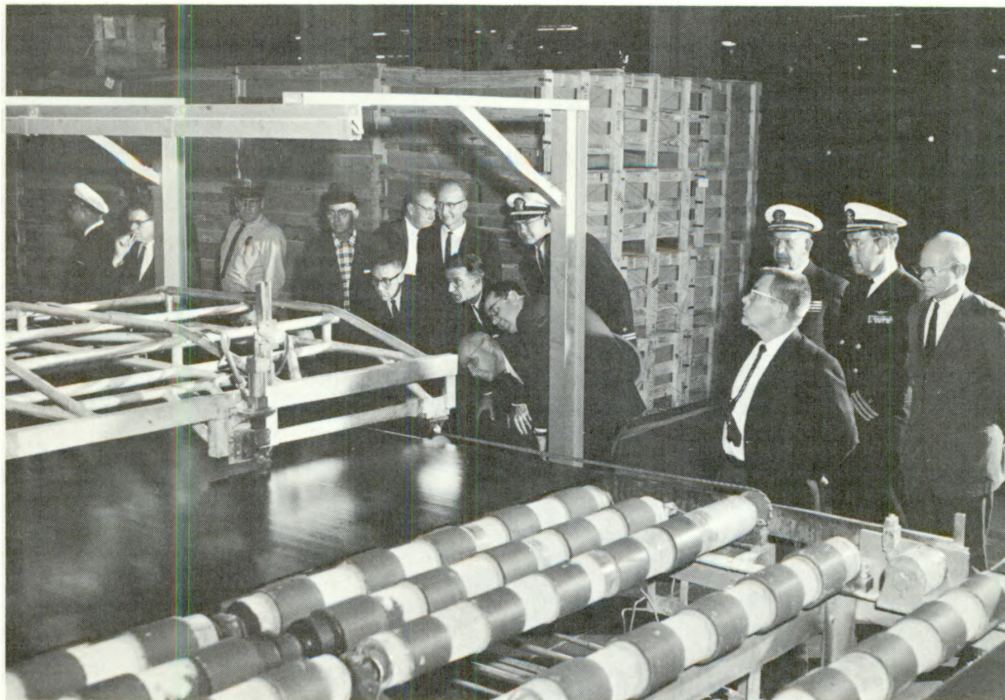
During the two-week seminar, discussions were devoted to various phases of the overall nuclear research program, including basic theory and applications in the field of nuclear energy, the life sciences, the use of isotopes, and the development of nuclear reactors for military, space, experimental, and power uses. The lectures were given by scientists and engineers associated with the Oak Ridge National Laboratory, the Oak Ridge Institute of Nuclear Studies, the University of Tennessee-AEC Agriculture Research Facility, and military speakers.

Military speakers and the subjects of their presentations were as follows: "The Research Reserve Program," by CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve); "Nuclear Weapons," by CDR Glenwood Clark, Jr., USN, Headquarters, Defense Atomic Support Agency, Research Division, Department of Defense; "Air Force Nuclear Power Program," by CAPT H. M. Mitchell, USAF, Nuclear Power Division, Headquarters, U.S. Air Force; "Army Nuclear Power Program," by LT COL E. J. Denz, USA, Office of the Chief of Engineers, U.S. Army; "The Polaris Submarine Program," by CAPT J. K. Leasure, USNR; and "Promotion-Retirement Attrition," by CDR R. D. Marion, USNR, officer in charge, U.S. Naval Reserve Recording Activity.

Field Trips were made to the University of Tennessee-AEC Large Animal Irradiation Facility, the Bull Run Steam Plant, and the Oak Ridge National Laboratory. At the Oak Ridge National Laboratory, the group visited the Biology Division Laboratory, the Tower Shielding Facility, the Homogeneous Reactor, the Molten Salt Reactor Experiment, the High Flux Intensity Reactor and Transuranium Facility, the Experimental Gas Cooled Reactor, the Oak Ridge Isochronous Cyclotron, the High Radiation Level Examination Laboratory, and the Oak Ridge Research Reactor.

Glassmaking Plant Visited

Members of Naval Reserve Research Company 6-18 observed the "last word" in technical research and development in the glassmaking industry during their visit to the Ford Motor Company Glass Plant in



Members of NRRC 6-18 observe glassmaking during field trip.

Nashville, Tennessee, on November 2, 1964. The officers were treated to a glimpse into the future in the largest automotive-glass-producing plant in the world. Particularly impressive were the demonstrations of technological developments that have been achieved in safety glass for automobile windshields.

CDR Ned L. Warren, USNR, is the commanding officer of NRRC 6-18, which recently received the Sixth Naval District second place award for Naval Reserve Research companies for fiscal year 1964.

NRRC 6-3 Visits RIDL

On November 18, 1964, members of Naval Reserve Research Company 6-3, Oak Ridge, Tennessee, visited the Ridge Instrument Development Laboratory, where they were shown the latest electronic analyzers and counting instrumentation. Since this unit was established in 1949, it has been interested actively in the nuclear sciences. This interest has been expressed through the company's organization of the first emergency radiological defense squad in the southeastern area, in 1950, and through its sponsorship of annual seminars covering current developments in the nuclear sciences.

IN THIS ISSUE

VOL XVIII NO. 2

Status and Potential of Research Ballooning HENRY DEMBOSKI 1

Plastic balloons have proved to be such effective research vehicles that they are constantly being required to reach higher altitudes and carry more weight. As a result, the flight reliability of research balloons is now approaching 50 percent.

Communication by Voice JOHN W. BLACK 7

Messages delivered by voice—still the most common means of communication in the military services—often fail to “get through” because of the speaking and listening practices of the communicators. The author discusses the problem and a solution to it.

Some Experiments in Marine Biotelemetry H. A. BALDWIN 15

Ways of overcoming difficulties that have been experienced in obtaining information on the activities of marine animals in their natural environment are explored in this discussion of the telemetering of physiological data from subject to investigator.

ARLIS II Traverses Greenland Sea 21

An ice island manned by scientists is moving from the Arctic Ocean into the North Atlantic. The “voyage” will enable the scientists to explore a new region, but it will also bring about the “island’s” disintegration.

Inventions 24

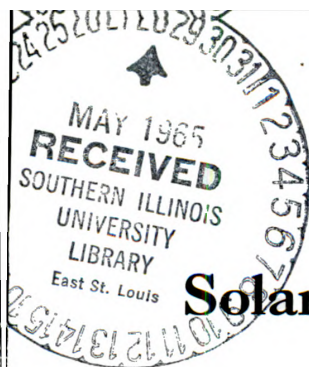
On the Naval Research Reserve 26

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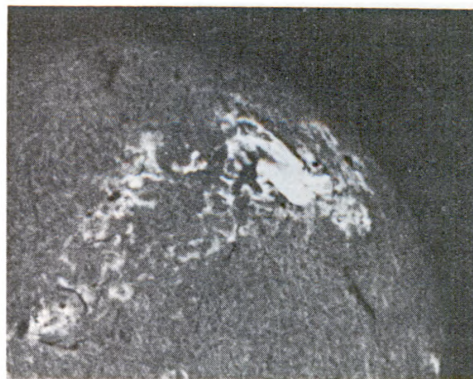
A new decay mode of an extremely rare elementary particle, known as the Omega-minus, was discovered recently by the Nucleonics Division of the Naval Research Laboratory in collaboration with the University of Maryland. The negatively charged Omega particle had been observed only three times before. Shown on the front cover is a photograph and an explanatory sketch depicting the new decay mode of Omega-minus. The path of the incident beam particle is labeled (1); that of the new Omega particle is labeled (3). Omega-minus (Ω^-) is produced by an interaction of particle 1 with a proton in the hydrogen bubble chamber along with particle 2 (a positive K-meson, K^+) and a neutral K-meson, K^0 , which decays into particles 6 and 7. The Omega particle decays shortly thereafter into particle 4 (a Xi-hyperon) and a neutral pion. The Xi-hyperon decays in turn into particle 5 and a Lambda-hyperon. The Lambda-hyperon then decays into particles 8 and 9, a proton and a negative Pi-meson, respectively.



Solar Flares

Harold Glaser

*Head, Nuclear Physics Branch
Office of Naval Research*



H₂-filtergram of northeast quadrant of solar disc showing a large solar flare. The filtergram, one of a series reproduced on page 3, was taken on May 10, 1959. Courtesy of the Lockheed Solar Observatory.

Interest in solar flares on the part of government agencies is due to consequences of their effects upon the earth's magnetic field, its atmosphere and ionosphere, and the earth's extra-terrestrial environment. In general categories, flares can be described as emitting (1) particles of high and low energies; (2) x-rays, ultraviolet and visible light; and (3) microwaves and radio waves. Each of these emissions is now known to have numerous practical consequences. Certain of these consequences will be mentioned in some detail later. The very intense high-energy particle streams emitted by some flares could be destructive to delicate equipment in a satellite or to an astronaut. Frequently, the effects of flares disrupt terrestrial communications and thus are of great concern to the military services and the Department of Defense. Recently, great interest has been shown in detecting nuclear explosions in the atmosphere and space. Solar flares can produce effects that may either mask various manifestations of nuclear explosions or cause some detection equipment to set off false alarms.

