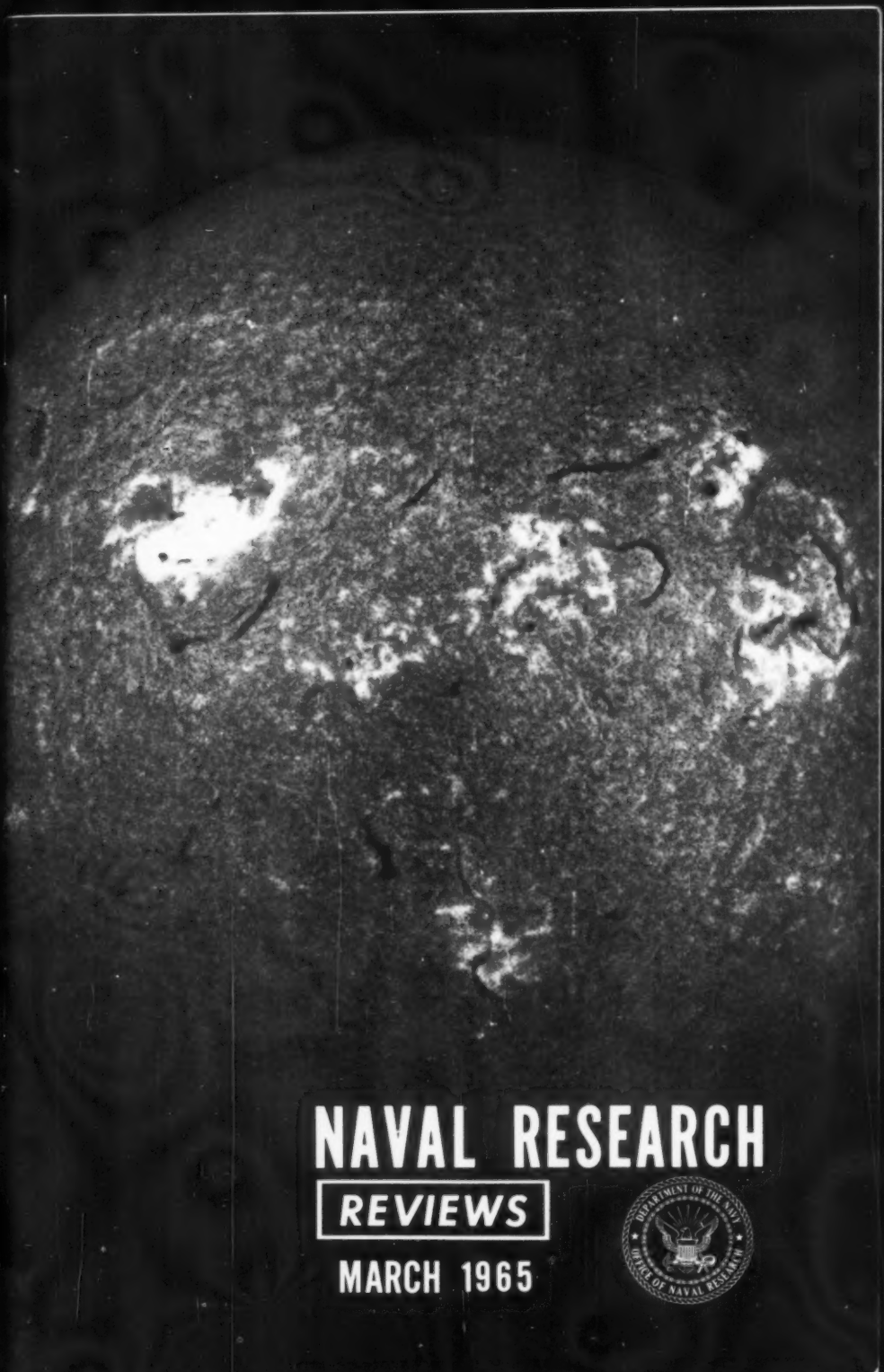


NAVAL RESEARCH

REVIEWS

MARCH 1965

Revolution in Communications at Sea

A review of "History of Communications-Electronics in the United States Navy," prepared by CAPT L. S. Howeth, USN (Ret.), under the auspices of the Bureau of Ships and the Office of Naval History. U.S. Government Printing Office, Washington, D.C., 1963. The book may be purchased from the Superintendent of Documents, Washington, D.C. 20402. Price, $4.75.

