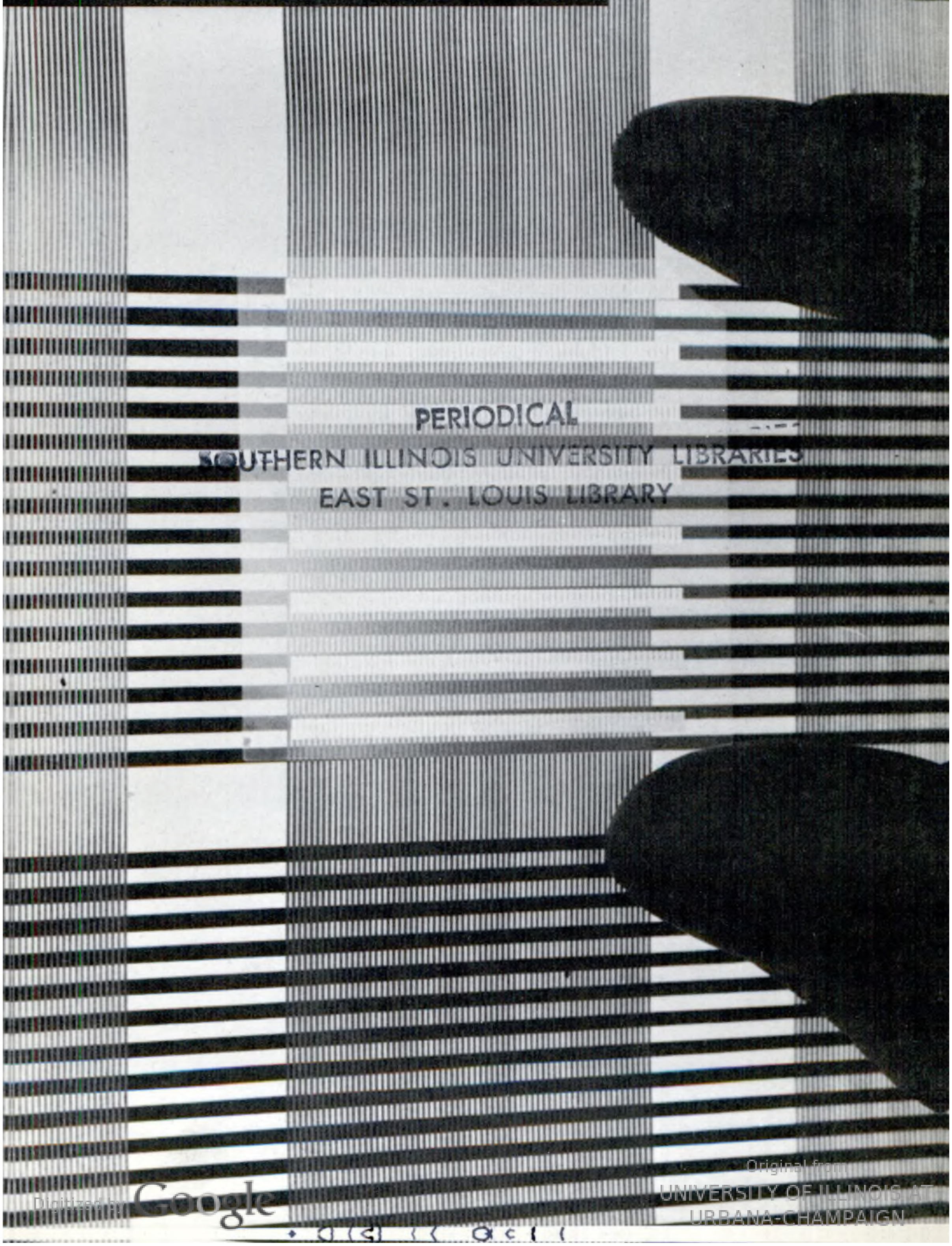
AVAL RESEARCH

REVIEWS

ECEMBER 1961

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH



Instrumented aircraft, bomb, and bomb truck on the 360° turntable of a simulated aircraft carrier deck at NWL, Dahlgren. The antenna at the left is used during electromagnetic radiation tests on the bomber's ordnance in connection with Project HERO.

The U.S. Naval Weapons Laboratory

"About three or four miles below town, she fired one of her large guns at the bow, which bursted at the breech, scattering death and destruction on every side." Among those standing near the gun and killed were: the Hon. Abel P. Upshur, Secretary of State and the Hon. Thomas W. Gilmer, Secretary of the Navy. So read a front-page story in the Alexandria (Va.) Gazette of February 29, 1844. The gun was aboard the USS PRINCETON—the first American warship to use screw propellers—as she sailed on the Potomac to show off her two new 12-inch guns before a "lively and joyous company" of ladies and gentlemen.

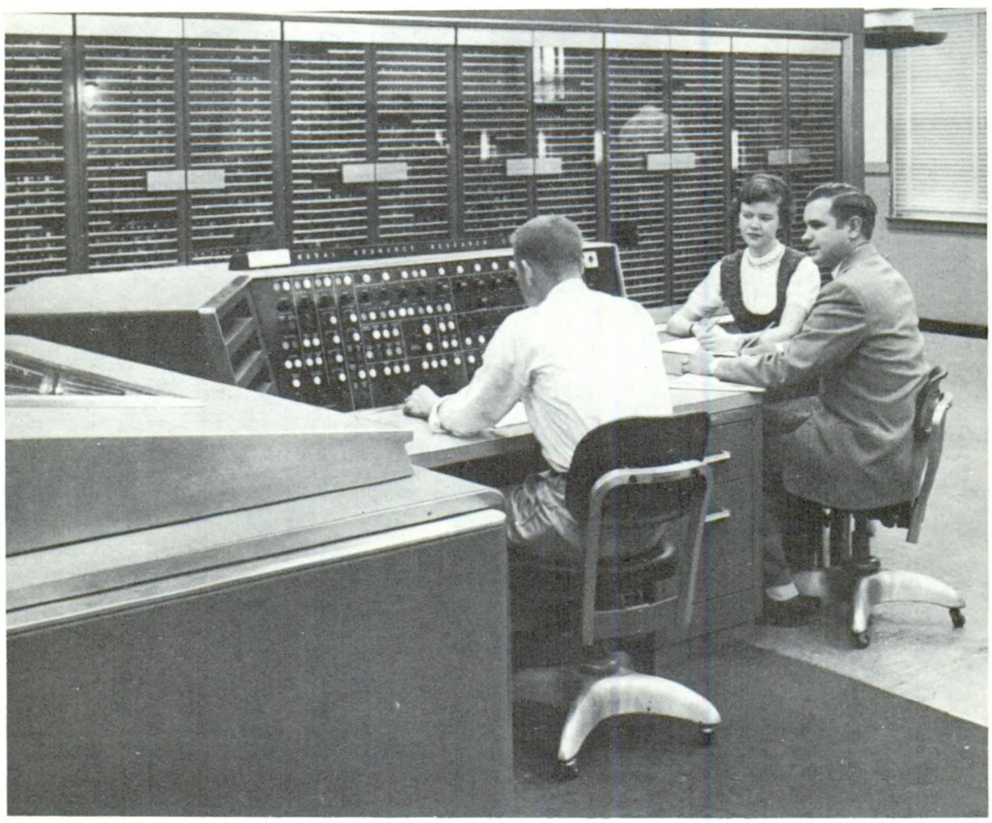
In those days, such accidents were all too commonplace. Today, however, these occurrences are rare because of the Navy's continuing emphasis on preventive ordnance safety pioneered by RADM John A. Dahlgren—the father of modern naval ordnance and gunnery practice.

A few years after the PRINCETON disaster, RADM Dahlgren began his ordnance development and testing program that eventually led to the establishment, in the early 1870's, of a Navy ordnance-testing shore station across the Severn River from the U. S. Naval Academy at

Annapolis. From there, the facility made two successive moves: in 1890 to the Maryland shore of the Potomac at Indian Head, and in 1918 to the Virginia shore east of Fredricksburg (about 50 miles south of Washington, D. C.). The latter site, of 5000 acres, is now called the U. S. Naval Weapons Laboratory (NWL) of Dahlgren, Virginia. The present mission of the Laboratory is "to conduct research, development, design, and technical evaluation of programs dealing with weapons, ballistics, ordnance, and astronautics; and to serve as prime agency of the Bureau of Naval Weapons in the field of computation and data processing."