To an observer, a solar flare appears as a sudden brightening of a small area on the solar disk over a limited part of the visible spectrum. The first recorded observation of a flare was made on September 1, 1859. This observation was very unusual in that only extremely bright flares can be seen in white light. This particular flare was followed by a great magnetic storm and intense auroral activity. The early investigators hesitated to connect these phenomena, but we now know that they were intimately related. Following this event, solar observers saw, on occasion, brightenings of various solar spectral lines, especially the hydrogen alpha line (6563A). However, the systematic study of flares did not begin until Ellery Hale invented the spectrohelioscope in 1926. Not until about 20 years ago were flares connected with radio fadeouts, and only since 1956 has the enhanced ionization of the D-

region of the ionosphere been associated with x-ray bursts from flares (this association was first made at the Naval Research Laboratory).

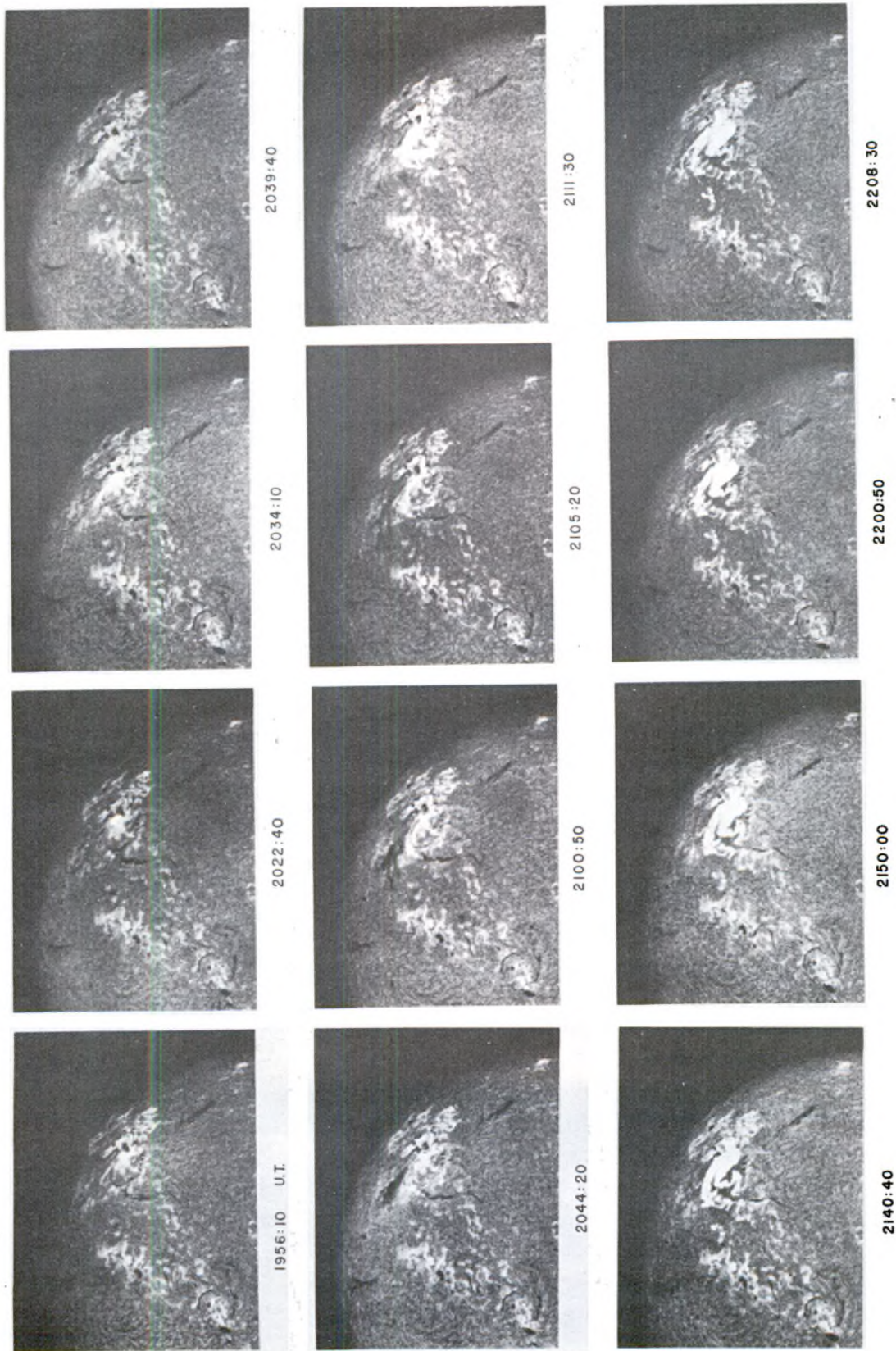
Observed flares are categorized according to the area of the solar disk that is brightened in hydrogen alpha (6563Å). The categories are termed "Importance," and they consist of Importance 1⁻, 1, 2, 3, and 3⁺. A flare of Importance 1⁻ covers less than 100-millionths part of the visible hemisphere of the sun, while a flare of Importance 3⁺ covers more than 1200-millionths of the hemisphere of the sun. The increase in visible light intensity is very sudden, taking about five minutes, and the decrease in the intensity is slow and not very well defined. Most of the energy of the flare in the visible part of the spectrum occurs in the hydrogen alpha line.

Many flares produce bursts of x-radiation that arrive in the atmosphere. This x-radiation causes additional ionization in the atmosphere that manifests itself in a variety of specific ways on the sunlit hemisphere of the earth:

- Shortwave radio fadeouts (5-20 mc).
- Increased absorption of incoming cosmic radio noise at frequencies of about 8 megacycles.
- Sudden enhancement of very long radio waves reflected from the base of the D-region (~ 30 kc).
- Phase changes of very long waves (16 kc sky waves) due to a lowering of the effective ionospheric reflecting ceiling.
- Sudden field anomalies due to interference between ground wave and reflected wave from a transmitter at intermediate distances.
- The disappearance of vertically reflected waves from the E, F-1, and F-2 layers of the ionosphere (increased absorption).
- A sudden magnetic-field anomaly. This effect, called a "magnetic crochet", is due to increases in conductivity of one or more layers of the ionosphere.

In addition to radio effects produced by added ionization of the upper atmosphere, direct radio-wave emissions originating in the vicinity of the solar flare and the solar corona are detected directly on earth as radio noise. These direct radio-wave emissions are characterized by types, which range from Type 1 to Type 4. They occur at various parts of the frequency spectrum, they have different durations, and their frequencies may change with time. Physical mechanisms producing these emissions are not understood fully, although plausible hypotheses are available. The understanding is not complete, particularly because a 100-percent correlation has not been found between the occurrence of the particular radio-wave emission and other characteristics of the flare.

H₂-filtergrams of northeast quadrant of the solar disc showing the development of a large solar flare. The series was taken on May 10, 1959. Courtesy of the Lockheed Solar Observatory. 



Some flares emit low-energy particles in the form of plasma streams which perturb the earth's magnetic field as they pass. Some of these particles probably interact with the atmosphere to produce aurorae and may also feed the Van Allen belts. Of great importance to communications are what are called "polar cap absorptions." The flare particles—low energy protons—arrive at the polar regions of the atmosphere, getting in around the earth's magnetic field. The protons ionize atoms and molecules in the upper atmosphere, increasing the net ionization of the ionosphere. This activity changes the character of the ionosphere and very strongly perturbs communications. A very strong correlation has been found between polar cap absorptions and flares of Importance 3 and 3+.

The prediction of a flare and its consequent space and terrestrial effects is a basic problem of great importance to various government agencies. Empirically, we know the following: flares occur in solar regions having complex spot groups. However, not all complex spot groups produce flares. Flares tend to occur in regions having a complex magnetic-field structure and in the vicinity of a magnetic neutral point. Large magnetic-field gradients must be present for a flare to occur. None of these conditions, however, guarantees that a flare will occur. Lastly, we know that flare activity follows very closely the 11-year sunspot cycle. In general, the most important practical reason for conducting research on solar flares is to discover pre-flare indicators so as to enable predictions to be made of both the occurrence and consequences of flares.

Parenthetically, in an article in *Science*, January 17, 1964, H. W. Dodson and E. R. Hedeman point out the near impossibility of predicting precisely the minimum in the solar activity cycle, the determination of which was very important to the IQSY.

Concerning the physics of flares, a fundamental problem exists which, as yet, has been answered only very tentatively: 10^{32} ergs are released in about 1000 to 2000 seconds; how is this energy suddenly released and where is it stored? A partial answer was provided very recently by a contractor of the Fluid Dynamics Branch of the Office of Naval Research—H. Petschek of AVCO Corporation. Dr. Petschek exhibited a magnetic-field configuration that could collapse rapidly enough to provide the necessary energy. Sometimes a region will produce a number of homologous flares, which are flares having identical characteristics. The rate of energy storage needed for this phenomenon has not yet been accounted for.

Another significant unsolved problem concerns the manner in which high-energy solar cosmic rays are emitted by flares. These rays have energies greater than one billion electron volts. What is the accelerating mechanism?

Still another important question that has not yet been answered relates to the fact that some flares produce no concurrent radio emission and that, conversely, some radio events take place without optical counterparts. What is the explanation? Is it possible, for example, that we are not observing all flares on the visible hemisphere? Does the situation exist because of the sensitivity of observations? Can the problem be resolved by improving seeing and by having observing stations manned more fully? The answers are not known now, but answers will have to be found.