Throughout his span on earth man has persistently striven to communicate intelligently over greater distances with ever increased speed and reliability. Fleets that speed over the world's oceans need to transmit information and intelligence over vast distances. From its outset, the U.S. Navy used signal flags, guns, and lights for swift communications, but these means were essentially limited by the horizon. In the Civil War, half a century after Captain Truxtun's signal book for the Fleet appeared, aerial reconnaissance began to extend the horizon. Only with the development of radio, however, did a breakthrough occur that unleashed a revolution in communications at sea even more than ashore.

With the first stirrings of radio last century, the Navy, in keeping with its traditional scientific leadership, recognized the impact on Naval operations of this new reach into the unknown. By means of radio, elements of the Fleet around the world could be coordinated almost immediately. Since then, through radar and satellites, the Navy has taken the lead in this never ending quest to broaden the reach and the tools of communications. It is most natural that the Navy should hold this place of dominance, because the nature of the vast and fluid element in which ships travel places reliable communication at the very heart of successful operations in war and in peace.

Captain Howeth, himself a longtime communicator and lifetime Naval officer of varied sea experience, has written this inspiring and well documented history with clarity and insight. It records the Navy's enthusiastic drive and encouragement to scientific research, which provided the initial impetus, the support, and the direction to what has become the vast electronics industry in America. Part I narrates the Navy's effort to prevent monopoly, improve equipment, and achieve orderly regulation of radio to the end that it might serve mankind in general as well as America's Naval needs. Part II relates the usage and improvement of radio during World War I and the years that followed. The final part continues the narrative through World War II and contains the history of the Navy's development of such electronic systems and devices as radar, sonar, drones, and the proximity fuse. It tells of the success in developing a large number of worldwide channels through the use of the spectrum's hitherto unthought-of frequencies.

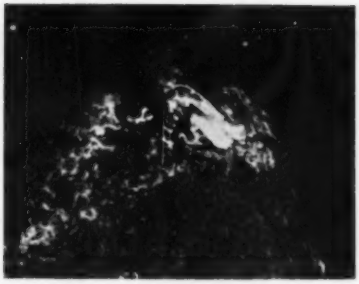
Giant strides have been made in the communications-electronics field. This mysterious power reaching into the infinite has played an ever increasing role with the Navy in the van. In only two decades since the last events covered by this book, the Navy's capabilities have expanded phenomenally. This amazing science of electronics has entered into most of the advances that have been made in the development of such equipment as undersea navigation and tracking devices, missile ships (submarine and surface), radio telescopes, and communication satellites. Yet, as Fleet Admiral Chester Nimitz writes in this volume's introduction, "we merely stand on the threshold of a new and exciting science."

—RADM E. M. Eller, USN (Ret.),
Director of Naval History

Solar Flares

Harold Glaser

Head, Nuclear Physics Branch
Office of Naval Research



H_2-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 hestitated 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).