FACILITIES AT DAHLGREN

The Laboratory's position along the Potomac provides a 90,000-yard, down-river range for ordnance testing. Among the more spectacular range-testing devices are the world's largest gun (a 24-inch smoothbore), a 110-foot launcher, a 2500-foot missile-firing track complete with recovery tank, and several full-sized mockups of shipboard missile magazines for damage-evaluation and stowage-safety tests. In addition, there are three 4000-foot aircraft runways and



The Naval Ordnance Research Calculator (NORC) located in the Computation and Analysis Laboratory of the Naval Weapons Laboratory at Dahlgren, Virginia.

two large hangars. The work at NWL is divided among three laboratories:

- Computation and Analysis Laboratory
- Warhead and Terminal Ballistics Laboratory
- Weapons Development and Evaluation Laboratory

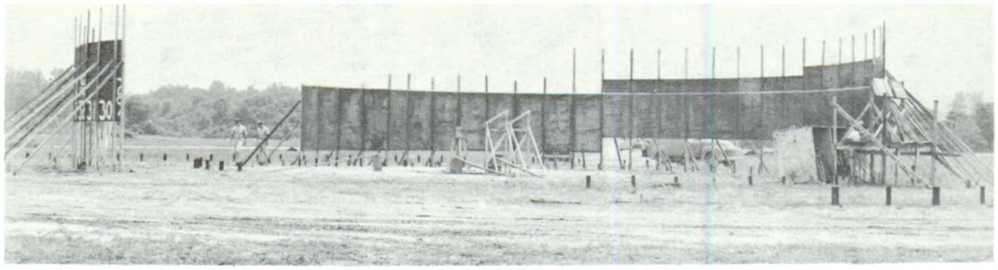
The Computation and Analysis Laboratory has, among its facilities, two unique devices: the Naval Ordnance Research Calculator (NORC) and the Universal Data Transcriber (UDT). The NORC, designed especially for the solution of highly complex computational problems of science and technology, is the main support of NWL's increased emphasis on research and development. This computer, in operation since 1955, is still recognized as one of the world's leading "electronic brains." It operates at a capacity of 15,000 operations per second; each operation may include addition, subtraction, multiplication, or division of as many as 13 decimal digit numbers. The UDT, designed and constructed by NWL computer research engineers, is a stored-program computer used to convert digital data from one form to another. It receives data from cards, paper tape, magnetic tapes of many types, or from almost any other digital device. Its output may also be in any of these forms as well as many others.

RESEARCH AND DEVELOPMENT PROGRAMS

Because of NORC's capability, NWL has played significant roles in research and development programs, such as the Navy's Polaris missile. For example, NORC was assigned the major data-processing function of keeping track of this highly diversified development program. This contribution, known as Project PERT, represents a unique managerial control of the entire development of an advanced weapon system. In essence, NORC's contribution enabled Polaris managers to coordinate the enormous number of individual steps in the development of all the components, insuring that each meshed smoothly with the others, and allowing for modifications or alterations in plans as work situations developed or as time schedules were exceeded. Another important function of NORC in the Polaris Program has been the development of trajectory data, including the preparation of firing tables. Currently, NORC operates around the clock seven days a week. Closely allied technically to the Polaris trajectory work is the NWL effort on TRANSIT, a satellite system that will send radio signals to ships at sea to improve navigation. Also NWL has contributed heavily to the essential task of locating the satellite precisely at any time.

NWL is a major facility not only for the development of non-nuclear warheads but also for the study of weapons effects and terminal ballistics. The studies include metallurgical and physical research on warhead phenomena and design as well as testing, evaluation and development in the laboratory and the field. The Laboratory works closely with the Naval Weapons Station, Yorktown, Virginia, which develops the explosive loadings for NWL's warheads.

NWL is charged with the development and operation of the BuWeps safety program for surface-launched and air-launched guided missiles. This responsibility includes such tasks as examining missile systems



Warhead Testing Arena at the Naval Weapons Laboratory before (above) and after (below) detonation.

for potential hazards, conducting studies and experiments to develop data needed to solve specific problems, developing means of improving safety, and acting as a center for consultation purposes as well as for the dissemination of information on safety and related topics. One example of a safety consideration might be the inadvertent ignition of a missile motor stowed on shipboard. The possibility that such an event would produce a chain reaction in other stored missiles (probably resulting in the loss of the ship) as well as the development of means for preventing ignition and for extinguishing or controlling any fires are all vital considerations to the Fleet.

The power cartridges for various BuWeps Cartridge Activated Devices (CAD) are developed at NWL. These cartridges are packaged charges of propellent equipped with a primer. Generally similar to an ordinary blank cartridge but much more refined because of reliability requirements, the cartridges may be used wherever a single application of power is required. The Navy itself has more than 100 uses for CAD, such as in pilot ejection seats, bomb ejectors, missile-stage separators, line cutters, and auxiliary power sources. During the past three years, NWL's work in this field has resulted in the completed development of 35 of these cartridge types, the complete qualification of 26, and the release to the service of 19.

A relatively new research program at NWL is called Project HERO (Hazards of Electromagnetic Radiation to Ordnance). This project explores potentially dangerous hazards to ordnance that result from the close concentration of radars, communication transmitters, and similar electromagnetic generators in the vicinity of missile bases, and aboard aircraft carriers and command ships. These high-energy fields could prematurely explode electromagnetically triggered ordnance, such as missiles, although so far no fatalities have occurred from this type of accident. The problem is extremely complex because of the very large number of variables involved, and each weapon must be regarded as a possible receiver which is, or may be, tuned to a particular electromagnetic frequency. Further, each circuit element within the weapon system must be considered as a potential tuned circuit capable of absorbing energy at certain radio frequencies. Although much of the testing is done aboard carriers and missile ships (since most of the project is concerned with aircraft air-to-air and ship surface-to-air missiles), simulated ship installations are also set up on shore. One of these testing stations–a mockup of a carrier deck with a large turntable to permit 360° rotation of naval aircraft–is at Dahlgren (see inside front cover). (Another one is located at the U.S. Naval Ordnance Test Station at China Lake, California).

Ten years ago, almost the entire workload at NWL was devoted to the development of conventional weapons: providing aiming tables for bombs, projectiles, rockets, and mines; work on guns and ammunition, terminal ballistics tests of anything required to survive impact, etc. Currently only 10 percent of NWL's work is in this line.

The past ten years have witnessed a critical transition period at NWL: the leap from the big guns of battleships to missiles and space-satellite tracking. However, the step was a logical development for NWL. Viewed basically, space-satellite performance is really an extension of the ballistic problems encountered in determining the trajectory of large-caliber shells. The problems of space-missile flight are comparatively insignificant compared to the problems of ballistic objectives within the atmosphere. Large conventional shells, it will be recalled, were fired at speeds approaching Mach 4. Therefore, the basic atmospheric problems are still the same, with the additional fact that the space missile encounters the atmosphere twice during its flight.

FUTURE OF NWL

During the transition, BuWeps has doubled the funding of its programs at NWL. This has resulted in a corresponding increase in the professional staff at Dahlgren. These two significant increases confirm the success of the transition. The vigorous and capable research and development center now at NWL indicates that the Laboratory is very much a part of our rapidly changing Navy.– C.E.F.

Sow's Ears Into Silk Purse

Recently a silk purse made from sow's ears was presented to the Smithsonian Institution by a Navy contractor, the Arthur D. Little Company of Cambridge, Mass. The founder made it 40 years ago by reducing 100 pounds of sow's ears into glue and transforming the glue into silk-like filaments. With these, he wove the tasseled purse.

Navy Sniperscope May Help in Restoring Vision*

A Navy infrared sniperscope promises to aid doctors in the diagnosis and treatment of the blind. This device will be especially useful as a diagnostic tool in helping surgeons determine whether sight can be restored in patients afflicted with opaque corneas. This renewed vision is possible today by a surgical procedure referred to as a corneal transplant.

When the transparent part of the outer covering of the eyeball (the cornea) becomes opaque, it acts like a drawn curtain: the patient not only cannot see out, but the examining doctor cannot see—in the conventional white-light ophthalmoscope—the condition of the many structures within the eye. Conditions of the anterior (front or forward portion) inner eye (Figure 1) that may contribute to blindness or otherwise make a corneal-transplant operation impractical include: atrophy, adhesion, or destruction of the iris; a tumor or an increase in the number of blood vessels in or near the cornea; increased turbidity of the aqueous humor; blood clots; or an opaque crystalline lens (cataract). The newly adapted Navy infrared device will enable physicians to ascertain better these and other conditions.

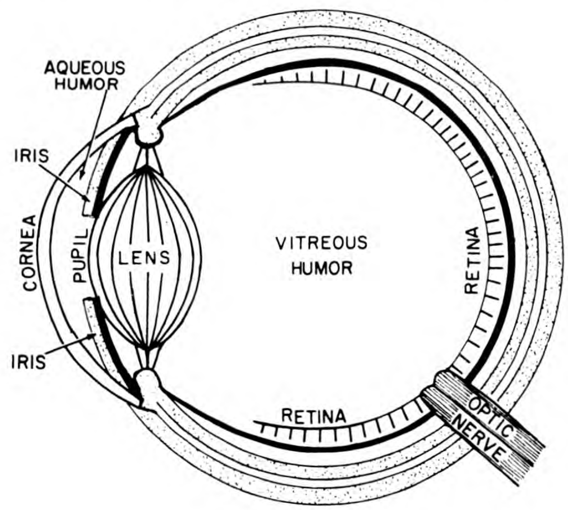


Figure 1—Structures of the human eye

INFRARED ELECTRONICS IN OPHTHALMOLOGY

The phenomenon of tissue penetration by infrared radiation has been known since 1933. Since then, infrared photography has been applied as a diagnostic aid for visualizing superficial blood vessels and tumors in the skin and mouth, as well as various structures within the eye.

*Adapted from two research reports by Joel Friedman, D.D.S., of the Jewish Chronic Disease Hospital, Brooklyn, New York and the Institute of Cancer Research, College of Physicians and Surgeons, Columbia University, New York.