A joint ONR-ARPA program on flare prediction consists primarily of looking for pre-flare indicators. There are four particular tasks which should be mentioned in this connection. One, which is being performed at the Lockheed Solar Observatory, consists of making correlations between magnetic-field changes and hydrogen-alpha spectroheliograms. The second task, located at the McMath-Hulbert Observatory, involves correlating various optical phenomena with the occurrence of flares. The third task, which is underway at the High Altitude Observatory, requires the correlation of pre-flare solar-limb spectra with flare activity. The fourth task is a solar-flare prediction conference run by the National Academy of Sciences.

An interesting discovery was reported in an article in the January 1964 issue of *Nature*. Z. Kopal and his co-workers detected on two occasions a red fluorescence on a lunar sea. The fluorescence is believed to have followed the occurrence of two solar flares. In prior laboratory work, a similar fluorescence was induced in some minerals by bombardment with 40-kilovolt protons, a relatively common component of large flares. This paper opens up two potentially new avenues of investigation: the use of the moon as a flare detector and the use of solar-flare emissions as diagnostic tools for determining the composition of the lunar surface.

The reader is directed to the following publications for further details on solar flares:

- Ellison, M. A., *Quarterly Journal of the Royal Astronomical Society*, 4, 62, 1963.
- Ellison, M. A., *Planetary and Space Science*, 11, 597, 1963.
- Friedman, H., *Annual Review of Astronomy and Astrophysics*, 1, 59, 1963.
- Gassman, G. J. (Editor), "The Effects of Disturbances of Solar Origin on Communications," AGARDograph 59, The Macmillan Co., N. Y., 1963.
- McKenna, S. M. P., *Astronomical Society of the Pacific*, Leaflet No. 401, 1962.
- McKenna, S. M. P., I.E.E.E. *Transactions of the Professional Technical Group on Communications Systems*, CS-11, 79, 1963.
- Odishaw, H. (Editor), "Research in Geophysics: Vol. 1, Sun, Upper Atmosphere, and Space," The M.I.T. Press, 1964.
- Smith, H. J., and Smith, E. vP., "Solar Flares," The MacMillan Co., 1963.
- Wild, J. P., Smerd, S. F., and Weiss, A. A., *Annual Review of Astronomy and Astrophysics*, 1, 291, 1963.

Secretary McNamara Sets a Goal

The following statement was extracted from a briefing given by Secretary of Defense Robert McNamara to the House Armed Services Committee, February 18, 1965:

Our military strength a decade or more hence will depend importantly on the skill and energy with which we conduct our current research effort. It is from this realm of ideas and theory that the new devices and inventions applicable to military requirements eventually emerge.

In addition to its own in-house laboratories, the Department of Defense supports nearly half of all the academic research in the physical sciences and engineering now being done in American universities and colleges. As the size of the faculty and number of graduate students in these institutions increase, their research potential will expand. We believe that in the interest of the nation this potential should be fully exploited, not only for military purposes, but for the benefits of our society as a whole. Accordingly, the Government as a whole should each year increase its support of research in these institutions, and the Defense Department should carry its share of that increase. From the point of view of the Defense Department itself, it is extremely important that we maintain our contacts with the creative research people who staff these institutions. These are the people who, in the past, have been responsible for some of the most important technical improvements in the equipment now being used by our military forces, and we should not deprive our national defense of the benefits of their creativity. We have, therefore, included in our FY 1966 request a total of \$387 million for research, about ten percent more than the amount provided for the current fiscal year. A large part of this increase is required to offset the rise in research costs, which have been moving up at a rate of about five percent a year.

In order to increase the effectiveness of our research expenditures (and our exploratory development expenditures as well), we are examining the missions and management practices of our in-house laboratories, which spend about one-third of these funds. A general upgrading of both the quality and utilization of these laboratories, together with a reduction in administrative details of their technical operations, is urgently needed.

The Neuristor

An electronic device that can serve as a substitute for transistors, resistors, and capacitors has been demonstrated at the Naval Ordnance Laboratory, White Oak, Maryland. The behavior of the device, called a neuristor, is somewhat analogous to that of a nerve fiber and thus is altogether different from the behavior of computer devices and circuits now in use.

An idea of how the neuristor functions can be obtained by comparing the device to the fuse of a firecracker. An electrical impulse moves along the neuristor's length in a way similar to that in which the burning region moves along the fuze. Unlike the fuze, however, the neuristor can be reused indefinitely. Also, a flame moves slowly down a fuze, whereas the electrical impulse moves along one inch of neuristor in less than one-millionth of a second, which is about ten thousand times faster than an impulse moves along the axon "wire" of a biological nerve cell.

The neuristor concept was proposed first by Dr. H. D. Crane of Stanford University (now with the Stanford Research Institute) in late 1960 while he was working under the sponsorship of the Office of Naval Research. Dr. Crane showed that transistors, resistors, and capacitors could all be replaced by networks of appropriately interconnected neuristors in digital computers and some other electronic systems. Since Dr. Crane's original proposal, several investigators have attempted to find a means of building such a device, but most results thus far have been too complex to be practical.

Materials Testing Unit Recovered from Deep Ocean Floor

A 7350-pound metal framework loaded with 2385 specimens of 603 different materials was recovered on December 17 from a depth of 2340 feet on the floor of the Pacific Ocean by the U.S. Naval Civil Engineering Laboratory, Port Hueneme, California. The "prize," called "Submersible Test Unit II-1," was placed on the ocean floor off the coast of California at a point approximately 14 miles west of San Miguel Island in the Santa Barbara Channel. The experiment was conducted in order to obtain information on the behavior of materials, structures, and instruments over a long period of time under conditions existing at great depths.

The frame of STU II-1 was made of 5086 aluminum alloy members joined by stainless-steel bolts, nuts, and washers. It measures 12 feet on a side and weighs approximately 2000 pounds empty.

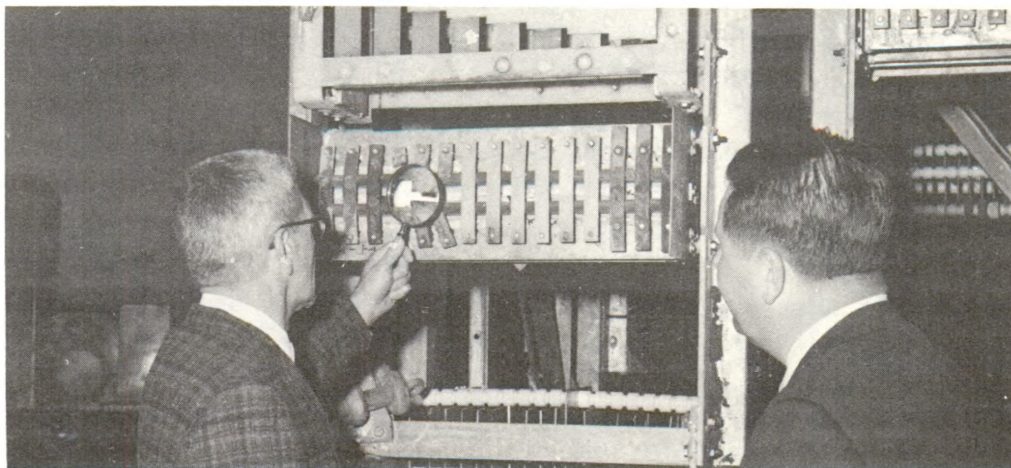
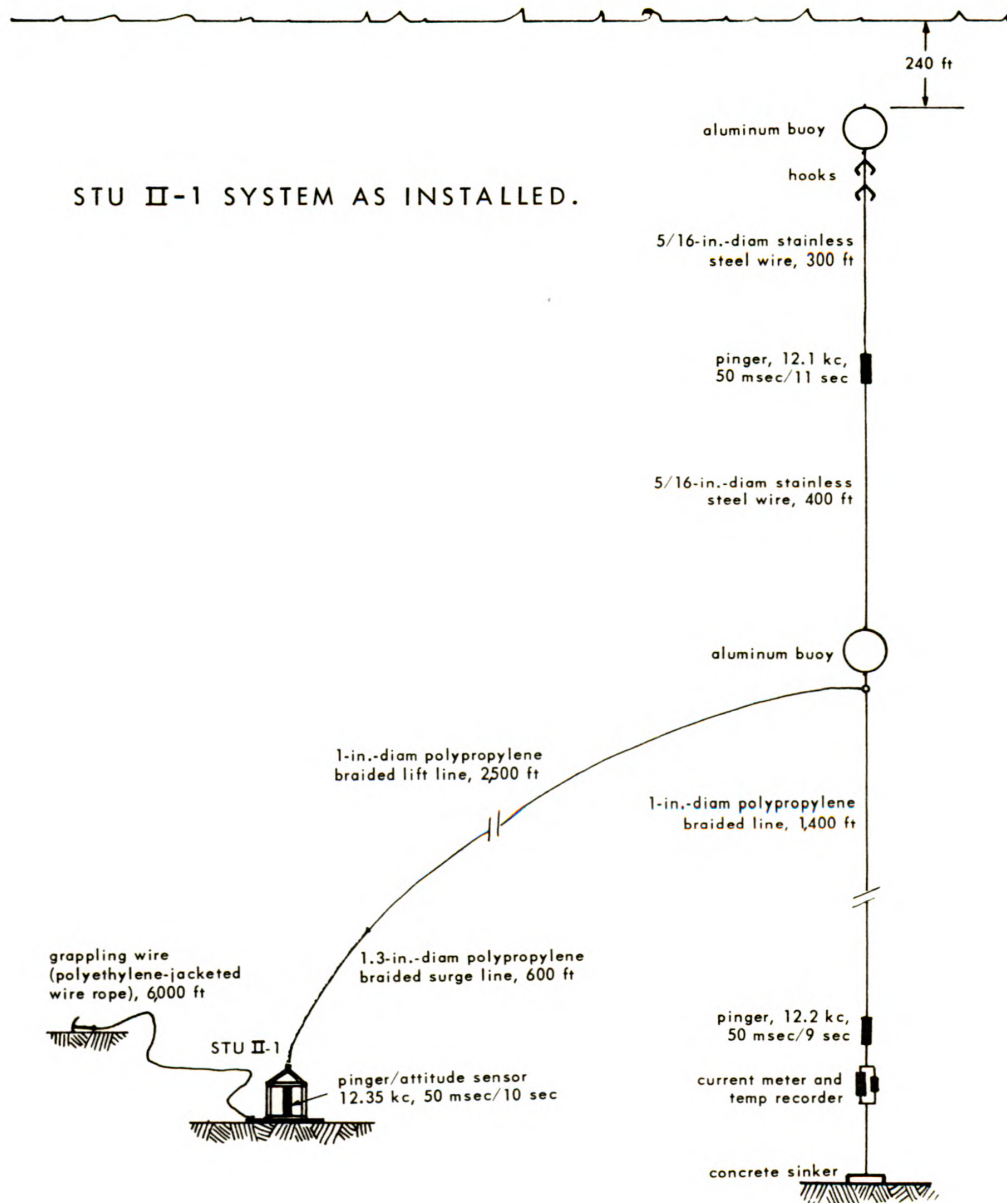
Like its forerunner, STU I-3, which was recovered in February 1964 from a depth of 5640 feet, STU II-1 carried specimens of materials likely to be used in deep-ocean structures and installations. Included among the materials and instruments tested were ferrous alloys, aluminum alloys, plastics, cupro-nickel alloys, special high-strength types of glass, buoyancy materials, welded specimens, beryllium alloys, and various electronic devices. The specimens were provided by a number of private firms and several government agencies as well as by NCEL.