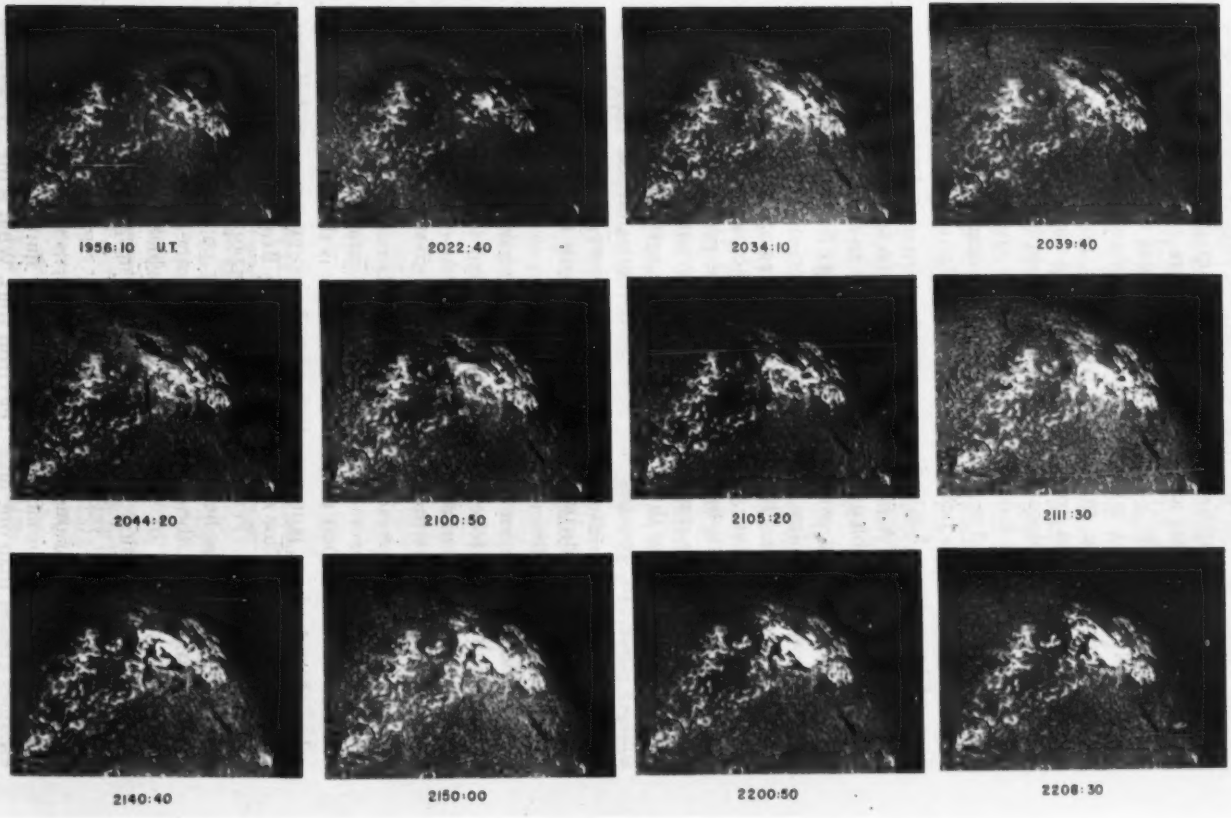
Observed flares are categorized according to the area of the solar disk that is brightened in hydrogen alpha (6563A). The categories are termed "Importance," and they consist of Importance 1^-, 1, 2, 3, and 3^+. A flare of Importance 1^- covers less than 100-millionths part of the visible hemisphere 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.

H_2-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. ▶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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.

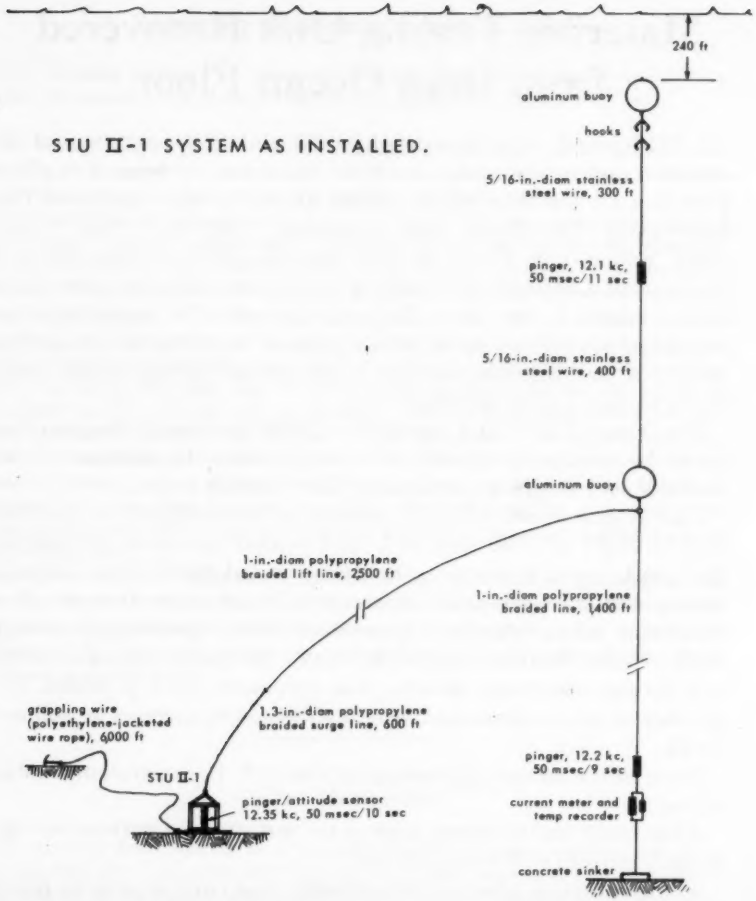
Some of the interesting features of the STU II-1 operation are listed below.