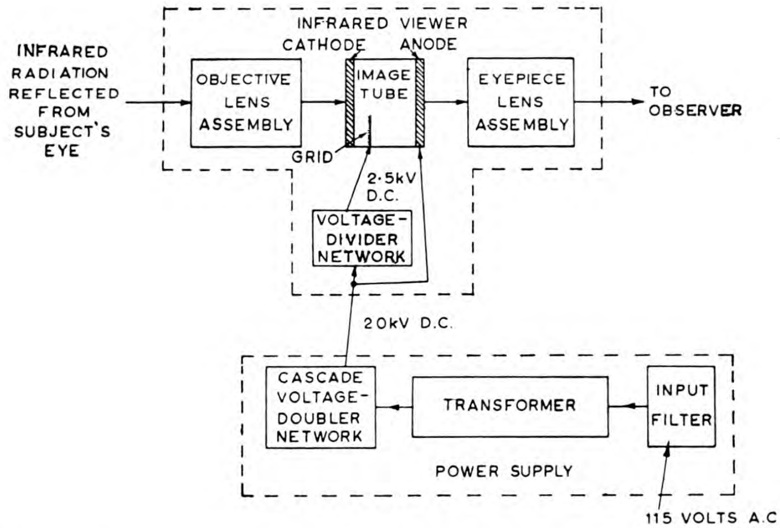


Figure 2—Diagram of infrared receiver and power supply.

The first application of war-surplus infrared tubes to the study of corneal opacities was made by two ophthalmologists, Vasko and Peleska, in 1947. Then in 1958, Ogg of Britain adapted a British World War II electronic image converter (CV-147) to one eyepiece of a slit-lamp microscope with a filtered tungsten light source to penetrate opaque corneas. The adaptation of the U. S. Navy infrared receiver and image converter (loaned by the Office of Naval Research) was made by Joel Friedman, D.D.S., in 1959. He became interested in this research through his studies of infrared photography of the oral mucosa. Since then he has refined his technique and applied it to many clinical studies in ophthalmology.

The near-infrared receiver was developed during World War II for receiving blinker signals at night and, when combined with an infrared light source, as a telescopic rifle sight (''sniperscope'') against enemy personnel. The Navy instrument adapted by Dr. Friedman incorporates an image-converter phototube coated at its larger end with silver-cesium powder. Near-infrared radiations (of 0.8 to 1.0 micron) strike this semitransparent coating (the cathode) and excite a discharge of electrons, which are then electrostatically focused to form a reduced, erect image on the yellow-green fluorescent screen (the anode) at the smaller end of the tube. This image is magnified by viewing it through the eyepiece lens assembly (Figure 2). The sniperscope, originally designed for telephoto viewing, is easily adapted to four-inch closeups by fitting a +12 diopter lens in front of its objective lens assembly. A powerpack transforms 115 volts ac to 20 kilovolts dc. This is applied to a grid arrangement within the tube to accelerate the electron beam and to provide adequate luminescence of the image.

Combination of this instrument (plus the close-up lens) with routine ophthalmic diagnostic devices is effected by placing the sniperscope behind the eyepiece lens assembly of the ophthalmic instrument so that the sniperscope is interposed between the ophthalmic

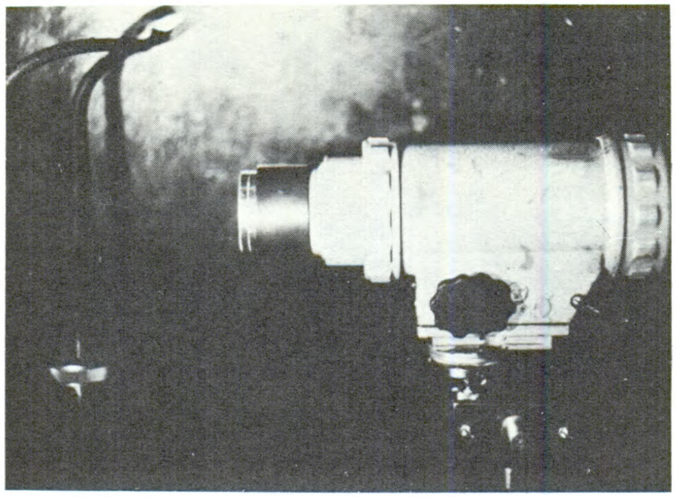
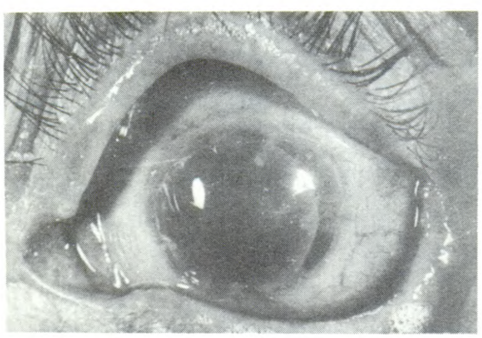


Figure 3–The new infrared ophthalmic instrument devised by Dr. Friedman. (Photo courtesy of Dr. Friedman)

instrument and the observer. After the exact distance between the objective and the eyepiece lens assemblies is established for optimal focus, a metal tube is constructed to fix the elements at the proper distance and exclude ambient light (Figure 3). The regular ophthalmic white-light source may be used.

The rays of light are reflected from the eye of the patient, and only the longer, more penetrating, near-infrared wavelengths then pass through the viewing device to the eye of the observer. A highly useful application of this technique is effected by filtering the light source with an infrared filter, so that only the infrared radiation—invisible to the patient's eyes—is used. This permits the patient's pupil to dilate



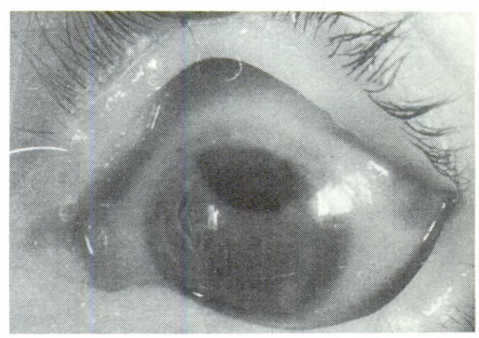


Figure 4–Left: Clinical photo taken with white light. Left eye showing opacification of the cornea (following an unsuccessful graft) obliterating the underlying eye structures. Right: View of the same eye as seen through the infrared image converter reveals an updrawn pupil (darkest area), indicating earlier cataract removal with possible loss of vitreous humor. (Photos courtesy of Dr. Friedman)

and does not affect the brightness of the perceived image. By alternately removing and replacing the filter, the physician may accurately appraise the dilating and constricting neuromuscular function of the iris. A further advantage in using infrared light to examine the eye is the elimination of excessive blinking and eye movement by the patient. This would be especially helpful in examining patients with corneal disease because they are frequently supersensitive to visible light.

DISCUSSION

The studies in this paper were made with a U. S. Navy infrared receiver utilizing an R. C. A. No. 6032 image converter and a Type 20 phosphor screen anode. Although the observer has the impression of seeing directly through the instrument, his eye sees only the image formed on the phosphor screen.

The longer, more penetrating wavelengths of the near-infrared segment of the spectrum facilitate examination of the anterior chamber of the eye behind relatively dense, long-standing corneal opacities. There are some instances where it is possible to "burn through" a mild corneal opacity with strong visible light from the ophthalmoscope or slit-lamp microscope and gain a reasonable view of the subcorneal structures. For the most part, however, a distinctly superior penetration is gained by the use of the image converter combined with routine diagnostic instruments (Figure 4). The Navy sniperscope, compared with the 1P25A American World War II and its British (CV-147) and German (Vampire) counterparts, has a superior screen-image resolution (18 line-pairs per mm compared with an average of 12 line-pairs per mm of the other models mentioned). Also, the coating of the phosphor screen of the Navy model is appreciably finer-grained than the others.

However, as applied in the present studies, the instrument still has definite technical and biological limitations. For one, the grain of the coating of the phosphor screen is still too coarse to permit good photographs of the screen image. Also, pincushion field distortion is marked, despite the correcting lens built into the optics, and peripheral blurring is apparent. Limitations to the penetration of opaque corneas have been noted in six patients out of a series of 21 studied. These limitations were experienced chiefly in longstanding, thick opacities with marked formation of scar tissue and well-organized circulatory systems. Finally, infrared-light techniques, although very useful in visualizing anterior eye structures, are of limited value in examining the back part of the eye (the fundus). Here the retina is highly reflective to infrared, and the blood vessels and optic disc lack definition, because they are in the yellow and pink color zones. Only a bluish or bluish-gray lesion, such as a pigmented tumor (melanoma), would possess the color contrast necessary to make it visible to infrared light. Such tumors of the retina have already been disclosed with infrared light. The new device, though, will still perform a very useful function in the diagnosis of conditions of the anterior of the eye when complicated by an opaque cornea.

Life-Like Manikins Aid Navy Medicine

The two clear-plastic manikins illustrated in the accompanying half-tones are permanently detailed to the National Naval Medical Center, Bethesda. They can neither walk nor talk, but they are nonetheless anthropomorphic (life-like) in several aspects that are important for medical research: they are the exact size (5 ft 9 in. tall, 162 lb) of the average serviceman, and their fabric is equivalent to human tissue in absorption of neutron, gamma or X-radiation. Thus REMAB* (Radiation-Equivalent Manikin-ABsorption) and REMCAL* (Radiation-Equivalent Manikin-CALibration) can take the place of either a living person or a cadaver for measuring radiation dosage or for calibrating radiation equipment. Both are articulated so that they can stand or sit, and they can bend their arms at the shoulders and elbows.

REMAB's plastic skin covers a human skeleton. Dosimeters can be inserted next to, or inside of, the long bones, to measure the bone-marrow dosage from, say, a large X-ray machine. Similarly, the manikin—with dosimeters inside—can be exposed at the scene of a radiation accident, to determine how much radiation the victim received. Other foreseeable uses are testing of protective systems and shielding, measurement of fallout absorption that would be experienced by human beings, and the like.