Some of the interesting features of the STU II-1 operation are listed below.

- Discovery on the ocean floor at the test site of a current having a velocity of from 0.30 to 0.35 knots.
- Acquisition of complete temperature and current records for the six-month period the platform rested on the ocean floor.
- Attachment of deep-submergence floats to the STU to provide buoyancy, which made the load easier to handle than loads placed on the ocean floor previously.
- Use of pingers as a means of acoustic navigation during recovery. No other navigation aids were relied upon in positioning the recovery ship relative to the submerged unit.

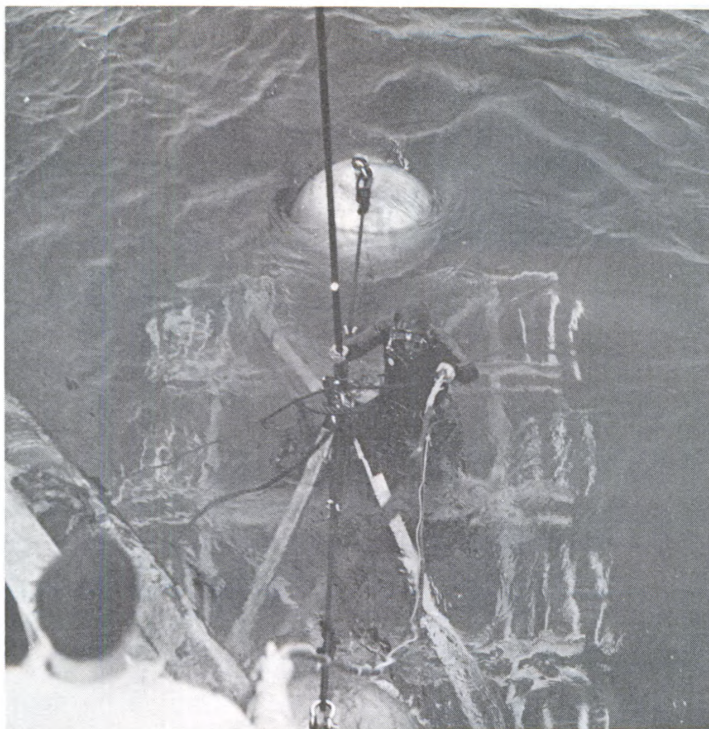
Present plans call for 16 STUs to be placed on the ocean floor at several test sites. Five units have already been lowered; two have been recovered, and three remain in place. During the next six months, a sixth unit will be placed on the bottom, and attempts will be made to recover one or more of the units now in place.

The retrieval of STU II-1 is described pictorially on the following two pages.

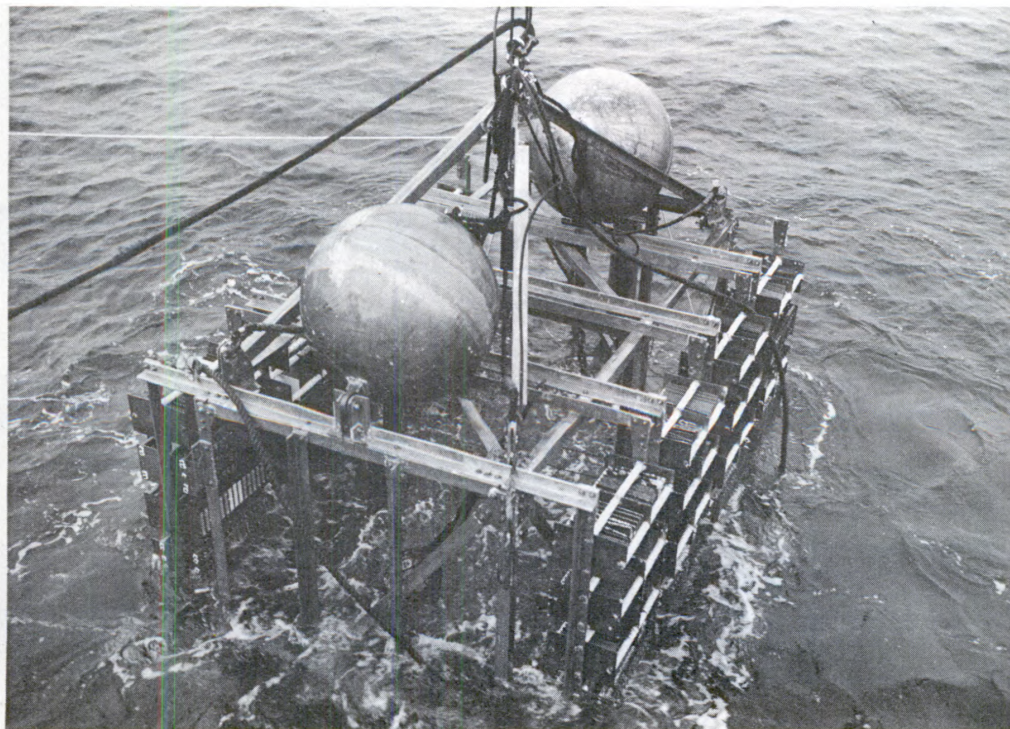


STU II-1 Installation and Recovery

Diver attaches handling lines to submersible test unit in preparation for the hoisting of the unit aboard ship.



Metal frame containing specimens is lifted aboard ship. Racks containing test items are clearly visible. Two buoys that provided buoyancy during retrieval of the STU rest on top of the framework.



Scientists inspect test specimens that failed after six-months exposure to the deep ocean.