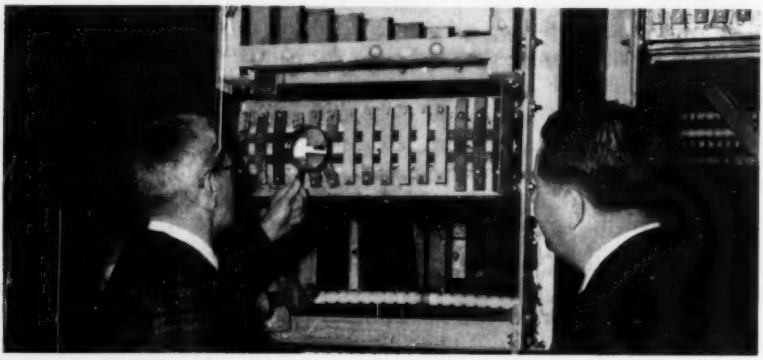
- Discovery on the ocean floor at the test site of a current having a velocity of from 0.30 to 0.35 knots.
- Acquisition of complete temperature and current records for the six-month period the platform rested on the ocean floor.
- Attachment of deep-submergence floats to the STU to provide buoyancy, 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.

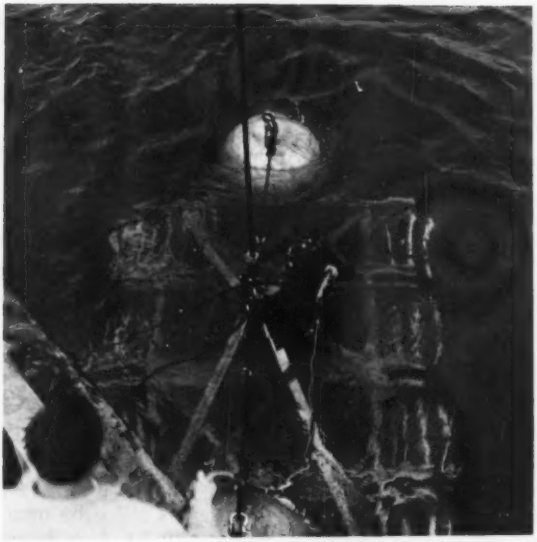
The retrieval of STU II-1 is described pictorially on the following two pages.

STU II-1 SYSTEM AS INSTALLED.