Whereas REMAB is used to measure radiation absorbed, from radiating instruments and other sources, REMCAL is used primarily to calibrate the radiation instruments employed for medical treatment or research. The calibrating is done by loading the manikin with a known radiation burden and then checking the reading of the instruments. Accordingly, REMCAL is equipped with all of the principal internal organs: liver, stomach, kidneys, etc. These, like the manikin's body, are made of hollow plastic. The organs can be fitted into REMCAL's body in any combination, after which they are filled with a solution which is radioactive in precisely known amounts. Filling ports on the arms and legs permit the whole manikin to be similarly loaded.

In the Naval Medical Center's Radiation Exposure Evaluation Laboratory, REMCAL is used to calibrate accurately a wide variety of counting instruments and recorders, including those in the whole-body counting room. The latter is a vault-like chamber surrounded with eight inches of battleship armor plate.

The third, and startlingly realistic, manikin pictured here is commonly known as "Mr. Disaster." It is a training aid which is used for instruction in emergency casualty care. Pioneered and developed by the U. S. Naval Dental Corps, Mr. Disaster is in use by the U. S. Navy, Army, and Air Force to train their personnel to be of assistance in the medical effort in case of major disaster.

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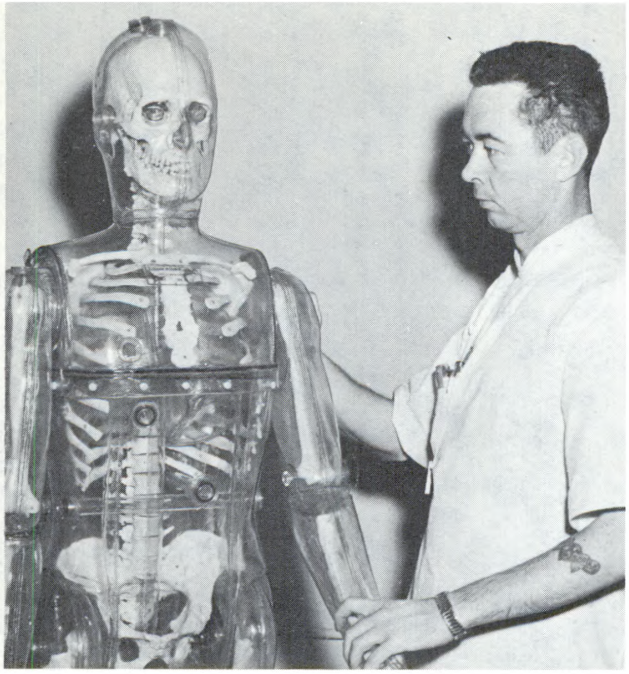
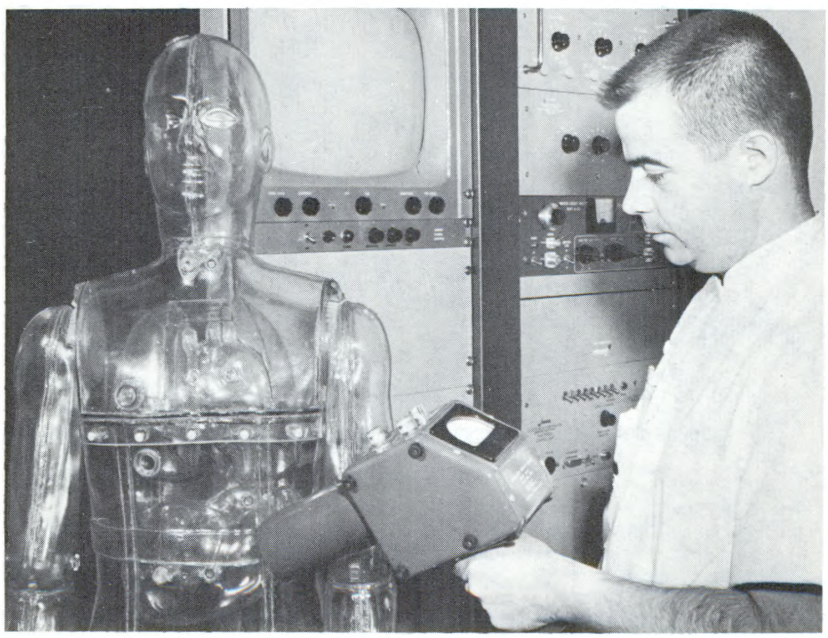


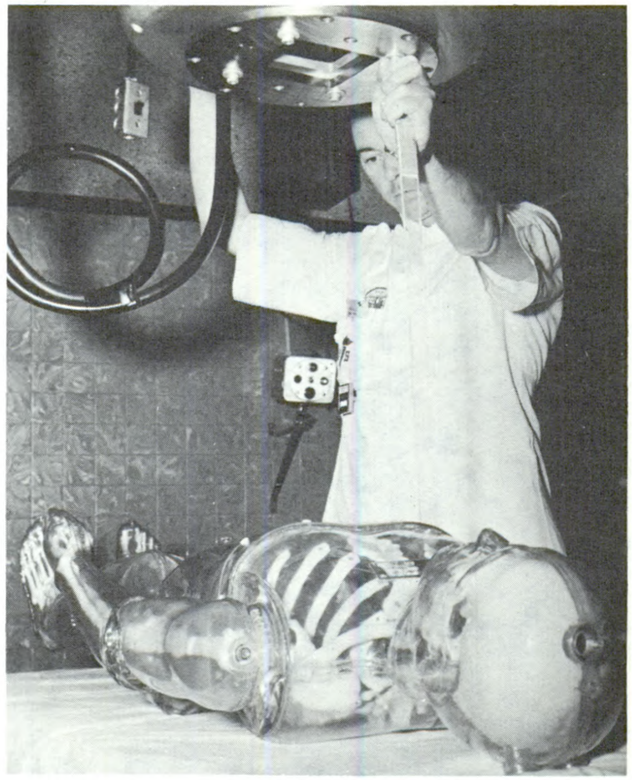
NNMC's radiation manikins: REMAB (left) contains a human skeleton; REMCAL (below) is fitted with the principal internal organs.



Highly realistic wounds—plastic moulages—can be attached to the head, body, and limbs. Simulated bleeding of individual wounds is accomplished through the use of an ingenious pumping system which circulates a scarlet fluid consisting of water, glycerin, and vegetable coloring.

The life-size manikin was fabricated under Navy contract by Rogay Models, Inc. of Bethesda, Maryland, specifically for the U. S. Naval Dental Corps.

Right: REMAB being measured for a dose of X-rays. Below: Mr. Disaster, bleeding on cue, is the complacent subject for a demonstration of first-aid techniques.



Livability in Isolation*

The psychological effects experienced by men during prolonged isolation has become increasingly important with the advent of such isolating situations as Operation Deepfreeze, the prolonged voyages of nuclear submarines, Arctic DEWLINE outposts, and Texas Tower operations. And it is apparent that the problem will become more acute as man reaches into outer space. Today several programs are underway to study these effects and make recommendations to alleviate some of the problems encountered. The Navy's studies of submarine habitability are under the direction of the Intra-Navy Committee for Submarine Habitability Research and Development, whose job it is to plan, initiate, and maintain a continuing R & D program designed to insure maximum sustained human performance under the conditions imposed by submarine systems.

To further their mission, the Committee sponsored a Pentagon seminar earlier this year on the psychological effects of prolonged isolation in submarines and other detached habitations. It consisted of four presentations by individuals who have gained experience and knowledge under differing environmental conditions. Introductory remarks were made by CAPT L. V. Young, USN, (former Undersea Warfare Officer at the Office of Naval Research and now C. O. of the USS FREMONT) and RADM I. J. Galantin, USN, (Director of ASW/SS Warfare Division under the CNO.). CAPT Young, Chairman of the Committee and organizer of the seminar, explained that, in his opinion, the subject of submarine habitability encompasses two broad areas: one dealing with man's physical existence, concerning itself with such things as food, clothing, and the air he breathes; and the other with psychological problems of living, such as motivations and outlook. The term "livability" was coined to describe the psychological—or living—aspects of the subject. Admiral Galantin agreed that although mental well being is of prime importance, livability competes with essential operations and usually has to be compromised in terms of space and human effort. [A submariner can be made quite comfortable, but he still may have to have a torpedo for a bunkmate].

The first formal talk was given by Captain Edward L. Beach, USN, Commanding Officer of TRITON, who discussed the behavior of his men during the 84-day submerged cruise of his ship from 16 February 1960 to 11 May 1960, 61 days of which were spent in circumnavigating earth along the approximate route followed by Magellan in 1519-1522. Captain Beach pointed out that it is neither possible nor desirable to maintain morale at a constant level. He holds that it is as desirable to prevent excessive heights as it is to circumvent excessive lows in morale. Most important, according to Captain Beach, is strong incentive. The crew that circumnavigated earth, of course, had this. Beach noted that present automatic machinery may require more

*Adapted from a report prepared by S. H. Herzfeld of ONR Branch Office, Chicago.

work for maintenance than it eliminates in the replacement of men by machines. Most men, apparently, are unable or disinclined to spend leisure time with a book. The TRITON crew very quickly tired of games.