The “Main Event” in Underwater Living

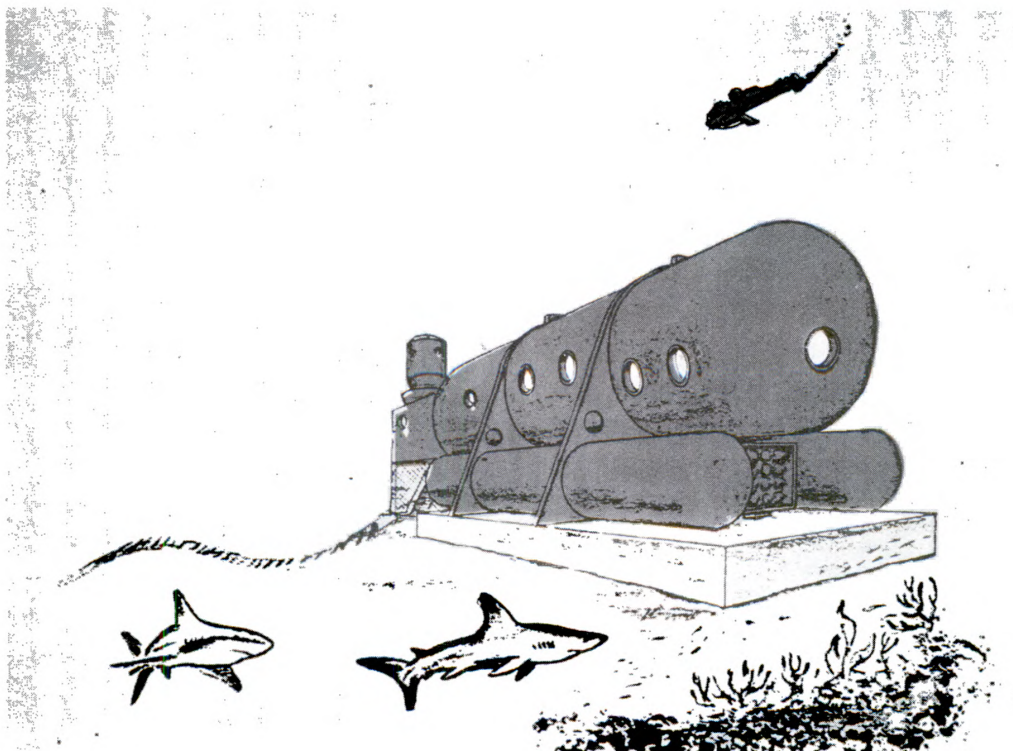
Navy Divers and Scientists Prepare for 30-Day Assignment on Ocean Floor

At the Naval Mine Defense Laboratory, Panama City, Florida, 22 Navy divers and civilian scientists are learning how to live and work on the ocean floor at a depth of 250 feet. The exercise, which began in mid-March and will last a total of four months, is a preliminary to the “main event” of all underwater-living efforts yet made by man—an experiment called “SeaLab II,” which will take place late next summer one mile off the coast of southern California near LaJolla. During the experiment, teams of aquanauts will occupy a specially designed under-sea home and laboratory for from 15 to 30 days, performing scientific and operational tasks both inside and outside of this habitation almost as freely as they work in and around their homes on land.

SeaLab II will be conducted by the Office of Naval Research in collaboration with the Navy’s Special Projects Office as part of the Man-in-the-Sea project and the Deep Submergence Systems Program. SeaLab I, the first effort of this kind to be made by the Navy, was conducted last July by ONR 30 miles off Bermuda. In that experiment, four Navy divers lived and worked comfortably and safely at a depth of 193 feet for a period of 11 days (see *Naval Research Reviews*, Oct. 1963 and July and Sept. 1964).

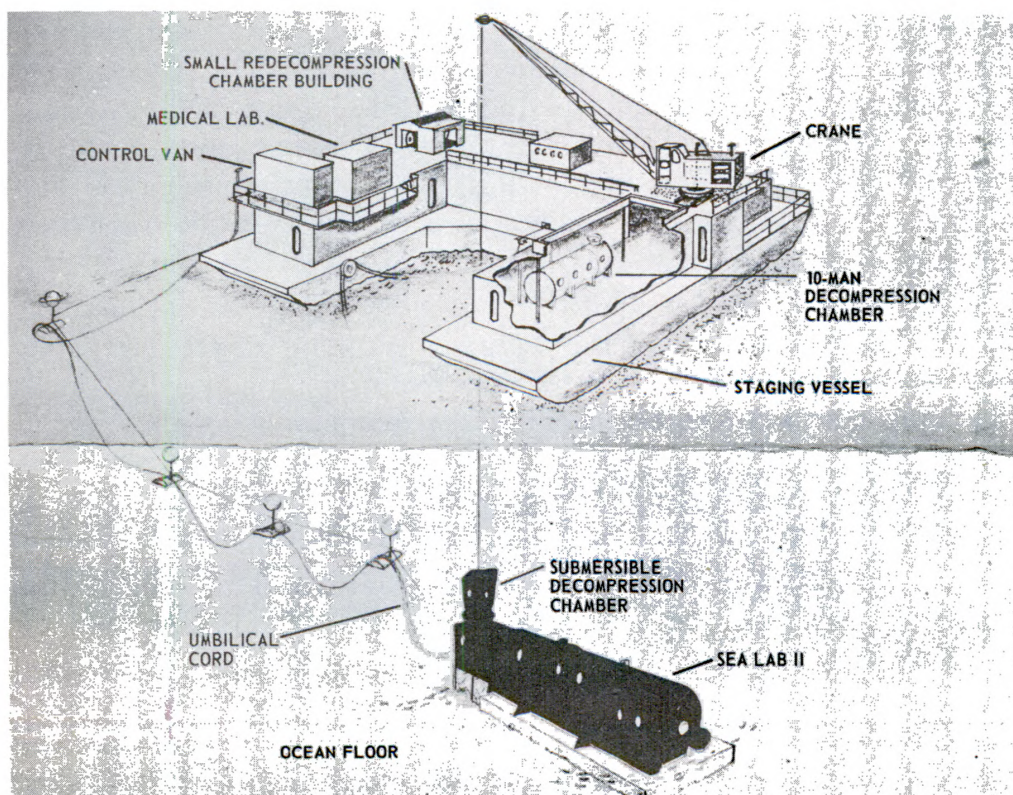
SeaLab II will be a cylindrical steel structure, 50 feet long and 12 feet in diameter, to which two pontoon “feet” will be fastened to provide stability while the habitation is resting on the ocean floor. Built into its sides will be a number of ports, through which the aquanauts will be able to observe their surroundings, and a 4-foot diameter entrance-exit tube which will remain open to the sea at all times. Water will be kept from entering the living quarters by the pressure of the interior atmosphere—100 pounds per square inch—which is the same as the pressure of the surrounding water. While living in this house, the aquanauts will breathe a specially formulated gas mixture consisting of rigidly controlled percentages of helium, oxygen, and nitrogen; helium will be the major component of this gas.

The house, for which specifications were prepared by the Naval Mine Defense Laboratory and which is being designed and built by



**ARTIST'S
CONCEPTS**

Above, the SeaLab II chamber as it will appear when in place on the ocean bottom and, below, as it will appear in relationship to the large catamaran barge and other support equipment during the experiment.



the San Francisco Naval Shipyard, will provide living and berthing facilities for ten men and space for storage and operation of the laboratory equipment required for the test. For at least six weeks, SeaLab will be self-sufficient with respect to food, water, and breathing-gas mixture. Power will come from the shore, but in the event of the failure of that source, an alternate source will be provided aboard the surface support vessel. In addition to power, the shore connections will be provided with channels for relaying underwater television, communications circuits, and data links. Both while at work and while relaxing, the divers will be monitored constantly by television. They will also talk frequently with topside and shore observers. During the conversations, their voice sounds will be routed through speech convertors installed both aboard the support craft and ashore. The speech convertor was designed by the Bureau of Ships' Applied Science Laboratory, Brooklyn, New York.

The temperature within SeaLab II will be maintained at 80°-90°F. and the humidity, at 60 percent, which is a comfortable combination for men living under high pressure in an atmosphere consisting largely of helium. Conventional galley equipment will be installed for storing, cooking, and serving food; and conventional food, with the exception of fried food, will appear on the menu. Fried food cannot be included because of the excessive amount of undersirable hydrocarbons which would be released in the SeaLab atmosphere.

About two-thirds of the men selected to train for membership of the SeaLab II crews are highly qualified Navy diving officers and enlisted personnel. The remaining aquanauts preparing for the test come from both military and civilian callings. In the final selection of the civilians, an effort will be made to provide a variety of backgrounds, including some or all of the following: biologists, geologists, mechanical and electrical engineers, and oceanographers. Other scientific disciplines also may be represented.

SeaLab II will be placed on the edge of Scripps Canyon, one mile off the end of the pier at the Scripps Institution of Oceanography (University of California) at LaJolla. In that ocean locality, the bottom is a compacted sedimentary material, the temperature of the water is about 50°F., and visibility is normally between 20 and 100 feet. These conditions are considered to be typical of those under which crews of aquanauts will conduct routine Fleet operations in the future.

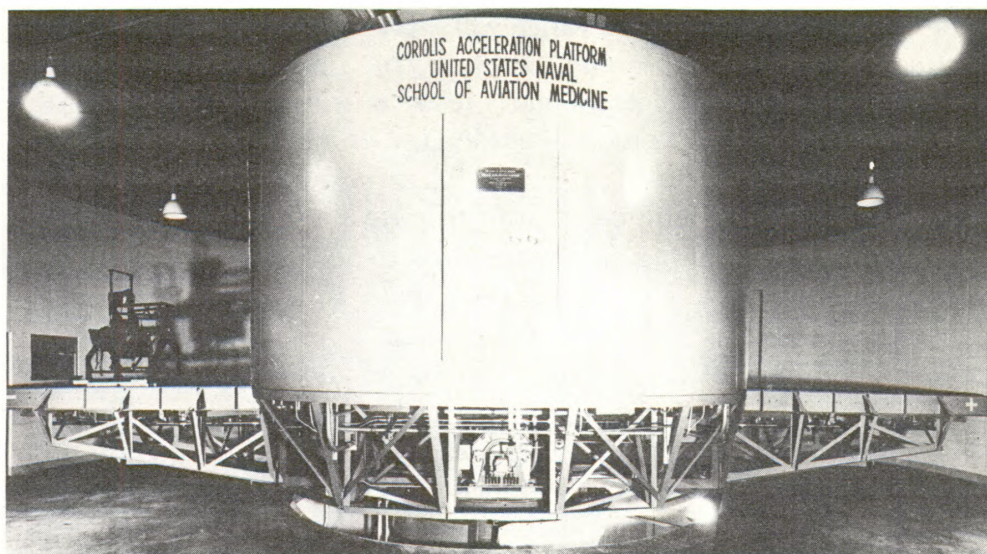
Three principal types of breathing apparatus will be used by the aquanauts: The standard Navy Scuba, the new Mark VI Scuba, and the Hookah, a closed-circuit pumping system extending from the habitation to the diver. Hot, fresh water for showers and radiant heaters will be supplied to SeaLab to enable the divers returning from the ocean to regain normal body temperatures quickly.