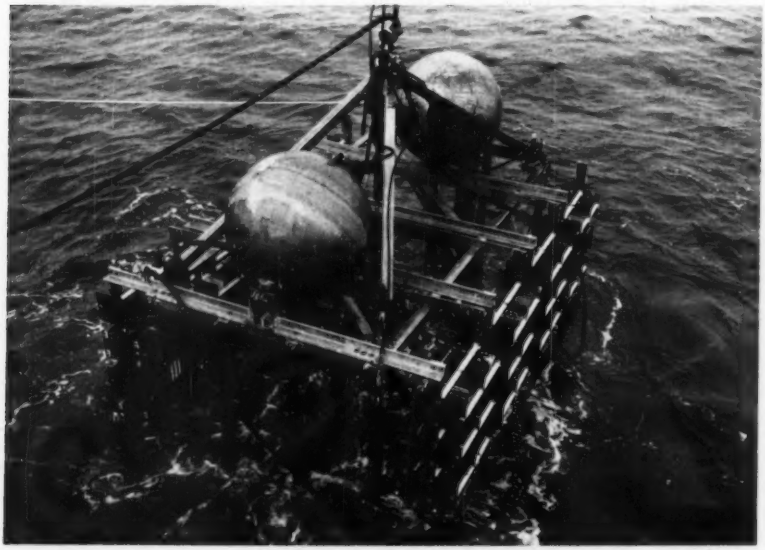


STU II-1 Installation and Recovery



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

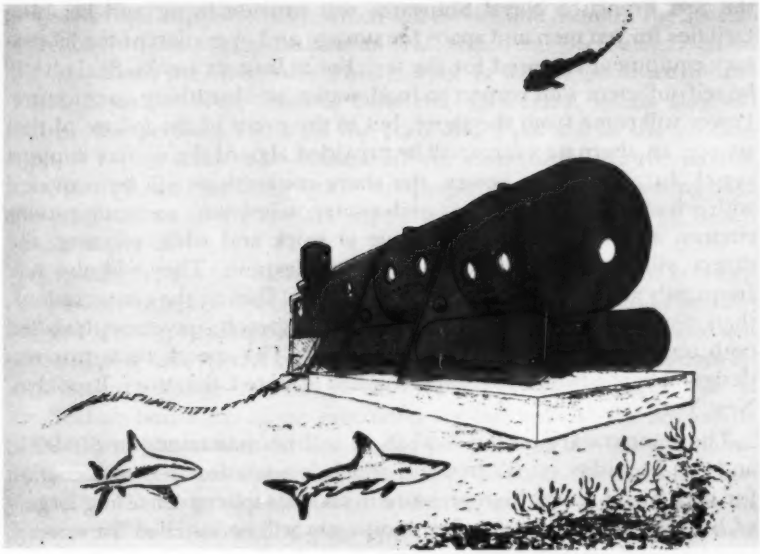
Navy Divers and Scientists Prepare for 30-Day Assignment on Ocean Floor

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 undersea 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).

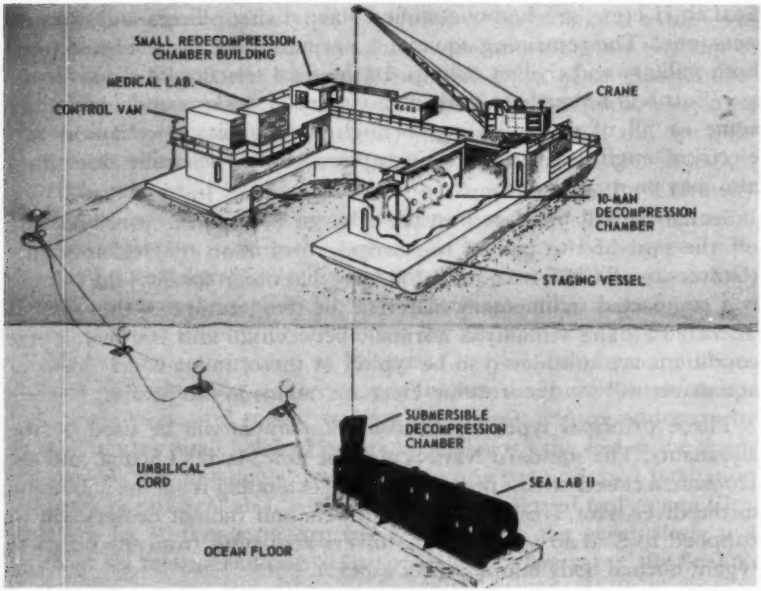
SeaLab II will be a cylindrical steel structure, 50 feet long and 12 feet in diameter, to which two pontoon "feet" will be fastened to provide stability while the habitation is resting on the ocean floor. Built into its sides will be a number of ports, through which the aquanauts will be able to observe 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.