The second speaker was LCDR Vernon N. Hauk, M.C., USN, who commanded the Amundsen-Scott South Pole Station during Operation Deep Freeze III from October 1957 to January 1959 in Antarctica. At the station, 18 to 24 men worked and lived in 5 buildings connected by underground passages. Temperatures at the site varied from -16° F. to -117° F. Supplies by ship can be brought in during December and January and perhaps also during the latter two weeks of November. Helicopters from McMurdo Sound can air-drop supplies during a somewhat longer period. More monetary compensation would have little or no effect in improving morale, according to Hauk. (The next speaker, however, reported that in commercial activities, extra remuneration had proved to be an excellent incentive). Hauk's men knew that no mail could be expected for 8.5 months and were not disturbed by this. Ham radio transmitters may be harmful as well as beneficial; one may learn bad news from home. Dr. Hauk had 160 movie films, of which all but three were of the lowest class and ''insulted one's intelligence.'' Games finally were burned. Of great importance was an area where a man could have privacy. LCDR Hauk stated one man became violent because another used a fork in a manner that irritated the observer. Knowledge that an unusual and significant event was transpiring served as an excellent incentive. In general, patience and tolerance were learned. Dr. Hauk believes that excessive coddling of men is neither expected nor desirable. With a group as small as that in the Amundsen-Scott Station, separation on a class basis is undesirable.

Third to speak formally at the livability seminar was Mr. John W. Guilfoyle, President, Federal Electric Corporation. His topic was psychological reactions of men working in units of the Distant Early Warning Line (DEWLINE) in northern Alaska, Canada, Greenland, and Iceland. This system, for the detection of air-breathing aircraft and for communication, employs 1100 men at a uniform net salary of $10,000 for 18 months. Increases are given to those volunteering for additional 12-month tours of duty. A part of the earnings is withheld and paid only upon completion of the tour of duty. Selection of the men, all volunteers, is based on technical, physical, psychological, and intelligence tests. Men selected are ''good electronics technicians;'' they are trained for DEWLINE duties before being cleared for transfer. Of 100 applicants, 10 are sent to training school, and 8 pass the course. The feeling of superior accomplishment which this gives the men assigned to DEWLINE duty undoubtedly aids in maintenance of satisfactory morale. DEWLINE is now in its fifth year (since 1956), and one man has returned for a fifth tour. Guilfoyle stated that the greatest single factor is a man's desire and willingness to do the job in the arctic zone. The long night is difficult. Among leisuretime facilities are a cinema (with three new prints each week), library and school, photographic supply and dark rooms, game areas, and communications (mail, radio, tapes, telephone). Three physicians and three dentists travel among the stations. Clergymen likewise pursue an itinerant way along the DEWLINE.

The final exposition of the livability seminar was made by LCDR John E. Rasmussen, M.C., USN, Coordinator for Neuropsychiatric Research, U. S. Navy Bureau of Medicine and Surgery, who discussed "key problems of human behavior in isolation." He emphasized four points: deprivation of sensory stimuli, long periods of inactivity, immaturity, and size of group. Lack of sensory stimuli may cause emotional disturbances akin to insanity. In simulated environments, survival is not involved; hence such tests are of limited value. Inactivity for long periods, as by pilots in frigid zones, is demoralizing. Immature, demanding, egocentric individuals are the worst. Size of the group is important; assemblages of 100 do better in isolation than collections of 15 to 25. Rasmussen concluded that present psychiatric-selection methods are effective in eliminating men that might experience mental breakdowns during isolation. Placement of a psychologist among the men is unwise, he added. Men react unfavorably, and the psychologist himself is subject to the same influences as others. A medical officer on a submarine has said that if the SANTA MARIA had had a psychologist on board, its voyage would not have been completed. Rasmussen proposed as a substitute for a psychologist in a submarine or other isolated space, a medical officer with a knowledge of psychology.

CDR Johnny L. Wallace, USN, (center), former executive officer of the ONR Branch Office in Pasadena, "going ashore" after his recent retirement ceremony.

Research Notes

Nobel Prize Winners

Two of the four recently-announced Nobel Prize winners for 1961 have been supported in their research for a long period by the Office of Naval Research.

Prof. Robert Hofstadter, recently announced as a co-winner of the Nobel Prize in physics, has been conducting the research which won him the Nobel award since 1951 at Stanford in a joint program supported by the Navy, the Atomic Energy Commission, and the Air Force and administered by the Office of Naval Research.

Prof. Hofstadter found that the proton and neutron both have a similar positively-charged central core structure which is very dense. Both central core structures are surrounded by a meson cloud, which for the neutron has a net negative charge. The proton on the other hand has a positively-charged cloud, which contributes roughly half of the portion's total charge. The neutron's negatively-charged cloud balances its positively-charged core resulting in a net charge of zero for the neutron. Hofstadter found that the nucleon has a diameter of about one forty-thousandth of a billionth of an inch.

The 300-foot long, high-energy linear accelerator at Stanford, which provided the electrons for Prof. Hofstadter's measurements of atomic nuclei and nucleons, was constructed under a contract initiated by the Office of Naval Research in 1946. Funds for the completion of the accelerator, until recently the largest linear accelerator in the world, were also provided by the AEC and the AF Office of Scientific Research.

The fabrication of the apparatus devised by Hofstadter to make his precise measurements was greatly simplified and considerably reduced in cost by the use of Navy surplus gun mounts as rotating platforms for two magnets, which measure the energy of the electrons scattered by the nuclei. Rotating the magnet makes it possible to measure the scattered electrons at a wide variety of angles.

Prof. Hofstadter's experiments have provided the first direct measurements of the size of structure of atomic nucleons (protons and neutrons) and have thereby contributed considerably to a deeper understanding of the basic forces of nature.

Dr. George von Beckesy won the Nobel Prize in medicine for his pioneering work in revealing the mechanics of the human ear, particularly the inner ear. Although his award-winning research was accomplished 30 years ago in Hungary, he followed up with further research at the Psychoacoustic Laboratory at Harvard University beginning in 1947 under the sponsorship of ONR.

Dr. von Beckesy has determined how the ear is able to hear sounds at frequencies as high as 40,000 cycles per second. His research has also thrown light on the remarkable efficiency of the human ear, which can distinguish one person's voice in a roomful of talking people or can pick out the sound of an individual instrument in a symphony orchestra. This is essentially accomplished by mechanical amplification, which in part utilizes hydraulic pressure on the fluid of the inner ear.

When Dr. von Beckesy began his work, little was known of the mechanics of the human ear, because instruments were not available to probe the delicate interior. He solved this problem in Hungary by examining the interior of the ear of human cadavers. At Harvard, he further developed his technique and special instrumentation, including an audiometer able to measure hearing acuity with great precision.

In addition to these two men, Dr. Melvin Calvin, winner of the Nobel Prize in chemistry was supported by ONR for a brief period in some research on algae.

Porpoise With a Purpose

A mechanical "porpoise," designed to conduct Navy oceanographic studies while gliding underwater, is currently under construction by the Aeronautics Division of Chance Vought Corporation, which is working under a licensing agreement with Oceanic Systems Corporation, Stony Brook, New York. Called the porpoise because of the way in which it will dive and surface, the vehicle is to be approximately 12 feet long and 21 inches in diameter. Construction of an experimental model is proceeding under a contract co-sponsored by the Office of Naval Research and the Navy Hydrographic Office.

If tests are successful, the Porpoise may be used for a number of projected oceanographic studies. One of the first applications to be attempted will be the charting of water temperatures at various depths. By obtaining water temperature profiles, the Porpoise is expected to contribute materially to the determination of sonar equipment performance. In addition, since sharp differences in water temperature at certain depths make sonar detection difficult, the data obtained would aid in forecasting sonar performance in certain areas.

After the Porpoise is dropped overboard from the tending ship, its ballast tanks will fill with ocean water, permitting it to descend at a pre-determined angle. When the desired depth has been reached, special instrumentation will release air into the tanks, expelling the water ballast and allowing the vehicle to commence its ascent. A combination of gravity and buoyancy provides the motive power. Upon surfacing, a balloon enclosed in a net will automatically inflate. Recovery will be accomplished by grabbing the net with a simple boat hook, breaking the balloon in the process.

The model vehicle will operate automatically after launching, without direct control from the tending ship. Its design will permit relatively long-range operation at varying depths and speeds with a small fuel consumption. Although initial testing will be only in depths up to 500 feet, later tests may allow for greater depths, together with more sophisticated control and recovery systems.

New ASW Crew Trainer

A proficiency trainer for Antisubmarine Warfare crews, better known as the "Wingless Wonder," has been developed by WO James M. Schneider, Norfolk Naval Air Station, and constructed with the aid of Frank Angelo and the Air Station crew of the Avionics Branch.

The urgent need for a modernized, operational trainer to train entire ASW crews, including tactical coordination as a crew, was pressing. Loral Electronic Corporation of New York provided NAS Norfolk with an aircraft mockup suitable for conversion to an operational trainer, along with certain necessary electronic equipment and a top engineering assistant, Mr. Angelo.

The trainer began its new life as an empty wooden hull, 26' x 9' x 7'6", and within 90 days was constructed into the most modern trainer for ASW crews. It features electronic equipment comparable to that which was installed in the P5M aircraft backfit program earlier this year.

The basic idea of this trainer is to promote proficiency training on the ground for the entire ASW crew. Any further problems that may arise while the aircraft is in the air are simulated and solved by the entire crew. No other program similar to this is in effect in the Navy today. (Fleet Airborne Electronics Training Unit, Atlantic Fleet, offers individual training programs, but no proficiency of the crew as a unit). The trainer, with the extensive research and expensive equipment, was constructed without cost to the government and is comparable to a $2,000,000 trainer.