The surface support vessel, which will service and monitor the SeaLab structure, will be a large catamaran craft which has been employed on the San Clemente Range for Polaris tests. It will be provided by the Naval Ordnance Test Station, Pasadena, California, which also will furnish the personnel to man the craft and a portion of the surface-support diving team. The catamaran will have administrative, laboratory, control, and berthing spaces for project personnel. Assisting with the preparation of the surface support vessel will be the Long Beach Naval Shipyard.

A special system for transporting personnel and equipment between the surface support vessel and SeaLab II has been devised. The submerged decompression chamber that will be used for this purpose will be equipped with special fittings so it can be coupled to a large, double-lock decompression chamber to be installed on the surface craft. If the SeaLab house has to be evacuated for any reason, the aquanauts will be brought to the surface under pressure, in the same helium-oxygen-nitrogen atmosphere in which they lived at depth, and transferred to the large chamber without having to undergo a change in pressure. This experimental technique of personnel transfer is expected to contribute to the long-range DSSP program of developing salvage and submarine rescue facilities. In addition to this equipment, a surface diving unit will stand by to maintain communications with the SeaLab team and to perform liaison functions.

Obtaining physiological data and providing for diving safety will be of prime concern during the test. A Navy physiological group will monitor the team personnel constantly. Collaborating on this aspect of the test will be CAPT George Bond, MC, USN, of the Special Projects Office; the Naval Medical Research Institute, Bethesda, Maryland; the Navy Experimental Diving Unit, Washington, D.C.; and the Submarine Medical Center, New London, Connecticut. Physiological research conducted by the University of Pennsylvania, the University of Buffalo, and the University of California at Santa Barbara also will play an important role in the project. In addition, the Scripps Institution of Oceanography will assist in the physiological and oceanographic research through its laboratory facilities.

The rigorous training program that the 22 candidates for SeaLab II assignment are undergoing at Panama City will include many hours of work with the most advanced underwater navigation, communication, propulsion, and diving systems, and it will feature addresses by leading figures in all fields of oceanology. Toward the end of the training period, the aquanauts selected to occupy the undersea habitation will work out of SeaLab I, which has been transferred to Panama City. That 40- by 10-foot structure will be placed on the ocean floor at a depth of 65 feet, permitting a nearly realistic rehearsal of the SeaLab II exercise.

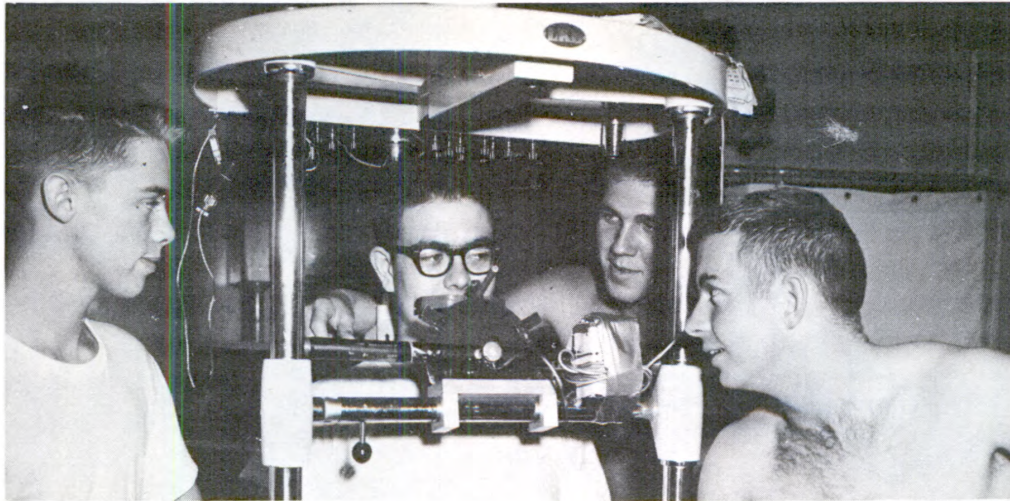


Four Young Men in a Long, Slow Spin

As part of a study of the effects on humans of conditions that would exist in a spacecraft set in rotation to produce artificial gravity, four young Navy men were subjected recently to 28 days of "merry-go-round" spinning at the Naval School of Aviation Medicine, Pensacola, Florida. Home and laboratory for the volunteers during the period was the Coriolis Acceleration Platform, a windowless, rotating room that is 20 feet in diameter and 10 feet high. It was equipped with all of the conveniences of many conventional homes, including hot and cold running water, sewage-disposal system, refrigerator, stove, sink, television, and wall-to-wall carpeting.

The four men, all of whom hold the rating "airman apprentice" in the Navy, are Curtis L. Browning, Jr., 19; Rodney G. Holzinger, 17; Terrence L. Duverney, 18; and Harold K. Gribbin, 18. They began living on the acceleration platform on February 8 so that pre-experiment indoctrination and testing could be accomplished before the platform was set in motion on February 12. The long journey began at a speed of two revolutions per minute. Every two days this speed was increased one revolution per minute, until a velocity of 10 rpm was reached—the maximum for this experiment.

Although spins have been started at higher speeds for investigations conducted previously at Pensacola, a slow start was made on this occasion in an effort to determine whether or not men can adapt to the rotating environment without the onset of motion sickness and subse-

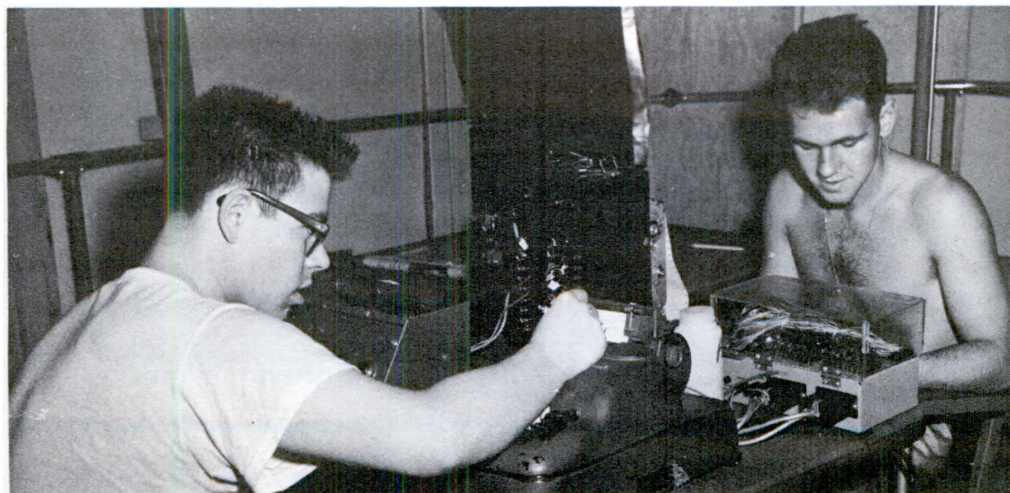


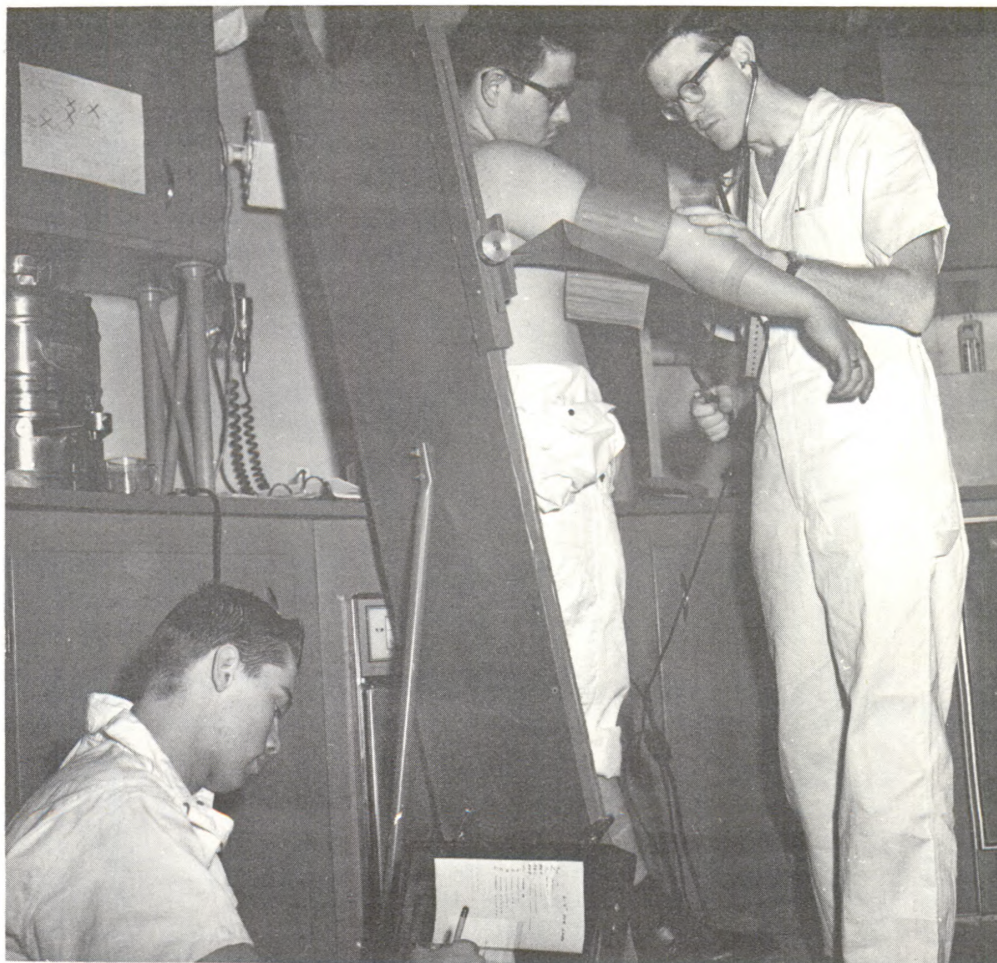
subject, seated in a special chair installed on the rotating platform, is examined for nystagmus (involuntary movement of the eyes).