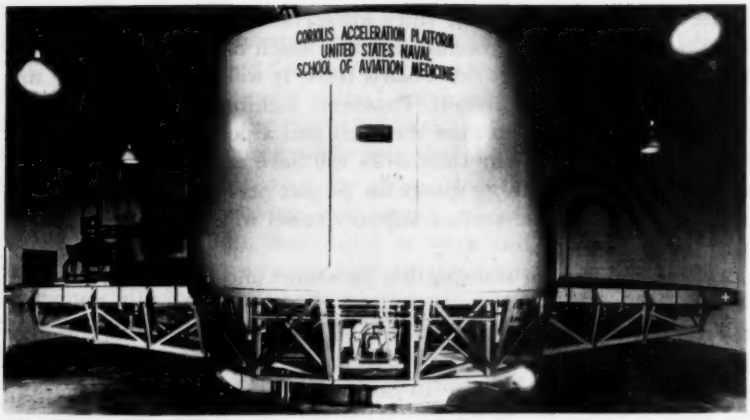
Three principal types of breathing apparatus will be used by the aquanauts: The standard Navy Scuba, the new Mark VI Scuba, and the Hookah, a closed-circuit pumping system extending from the habitation to the diver. Hot, fresh water for showers and radiant heaters will be supplied to SeaLab to enable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

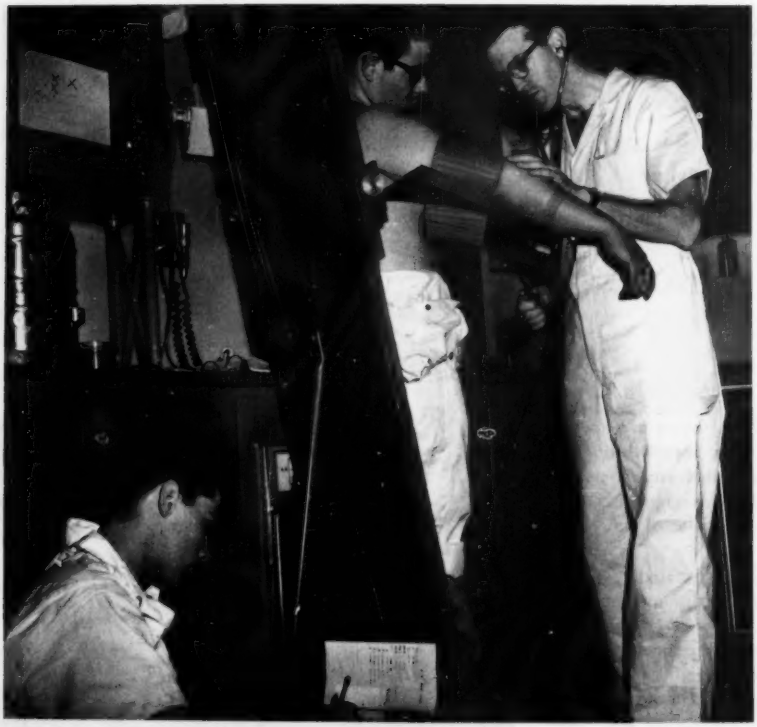
The four men, all of whom hold the rating "airman apprentice" in the Navy, are Curtis L. Browning, Jr., 19; Rodney G. Holzinger, 17; Terrence L. Duverney, 18; and Harold K. Gribbin, 18. They began living on the acceleration platform on February 8 so that pre-experiment indoctrination and testing could 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-

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

LT Deane, seated, explains operation of a mathematical evaluator used during the rotation experiment. Standing, left to right, are Rodney Holzinger, Harold Gribbin, Curtis Browning, and Terrence 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 nonprofit 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
Antisubmarine Warfare, Newport, Rhode Island	July 19
Applied Research, Albuquerque, New Mexico	Aug. 2
University Research in Relation to Government and Industry, State College, Pa.	Aug. 9
Electronic Computers, College Station, Texas	Aug. 30
	1966
West Coast Research Reserve, San Francisco, California	Jan. 24
Midwest Research in Oceanography, Ann Arbor, Michigan	May 2
Research Reserve, 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 recieved 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.

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MEETING TODAY'S CHALLENGE
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An H_2-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.