DTMB Scientist Wins BuShips Award

Dr. Pao C. Pien, of the David Taylor Model Basin, was the first annual recipient of the BuShips Scientific Award, and will automatically become the Bureau's nominee for the Navy-wide Robert Dexter Conrad Award.

RADM R. K. James, USN, Chief of the Bureau, made the presentation *in absentia* because Dr. Pien is currently on leave in Tokyo doing research on a National Science Foundation Fellowship. The citation reads: "By developing methods of applying mathematical techniques to the solution of urgent military problems you have made unique contributions to the field of digital computer utilization. You developed a ship-hull fairing technique which introduces the possibility of automated techniques for ship fabrication; you developed and programmed a lifting surface theory which is available for application to propeller design work; you developed and programmed an advanced form of quasi-steady theory for determining unsteady propeller forces. I consider your distinguished service richly deserving of the first

Dr. Pao C. Pien (see inset) is the winner of the Bureau of Ship's first annual award for scientific achievement. RADM R. K. James, Chief of BuShips, (left) presents the award to Mr. Jacques B. Hadler who accepted it in absentia for Dr. Pien.

annual award for the outstanding contribution to the field of research and development.''

The Bureau of Ships has eight laboratories engaged in R&D for the Navy. Each Commanding Officer and Director was invited to nominate one or more scientists for the Chief's award. So that the many capable scientists and engineers working at the Bureau would not be overlooked, a similar award was established in the name of the Assistant Chief of Bureau for Research and Development.

The ''men of the year'' at BuShips were:

- Assistant Chief's Award: Mr. Robert M. Sherwood, Director of Project TEACUP, for work in ship silencing.
- Radiological Defense Lab: Dr. E. L. Alpen, for contributions of a far-reaching nature in the field of biological effects of ionizing radiation.
- David Taylor Model Basin (second nominee): Dr. Feodor Theilheimer, for developing a technique for calculating ship profiles automatically.
- Mine Defense Lab: Dr. Julius Hagemann, for outstanding contributions to the art of mine countermeasures.
- Navy Electronics Lab: Dr. Maurice H. Halstead, for his share in the promotion and development of the NEL International Algorithmic Compiler (NELIAC). (NavResRev, July 1961)
- Underwater Sound Lab: Mr. Thaddeus G. Bell, for outstanding contributions to Fleet readiness in the area of acoustic range prediction.
- Engineering Experiment Sta: Mr. L. J. Argiro, for the planning, development, and engineering of the Station's integrated acoustic data processing facility.

• Material Laboratory, NYNS: Mr. Louis Pellecchia, for invention of a precision analog angular data transmission system.

• Boiler and Turbine Lab, PhilaNS: Mr. R. C. Brierly, for outstanding contributions to Fleet engineering problems during 41 years of service at BTL.

• And, of course, Dr. Pien.

FX-1 Computer

The fastest digital computer ever built is now in operation at the M. I. T. Lincoln Laboratory in Lexington, Massachusetts. Known as the "FX-1," this new computer is in every important respect a working model for a new generation of machines, ten times faster than any computers in general use today. The significance of the new machine lies not in its size or capacity, which are modest, but in the unusually high speed at which it operates, and in new construction techniques designed especially for high frequency operation.

It is the first machine with a main memory using thin magnetic films in place of ferrite cores for high-speed, random-access storage. FX-1 is designed to be a complete, small-scale, general-purpose computer for realistic tests of fast logic circuitry and magnetic film storage in system operation.

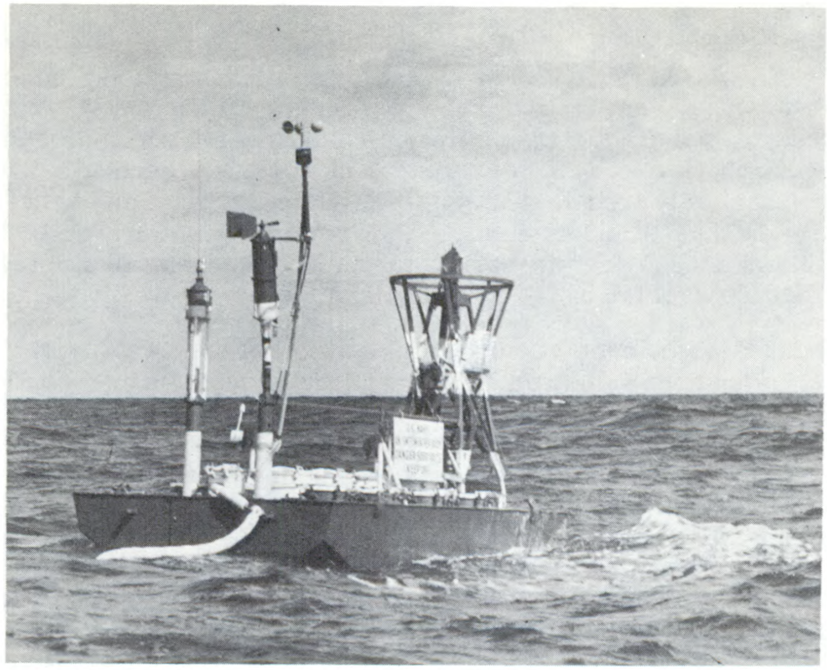
In specifying the speed of a computer, there are two items of particular interest: (1) the time required to read a computer word out of the memory and to write in a new word (the "read-write cycle time"), and (2) the speed of the logic circuits, which may be specified by the rate of the timing pulses which govern the operation of these circuits (the "clock rate"). Both of these items are noteworthy in the FX-1, since in both instances the new machine is substantially faster than the most advanced commercial computers of today.

The magnetic-film memory employs printed-circuit wiring on a flexible sheet of resin-impregnated glass-fiber cloth. The arrays of memory elements, deposited on thin-glass backing plates, are positioned on the wiring so that each magnetic-film element rests on the intersection of two perpendicular leads on the wiring sheet—making the plaid-like design of this month's cover.

The FX-1 computer was designed and built by the Digital Computers Group in the Information Processing Division of the M. I. T. Lincoln Laboratory, with assistance from Lincoln's Computer Components Group. Lincoln Laboratory is a center for research, operated under Air Force contract by the Massachusetts Institute of Technology, with the joint support of the U. S. Army, Navy, and Air Force.

Unmanned Weather Station

Ships in the vicinity of Hurricane Carla prudently kept their distance, but an unmanned Navy weather station was anchored in the path of the storm to keep vigil and help track it. This is the newest weapon in the U. S. Navy's arsenal of war against hurricanes.



NOMAD-1 monitors and relays weather conditions from its lonely anchorage in the middle of the Gulf of Mexico.

As a part of the National Weather Observing Network, the floating station is anchored in 11,000 feet of water in the middle of the Gulf of Mexico. Officially designated as the Navy Oceanographic and Meteorological Automatic Device (NOMAD), the 20 by 10-foot platform is designed to monitor and report weather data automatically from a surrounding area of hundreds of miles of open water. NOMAD has already proved its capabilities: the first model, moored late last summer, provided advance warning of the buildup of Hurricane Ethel on September 12 and gave Gulf Coast areas a 48-hour early notice. Devices such as NOMAD can monitor large areas of water where there are no human observers and pick up the first tell-tale signs of a hurricane or typhoon—increase in wind velocity and decrease in pressure.

NOMAD I, moored at latitude 25 North and longitude 90 West in the Gulf of Mexico, reports its data to the U. S. Fleet Weather Facility, Miami, Fla. It is also monitored by the U. S. Weather Bureau Stations at Burrwood, La., and Key West, Fla., which incorporate the data in weather circuits to forecasting offices throughout the country. During periods of low winds, reports are transmitted once every six hours; during periods of high winds, at hourly intervals. Built under the direction of the Bureau of Naval Weapons, the hull was designed by the Navy's David Taylor Model Basin and built at the Philadelphia Naval Shipyard. The sensing devices, electronic components, radio transmitter and power supply were designed and fabricated by the National Bureau of Standards. The anchor system was designed and fabricated by the Woods Hole Oceanographic Institution, and the U. S. Coast Guard Cutter BLACKTHORN anchored the station.

SPAR

The U. S. Navy has design plans for a 350-foot long, unmanned research vessel that will swing down on its aft end anywhere on the high seas to serve as a stable floating platform for conducting acoustics research (see drawing on inside back cover). Designed for use in the comparatively rough seas of the Atlantic Ocean, the vessel will measure the speed and intensity of underwater sound transmission at depths down to 300 feet in various parts of the ocean. A construction date for the vessel has not yet been determined.

Under development at the U. S. Naval Ordnance Laboratory, White Oak, Maryland, the instrumented research vessel is called SPAR— Seagoing Platform for Acoustics Research. Essentially a 16-foot diameter steel tube longer than a football field, SPAR has a displacement equal to that of a World War II submarine. On the exterior of its hull are attached sensitive underwater listening devices, as well as thermometers, pressure gages, and instruments for determining the amount of salt in the surrounding sea. Ballast and free-flood tanks make up the interior of the lower 280-foot section, while operating machinery and additional instrumentation are housed in the upper 70-foot buoyancy section.

During operation, SPAR is towed horizontally anywhere in the rough Atlantic by a tending towship which can remotely flood the research vessel's aft end and make it swing down and settle in the water like an iceberg. Carrying its hydrophones and other external instrumentation down to depths of 300 feet, SPAR floats vertically in the water with only 50 feet of its buoyancy section protruding above the surface. All research data collected with SPAR is relayed to the tending mother ship via electrical cables linking the two vessels. In its operating position, SPAR is so stable in the water that its vertical motion is less than one foot per second. This reduces acoustical background interference during research by minimizing the intensity of water noise around the vessel's underwater hydrophones.