Deane, seated, explains operation of a mathematical calculator used during the rotation experiment. Standing, left to right, are Rodney Elzinger, Harold Gribbin, Curtis Browning, and Terence Duverney.



The ability of two volunteers to work out math problems is tested during the long spin.





LT Deane checks blood pressure of a subject during the spin study.
He is assisted by a second volunteer subject, at lower left.

quent disorientation brought about by stimulation of the organs of the inner ear.

Throughout the run, a group of scientists and doctors observed the reactions of the men closely by means of psychological and biochemical tests. A subject of special interest investigated by means of the tests was nystagmus (involuntary eye movement) which often occurs in a rotating environment. A Navy doctor, LT Frederick R. Deane, MC, USNR, a research assistant at the School of Aviation Medicine, was the on-board investigator. In order to make the medical tests and observations required, Dr. Deane had to travel a considerable distance with the four subjects.

The experiment, the longest of its kind ever attempted at the Naval School of Aviation Medicine, was carried out as part of a study of rotational stresses sponsored by the National Aeronautics and Space Administration.

Inventions

Two \$5000 Checks

Dr. Kathryn Shipp and Mr. Marion Hill of the Naval Ordnance Laboratory, White Oak, Maryland, were given checks for \$5000 recently in recognition of their invention of a method of manufacture of a compound used in the Polaris second-stage propellant. The presentation of the Invention Awards is pictured below.



CAPT Saxe P. Gantz, Assistant Technical Director for Administration, NOL, reads Invention Award checks prepared for Dr. Kathryn Shipp and Mr. Marion Hill, who stand beside him. Behind the captain and the award winners are, left, CAPT Jack C. Davis, Assistant Chief for Patents, Office of Naval Research, and Dr. R. E. Wilson, acting Technical Director, NOL.

Ideal Boat Fender

The ideal boat fender or bumper is light in weight, easy to handle, rugged enough to withstand extended periods of use, fire resistant, not absorbent, and easy to keep clean. All of these features are to be found in a fender invented by Mr. Albert E. Mountcastle of the Bureau of Ships. Mr. Mountcastle, who is now retired, has been granted U.S. Patent No. 3,113,546 for his concept, which is entitled "Boat Fender Device."

The fender consists principally of a sheet of foam or cellular material wrapped in a spiral configuration, like that of a jelly roll, around a novel mooring-line structure and covered with a nylon cord fabric wrapper. The foam material provides a pliable or resilient body that

is both light in weight and buoyant, and the nylon wrapper provides a water-repellent and heat-resistant assembly. Little maintenance of the fenders is required.

A substantial number of these units has been procured for the smaller ships of the Fleet.

The Silent Pump

One of the most important problems facing the Navy today is that of reducing noises made by ships of the Fleet so as to prevent their detection by acoustic listening devices. In the past, one of the most worrisome sources of noise has been a ship's pumping system. To eliminate this source, the invention described in U.S. Patent No. 3,150,592, issued September 29, 1964, was conceived. The patent, entitled "Piezoelectric Pump," was granted to Charles L. Stec, a chief engineer of the Bureau of Ships.

Certain materials, such as quartz crystals, rochelle salts, and barium titanate, change shape or dimension when a voltage is applied to opposite faces of the material. By applying this piezoelectric property, Mr. Stec invented a pump that functions both silently and without friction losses because it has almost no moving parts. Essentially, this pump consists of a hollow sphere of piezoelectric material mounted within a hollow outer spherical casing. The two spheres are spaced so that a uniform pumping chamber is formed between them. The inner and outer surfaces of the piezoelectric sphere are oppositely polarized. When an electrical potential is applied to the surfaces of this sphere, they expand and contract, causing the pumping chamber to become larger and smaller. As the chamber becomes larger, fluid is sucked into the space through a check valve, and as the chamber becomes smaller, the fluid is pumped out through a second valve. The amount of fluid pumped is a function of the voltage applied, the frequency, and the material characteristics of the piezoelectric sphere.

The invention also conceives of a pump consisting of two piezoelectric spheres, one contained within the other. As one sphere expands, the other contracts, thereby increasing the pumping capacity.

A Dall porpoise that was being studied by the Marine Science Division of the Naval Missile Center, Point Mugu, Calif., died unexpectedly after surviving 26 days in captivity, longer than any other member of her species. The porpoise succumbed to hemorrhaging in its second stomach, believed brought on by the stress of captivity. The porpoise appeared to have been adapting well and was taking food until the day it died. Investigators have reported, however, that a great deal was learned about the animal during the study.

On the Naval Research Reserve

Office of Naval Research Seminar

On January 25, 1965, the seventeenth annual Naval Reserve Research Seminar convened in Washington, D.C., with an attendance of 80 Navy and 10 Army Reserve officers. The program was under the general direction of CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve) and CDR F. H. Langdon, USNR, Training Officer. Technical direction of the program was provided by CAPT L. B. Melson, USN, Director, Naval Applications Group, ONR. The general theme of the technical sessions was "Deep Submergence," and the presentations reflected a great deal of ONR's pioneering efforts in this area.

The seminar was opened with a welcoming address by RADM J. K. Leydon, USN, Chief of Naval Research. RADM C. T. Booth, USN, Deputy Chief of Naval Operations (Development), then pointed out the Navy's special needs for research in the fields of ASW, oceanography, and electronics. Another opening-day speaker was Dr. Chalmers W. Sherwin, Deputy Director of Defense Research and Engineering (Research and Technology), who discussed the pros and cons of having research conducted by in-house laboratories and by contract non-profit laboratories. Dr. F. Joachim Weyl, Deputy Chief and Chief Scientist, Office of Naval Research, spoke also, giving a particularly comprehensive view of Naval research and its various categories.

Notable presentations were given by two outstanding officers from the Bureau of Naval Weapons: RADM Eli T. Reich, USN, Director, Surface Missile Systems Project, on the Navy's surface missile systems programs; and RADM I. J. Galantin, USN, Director, Special Projects, on the progress of the Polaris program. Some aspects of the Navy's research on malaria were presented by Dr. Clay G. Huff, Director, Parasitology Department, Naval Medical Research Institute. LTGEN W. W. Dick, Jr., USA, Chief of Research and Development, Department of the Army, gave an extremely interesting account of the Army R & D organization and its aim of translating requirements to hardware.

Also making presentations at the seminar were the commanding officers and directors of three of the Navy's laboratories: CAPT D. K. Ela, USN, David Taylor Model Basin; CAPT T. B. Owen, USN, U.S. Naval Research Laboratory; and CAPT W. J. Christensen, USN (CEC), Naval Civil Engineering Laboratory. In addition, two members of the Research Reserve program—CDR C.L. Buchanan, USNR, Head, Sonar Systems, Naval Research Laboratory; and CDR I. H. Gatzke, USNR, Assistant Technical Director for Supporting Research, ASW Office,

Bureau of Weapons—gave very interesting and informative talks. Both CDR Buchanan and CDR Gatzke are affiliated with NRRC 5-9.

The four days that were devoted to the deep-submergence theme were chaired by CDR C. E. Rawson, USN, ASW Project Officer, ONR; CAPT S. R. Heller, Jr., USN, Head, Hull Design Branch, Bureau of Ships; Dr. A. L. Vine, Senior Scientist, Woods Hole Oceanographic Institution; and Dr. H. Liebowitz, Head, Structural Mechanics Branch, ONR. The presentations ranged from the history of deep submergence to ocean forecasting and covered in detail SeaLab, physiology in deep submergence, experimental diving programs, deep diving vehicles, Thresher area operations, Mohole, oceanographic ships, instrumentation, navigation systems, and deep-ocean structural mechanics.

During field trips taken to the Naval Ordnance Laboratory and the Naval Research Laboratory fine presentations were made and interesting tours of the facilities were conducted.