According to project manager, Dr. Benjamin L. Snavely of NOL's Physics Research Department, "SPAR provides the Navy with an exceedingly stable platform for studying sound over a range of depths. This includes the surface layer (which may be several hundred feet thick and have quite variable temperatures) as well as the deeper regions of stable temperature." Contract plans for the design of SPAR were prepared under the technical direction of NOL's Air and Surface Mechanical Engineering Department by M. Rosenblatt and Sons, Incorporated, naval architects and marine engineers of New York. Construction of the research vessel will be under the direction of the Navy's Bureau of Ships.

SPAR is a counter-part to a Pacific-Ocean vessel of similar design being developed by the Office of Naval Research in cooperation with the Marine Physical Laboratory of the Scripps Institution of Oceanography. Also financed by the Bureau of Naval Weapons through the Naval Ordnance Laboratory, the Pacific vessel has been dubbed FLIP — Floating Instrument Platform. It will be manned and allowed to drift with the wind and currents of the relatively calm Pacific and will be used to conduct studies similar to those performed with SPAR.

On the Naval Research Reserve

Attention Reserve Officers on Active Duty

If you are qualified in the scientific or technical fields you are eligible for association and may participate in the Research Reserve Program. Members of the Naval Reserve of any designator are eligible for membership subject to the following standards:

1. Research: Be qualified and currently engaged in the conduct or administration of scientific research. Those qualified to conduct research are individuals having, or working toward, advanced degrees in fields of interest to the Office of Naval Research. Practical work as a substitute for formal education will be evaluated by the Office of Naval Research. Individuals qualified to administer research can be adjudged as to both educational and practical qualifications primarily on the basis of current occupation. Such personnel are interpreted to include engineering and technical personnel qualified to evaluate research from the standpoint of application.

2. Training Devices: Aeronautical, mechanical, electronic, and electrical engineers with knowledge of the application of their field to synthetic training devices; statisticians; educators in technical fields qualified to coordinate and supervise the use of synthetic training devices and training aids in the Navy's training programs.

3. Contract Administration and Patent Law: Lawyers with experience in either field; individuals with experience in Government research contract administration; individuals specializing in patent, trademark, or copyright matters.

Participation in the Research Reserve Program offers you an opportunity to perform active duty for training in many of the Navy's Research and Development Commands. You will also be considered from a priority aspect for attendance at Office of Naval Research sponsored seminars in the fields of nuclear sciences, training devices, electronic computers, research planning and management, aviation and submarine medicine, research methods, and the Navy's current research programs. The objective of the Program is to train you for mobilization billets in the Naval Establishment requiring scientific and technical skills. In accomplishing this objective, the Research Reserve Program aids you in preparing yourself for promotion.

There are 116 Research Reserve companies located throughout the United States. Most of these companies meet twice each month and are generally located adjacent to or on the campuses of universities or colleges. The locations and the names of the Commanding Officers of Research Reserve companies are as follows:

Roster of Research Reserve Companies

ALABAMA

Auburn
NRRC 6-2
Room 301, Ross Chemistry Laboratory
Auburn University
1900 (no set schedule)
CDR James E. Land

Huntsville
NRRC 6-17
Naval Reserve Training Facility
Canal and Barnett Streets
1900, 2nd and 4th Tuesday
CDR John D. Beal, Jr.

ARIZONA

Phoenix
NRRC 11-6
USN&MCRTC, 2042 West Thomas Road
2000, 2nd and 4th Thursday
LT Chester F. Rice

Tucson
NRRC 11-7
USN&MCRTC, 1100 South Avernon Way
2000, 1st and 3rd Tuesday
LCDR Robert L. Voigt

CALIFORNIA

Los Angeles
NRRC 11-1
USN&MCRTC, 851 Chavez Ravine Road
2000, 1st and 3rd Tuesday
LCDR Asa H. Smith

Pasadena
NRRC 11-2
USNRTC, 2727 Paloma Street
2000, 1st and 3rd Thursday
LCDR Edwin D. Alford

Los Angeles
NRRC 11-3
Room 2147, Life Sciences Building
University of California at Los Angeles
2000, 1st and 3rd Monday
LCDR William L. Holser

Compton
NRRC 11-4
USN&MCRTC, 600 North Alameda
2000, 2nd and 4th Wednesday
CDR Victor H. Hunsaker

San Diego
NRRC 11-5
USNRTC, Camp Decatur
1930, 2nd, 3rd, and 4th Tuesday
LCDR Alvin J. Owens

Point Mugu
NRRC 11-8
Building 351, Pacific Missile Range
1645, 1st and 3rd Wednesday
CDR Lyle C. Read

Azusa
NRRC 11-9
Aerojet-General Corporation
2000, 2nd and 4th Wednesday
LCDR Gerald L. Starrh

Ventura
NRRC 11-10
A6, Ventura College
1930, 2nd and 4th Wednesday
CDR George B. McNeely

Santa Monica
NRRC 11-11
USN&MCRTC, 3400 Airport Avenue
2000, 1st and 3rd Monday
LCDR John N. Harvey

San Francisco
NRRC 12-1
1000 Geary Street
1930, 2nd and 4th Monday
CDR Ralph W. Beecher

Livermore
NRRC 12-2
Room 216, Building 143
Radiation Laboratory
University of California
1645, Mondays
CDR Carl E. Schweickert

Stanford
NRRC 12-3
Room 100, Physics Lecture Hall
Stanford University
1930, 1st and 3rd Wednesday
CAPT Clifton A. Smith

Fresno
NRRC 12-4
Room 119, Agriculture Building
Fresno State College
2000, 1st and 3rd Wednesday
CDR Herman D. Graham

Berkeley
NRRC 12-5
Room 247, Cory Hall, University of California
1930, 2nd and 4th Wednesday
CDR Norman L. Jensen

Davis
NRRC 12-6
246 Academic Office Building
1930, 1st, 2nd, and 4th Thursday
CDR Richard N. Doolittle

Monterey
NRRC 12-8
Room S-136, USN Postgraduate School
2000, 1st and 3rd Wednesday
CDR Gilbert F. Kinney

COLORADO

Fort Collins
NRRC 9-12
Room 220, Chemistry Building
Colorado A & M College
1930, 2nd and 4th Thursday
LCDR Robert D. LaRue

Boulder
NRRC 9-17
University of Colorado
1930, 1st and 3rd Wednesday
LT Walter E. Johnson

Denver
NRRC 9-21
John Greene Hall, Denver Research Institute
2000, 1st and 3rd Thursday
LCDR Gus Francis

CONNECTICUT

Hartford
NRRC 3-5
Hartford Electric Building, 176 Cumberland Avenue
Wethersfield, Connecticut
2000, 1st and 3rd Thursday
CDR Robert A. Evans

New London
NRRC 3-12
USNRTC, Building 137, U.S. Naval Submarine Base
2000, 2nd and 4th Tuesday
LT James W. Parker

DELAWARE

Wilmington
NRRC 4-5
USN&MCRTC, 3920 Kirkwood Highway
2000, alternate Mondays
CDR Russell Remage

DISTRICT OF COLUMBIA

NRRC 5-8
National Academy of Sciences
2102 Constitution Avenue, N.W.
2000, 1st and 3rd Thursday
CDR James R. Patton, Jr.

NRRC 5-9
Building 28, NRL Auditorium
4555 Overlook Avenue, S.W.
July: 1630, 1st and 3rd Wednesday
August: 1630, 1st and 3rd Wednesday
Sept: 1st Wednesday and 3rd Thursday
2nd, 3rd, and 4th quarters: 1630, 1st and 3rd Friday
LCDR Charles F. White

FLORIDA

Gainesville
NRRC 6-4
USNRTC, 1300 N.E. 8th Avenue
1915, 1st and 3rd Tuesday
LT Harold D. Wallace

Orlando
NRRC 6-8
USNRTC, West Livingston Avenue
1930, 1st and 3rd Tuesday
CAPT Donald T. Hawley

Miami
NRRC 6-10
Processings and Research Building
2030, 1st and 3rd Thursday
Research, 2nd and 4th Thursday
CDR Norman R. Buchan

Fort Walton Beach
NRRC 6-15
Choctawatchee High School, Shalimar, Florida
1900, alternate Tuesdays
CDR Ralph B. Coe

Patrick Air Force Base
NRRC 6-16
Conference Room, Building 425, Patrick AFB
1630, 1st and 3rd Tuesday
CDR Charles A. Hoffman

GEORGIA

Atlanta
NRRC 6-1
Conference Room, Research Building
Georgia Institute of Technology
1930, 1st three Thursdays each month
LCDR Clarence W. James

Athens
NRRC 6-9
U.S. Navy Supply School
1930, 1st, 3rd, and 4th Monday
(Some months, all four Mondays)
CAPT John C. Craig

IDAHO

Idaho Falls
NRRC 13-6
Tautphaus Park Armory
1930, 2nd and 4th Thursday
CAPT Thomas J. Wadsworth

ILLINOIS

Chicago
NRRC 9-1
Navy Pier Campus, University of Illinois
1900, 2nd and 4th Tuesday
LCDR Walter A. Bohan

Urbana
NRRC 9-2
"E"Law Building, University of Illinois
1930, 2nd and 4th Tuesday
LCDR Wylie H. Davis

Evanston
NRRC 9-10
Elder Hall, Northwestern University
1800, alternate Tuesdays
CDR R. W. Evans

Decatur
NRRC 9-18
USNRTC
1930, 2nd and 4th Wednesday
LCDR Edward B. Freyfogle

Forest Park
NRRC 9-23
Naval Ordnance Plant, 7500 Roosevelt Road
1930, 2nd and 4th Wednesday
LT Mahlon D. Burkhard

INDIANA

Lafayette
NRRC 9-7
Purdue Memorial 212, Purdue University
1900, 2nd and 4th Tuesday
CDR K. C. McLaughlin

IOWA

Ames
NRRC 9-5
USNROTC Building, Iowa State College
1900, 1st, 2nd, and 3rd Wednesday
LT Thomas J. Kieffer

Des Moines
NRRC 9-13
USN&MCRTC, Ft. Des Moines
1930, every Wednesday
LT John H. Wetherell

Iowa City
NRRC 9-19
Room 235, Medical Laboratory Building
University of Iowa
1930, every Monday
LT William J. Hausler, Jr.