Opening the discussion of the Naval Reserve was LCDR K. M. Hamilton, USNR, Reserve Officer Promotions Branch, Bureau of Naval Personnel. He was followed by CDR R. J. Borntraeger, USNR, Reserve Plans Section, Bureau of Naval Personnel. A talk was given also by CAPT D. J. Mooney, USNR, who discussed matters of particular interest to members of the Research Reserve program. The final speaker, whose appearance was one of the highlights of the seminar, was Dr. Paul Conroy, Chief of Professional Training, U.S. Information Agency, Department of State. His topic was "Soviet Impressions of American Life."

Assisting in conducting the seminar during the two weeks were LCDR Denton W. Elliott, USNR, Commanding Officer of NRRC 5-10, Bethesda, Maryland, and LT Paul J. Gerdon, USNR, a member of NRRC 5-8, Washington, D.C.

Selected for Admiral

CAPT Paxton



The Research Reserve is proud to announce the selection of one of its members for flag rank, CAPT Charles N. Paxton, USNR. CAPT Paxton, who was the only officer selected for flag rank by this year's Line Selec-

tion Board, is a member of Naval Reserve Research Company 11-3, Los Angeles, California.

CAPT Paxton is a graduate of Stanford University, class of 1935, where he received a B.A. degree in engineering with honors. He entered active duty in the Navy as an ensign, USNR, and served as a flight instructor at Oakland, California. CAPT Paxton received training for this duty previously, after he enlisted in the Volunteer Communication Reserve as a radioman second class in 1928. He was commissioned an ensign in 1932 after completion of flight training at the Naval Air Station, Pensacola, Florida, and later served in VF-2 aboard the USS LEXINGTON. After completion of his duty at Oakland, he served at the Naval Air Station, Pensacola, until 1937, when he embarked upon a civilian career as an associate professor of mechanical engineering at the University of Oklahoma at Norman.

He returned to active duty in the Navy in January 1941 and was ordered to the Naval Reserve Air Base, Kansas City, Missouri, where he served as an instructor. In 1942, the then LTJG Paxton was ordered to the Bureau of Aeronautics in Washington, D.C., where he served for a two-year period as the bureau's representative for Advanced Base Planning and later as head of the Training Airplane Branch. In 1944, he joined the staff, Commander, Air Force Pacific Fleet, as a commander and served as airplane structures and equipment officer. The Naval Air Missile Test Center, Point Magu, California, was his next duty assignment. Until his release from active duty in 1949, he served here as head of the Engineering Department.

Upon return to civilian life, CAPT Paxton became the manager of Engineering and Production Control at Aviation Maintenance Corporation, Van Nuys, California. He worked in this position until 1950. Since that time he has been associated with Hughes Aircraft, El Segundo, California, where he serves presently as a senior staff engineer, Space Systems Division.

CAPT Paxton has participated in the Reserve program since his release from active duty in 1949. For ten years he served in the air program at the Naval Air Station, Los Alamitos, and more recently with the Research Reserve. He has also enhanced his mobilization potential by frequent active-duty-for-training tours. He has served in the grade of Captain since July 1, 1954.

Seminars Planned for Fiscal Year 1966

Seven Research Reserve seminars are planned by the Office of Naval Research for fiscal year 1966. Final approval of the plans must be given by the Bureau of Naval Personnel. Further information will be promulgated officially in the BUPERS Instruction 1571.4 series. This instruc-

tion is expected to be available in May 1965. The titles, places, and convening dates of the seminars now planned are as follows:

	1965
<i>Antisubmarine Warfare</i> , Newport, Rhode Island	July 19
<i>Applied Research</i> , Albuquerque, New Mexico	Aug. 2
<i>University Research in Relation to</i> <i>Government and Industry</i> , State College, Pa.	Aug. 9
<i>Electronic Computers</i> , College Station, Texas	Aug. 30
	1966
<i>West Coast Research Reserve</i> , San Francisco, California	Jan. 24
<i>Midwest Research in Oceanography</i> , Ann Arbor, Michigan	May 2
<i>Research Reserve</i> , ONR, Washington, D.C.	June 6

Science Married to the Navy

Members of Research Reserve companies in the Philadelphia area heard an address by RADM John K. Leydon, USN, Chief of Naval Research, on February 3, 1965, at the Franklin Institute, Philadelphia. Three hundred Reserve officers and guests attended the meeting, which was proposed initially by Naval Reserve Research Company 4-13, Philadelphia.

In his talk, "Science Married to the Navy," Admiral Leydon described future trends in Naval research and attempted to pinpoint the position which independent research organizations, such as The Franklin Institute, now occupy in military scientific thinking. He indicated that a close similarity exists between the problems which face military research and those which face the scientific and industrial community at large.



Admiral Leydon as he addressed members of Research Reserve companies of the Philadelphia area.

Many of Admiral Leydon's military assignments have been closely related to science and technology. In 1949, he was assigned to the Armed Forces Special Weapons Project in connection with the development of atomic weapon systems. Ten years later he became commanding officer of the Naval Air Turbine Test Station, Trenton, New Jersey, in charge of testing and evaluating the jet aircraft engines which now power the Navy's first-line aircraft.

Schoolmaster of the Year

Upon his completion of two weeks of active duty at the Naval Air Technical Training Center, Memphis, Tennessee, Navy Reserve CAPT Arnold A. Shostak, USNR, a member of NRRC 5-8, Washington, D.C., was presented with an honorary "Schoolmaster of the Year" certificate by CAPT Robert H. Wood, USN, Commanding Officer. While at NATTC, CAPT Shostak worked with the training department and the Commanding Officer, becoming familiar with instructional methodology at the Center.

For the past ten years, CAPT Shostak has been Head of the Electronics Branch of the Office of Naval Research. He holds degrees in electrical engineering and physics and has taught at the University of California, Harvard, Massachusetts Institute of Technology and other institutions. He is also the author of a book on elementary electronics and of numerous articles that have appeared in scientific and Naval Journals.



CAPT Wood (right) presents CAPT Shostak with an honorary "Schoolmaster of the Year" certificate. Looking on, from left to right, are CDR Albert L. Dodson, USN, Executive Officer; CDR Michael F. Wasco, USN, Director of Training; CDR Thomas M. Campbell, USN, acting Administrative Officer; and CDR Vincent G. Quillen, USN, Administrative Officer.

THIRD NAVAL DISTRICT REPORT

Recruiting Program

During one of its meetings, members of Naval Reserve Research Company 3-15, New York, worked out a plan to recruit young officers to replace those who were nearing retirement age. The commanding officer of NRRC 3-15 is CDR John Strachan, USNR.

Some members offered to undertake a telephone-call and direct-contact program. Others, who worked for large companies, arranged to have the program information disseminated through company bulletins. LT Robert G. Wolfson, USNR, a publisher, accepted the assignment of creating a public-relations program.

The accompanying montage displays only a portion of the news stories, articles, and photos relating to the program that were published over a six-week period. The result: A Kiwanis (Circle K) International Award for "Outstanding Service to the Community," two recruits for active duty, several possible new unit members, and a deluge of telephone calls and commendatory letters.

LT Wolfson received the permission of the owner of the newspaper, Mr. Robert Metrick, to donate several thousand dollars worth of space. With the approval of CDR Strachan, the public-relations program was designed to make maximum use of the donated space, not only through articles on NRRC 3-15 but through Armed Forces Day, Composite Reserve Units, the Selected Reserve, Navy recruiting, and other ways.

Since the recruiting program is still underway, no attempt has been made to assess the success of the unit's efforts. However, LT Wolfson stated that he had lost his best copy editor, who was so influenced by the program that he enlisted in the Navy.

A collection of some of the stories and photographs published during NRRC 3-15's recruiting program.

The Weapons Improvement Laboratory, a \$1,700,000 facility of the Naval Ordnance Plant, Forest Park, Ill., was opened in February. Heart of the laboratory is a 32-foot-long walk-in chamber in which a weapon may be tested under conditions simulating those of the operational environment—temperature, humidity, and altitude—while being vibrated in the manner expected during actual flight. The chamber is supported over a 130-ton concrete slab that floats on columns of air which maintain the block level and isolate it from local disturbances, such as earth movement.



IN THIS ISSUE

VOL. XVIII No. 3

Solar Flares HAROLD GLASER 1

Development of the capacity to predict solar flares and their consequent space and terrestrial effects is a basic problem of great importance to various government agencies. What we know and do not know about flares is discussed here in terms of this problem.

**Materials Testing Unit Recovered
from Deep Ocean Floor**..... 7

A 7,350-pound metal rack containing 2,385 specimens of 603 different materials was recovered recently from the Pacific Ocean depths after being submerged for a period of six months.

The "Main Event" in Underwater Living..... 10

Navy divers and civilian scientists are now undergoing intensive training in preparation for their occupancy late next summer of an undersea home 250 feet deep in the Pacific Ocean.

Four Young Men in a Long, Slow Spin 14

Inventions..... 17

On the Naval Research Reserve..... 19

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.

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NAVEXOS P-510

An H₂-filtergram of the solar disc depicting an outstanding flare which occurred in the northwest solar quadrant on July 16, 1959. (Courtesy of the Lockheed Solar Observatory). A series of filtergrams depicting a similar event appears in the article beginning on page 1.

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