Waterloo
NRRC 9-24
USNRTC, 200 Riverside Drive
1930, 1st and 3rd Wednesday
LCDR Joy D. Hayes

KANSAS

Kansas City
NRRC 9-9
USN&MCRTC, Kansas City
1930, alternate Mondays
CDR Alonzo C. Hare

Lawrence
NRRC 9-20
104 Military Science Building, Univ. of Kansas
1930, alternate Tuesdays
LCDR James R. Thomen

LOUISIANA

New Orleans
NRRC 8-1
USNROTC Building, Tulane University
1930, alternate Tuesdays
LCDR Idas W. Lokmann

Baton Rouge
NRRC 8-2
USNRTC, 500 S. First Street
1900, every Thursday
LCDR O. M. Brown

MARYLAND

Frederick
NRRC 5-3
Building 426, Ft. Detrick
1930, 2nd and 4th Tuesday
CDR William G. Roessler

Baltimore
NRRC 5-4
School Board Administration Building
3 East 25th Street
2000, 1st and 3rd Thursday
CAPT Arthur S. Jensen

Bethesda
NRRC 5-10
Auditorium, NMRI, Naval Medical Center
2000, 2nd and 4th Tuesday
CDR John T. Holloway

Annapolis
NRRC 5-11
Auditorium, USN Eng. Experiment Station
2000, 1st and 3rd Tuesday
(No meetings during July and August)
CDR Winfield D. Pennington

MASSACHUSETTS

Cambridge
NRRC 1-1
Room 4-270, M.I.T., 77 Massachusetts Avenue
1930, 1st and 3rd Monday
CAPT Paul H. Flint

Amherst
NRRC 1-3
Room 10-11, Gunness Laboratory
University of Massachusetts
1930, 1st and 3rd Tuesday
LCDR William D. Scott

Worcester
NRRC 1-5
Stratton Hall, Worcester Polytechnic Institute
2000, 1st and 3rd Monday
(No meetings during July and August)
LT Lawrence C. Neale

Woods Hole
NRRC 1-8
Woods Hole Oceanographic Institute
1930, 1st, 2nd, and 3rd Thursday
CDR Robert J. Tilden

MICHIGAN

Ann Arbor
NRRC 9-3
112 North Hall, University of Michigan
1930, 1st and 3rd Monday
(Varied dates July, August, and September)
LCDR Robert M. Barrie

Midland
NRRC 9-15
Grace Dow Library
1900, 2nd and 4th Tuesday
LCDR Ralph W. Barr

East Lansing
NRRC 9-16
Room 313 Electrical Engineering Building
Michigan State University
1930, 1st and 3rd Monday
LCDR Ian O. Ebert

MINNESOTA

Minneapolis
NRRC 9-6
Room 211, Mechanical Engineering Building
University of Minnesota
1930, 2nd and 4th Monday
CDR Allan E. Hassinger

MISSISSIPPI

Gulfport
NRRC 6-5
USN&MCRTC, Broad Avenue
1930, 1st and 3rd Wednesday
CDR John S. Howkins, Jr.

MISSOURI

St. Louis
NRRC 9-8
Webster Groves Public Library
Webster Groves, Missouri
1900, 2nd and 4th Wednesday
CDR George W. Laidlaw, II

NEBRASKA

Lincoln
NRRC 9-22
Agriculture Engineering Building
University of Nebraska
1930, Tuesdays
LCDR Howard D. Wittmuss

NEW HAMPSHIRE

Hanover
NRRC 1-7
Wentworth Hall, Dartmouth College
2000, 1st and 3rd Tuesday
(No meetings during July and August)
CAPT George Z. Dimitroff

NEW JERSEY

Port Newark
NRRC 3-13
USN&MCRTC, Building 23, Naval Reserve Industrial Shipyard
1930, 1st and 3rd Wednesday
LCDR Harold R. Walker

Princeton
NRRC 4-1
10 Guyot Hall, Princeton University
2000, alternate Wednesdays
CAPT Harold D. Lockhart

NEW MEXICO

Albuquerque
NRRC 8-7
USN&MCRTC, 1805 Yale Avenue, S.E.
1930, 1st and 3rd Wednesday
LTJG Calvin B. Rogers

Los Alamos
NRRC 8-9
Lecture Room, Administration Building
Los Alamos Scientific Laboratory
1700, 1st and 3rd Tuesday
LCDR William J. McCreary

NEW YORK

New York
NRRC 3-1
3rd Floor, 663 Fifth Avenue
1845, 1st and 3rd Thursday
CDR Evans Kahn

Long Island
NRRC 3-2
Engineering Building, USN Training Device Center, Port Washington
1930, 2nd and 4th Monday
LCDR John H. Hickey

Buffalo
NRRC 3-3
Room S-1, Sherman Hall, University of Buffalo
2000, 2nd and 3rd Monday
CDR Rapier H. McMenamy

Rochester
NRRC 3-4
Harkness Hall, University of Rochester
2000, 1st and 3rd Tuesday
LT Robert B. Taylor

Syracuse
NRRC 3-6
General Electric Company, Electronics Park
1945, 1st and 3rd Monday
LCDR Austin J. Rudnicki

Scotia
NRRC 3-7
USNRTC, Scotia
2000, 2nd and 4th Tuesday
CDR Arleigh H. Markham

New York
NRRC 3-8
16th Floor, Young & Rubicam, Inc.
285 Madison Avenue
1900, 2nd and 4th Tuesday
LCDR Russell M. Wickett

Upton
NRRC 3-9
Brookhaven National Laboratory
1930, 1st and 2nd Thursday and 2nd and 3rd Wednesday
CDR Jere C. Austin

Kingston
NRRC 3-14
I.B.M. Conference Room
1800, 1st, 2nd, and 3rd Thursday
CDR James D. Quale

New York
NRRC 3-15
Room 1511, 90 Church Street
1845, 2nd and 4th Tuesday
CDR P. M. Randazzo

NORTH CAROLINA

Chapel Hill
NRRC 6-6
Physics Building, Duke University
1800, 1st, 2nd, and 3rd Monday
2nd, 3rd, and 4th quarters
2nd quarter, Chapel Hill Naval Armory
3rd quarter, Raleigh, NRTC
CDR James E. Wadsworth

OHIO

Columbus
NRRC 4-7
Ohio State University Research Foundation
1314 Kinnear Road
1930, alternate Thursdays
(No meetings during August)
LCDR Robert W. King

Cleveland
NRRC 4-8
USN Finance Center, 1901 E. 13th Street
2000, alternate Mondays
CDR Francis J. Callahan, Jr.

Dayton
NRRC 4-9
US Armed Forces Training Center
410 Gettysburg Avenue
1930, 2nd and 4th Monday
LT Jean C. Cassel

Cincinnati
NRRC 4-11
Room 54, Albers Hall, Xavier University
1900, 2nd and 4th Tuesday
LCDR George W. Pomeroy

OKLAHOMA

Bartlesville
NRRC 8-8
American Legion Building
1930, 1st and 3rd Tuesday
LCDR John A. Favre

Stillwater
NRRC 8-13
Room 2, Union Building, Oklahoma State Univ.
2000, 2nd, 3rd, and 4th Thursday
LCDR Robert C. Fite

OREGON

Portland
NRRC 13-4
USN&MCRTC, Swan Island
2000, 2nd and 4th Tuesday
CDR Francis D. Beers

Corvallis
NRRC 13-5
Room 132, Agriculture Building, Oregon State College
1930, 2nd and 4th Monday
LCDR Russell L. Lincoln

PENNSYLVANIA

Philadelphia
NRRC 4-2
Franklin Institute, 20th St. and Parkway
1930, alternate Thursdays
(No meetings during July and August)
LCDR Peter F. Suffredini

Pittsburgh
NRRC 4-3
Room 1112, Engineering Hall, Carnegie Institute of Technology
2000, alternate Thursdays
CDR John J. Hession

State College
NRRC 4-4
303 Wagner Hall, Military Science Building
Pennsylvania State University
1900, alternate Mondays
LCDR Earl P. Strong

Bethlehem
NRRC 4-6
USNRTC, Rodgers and Lewis Station
1930, 2nd and 4th Tuesday
LT Donald R. Hindmarch

Philadelphia
NRRC 4-13
Naval Science Building, Univ. of Pennsylvania
2000, alternate Mondays
CAPT Robert Mayer

Willow Grove
NRRC 4-12
Technical Training Building, U.S. Naval Air Station
1930, alternate Tuesdays
(No meetings during July and August)
CDR John W. Pobst

RHODE ISLAND

Providence
NRRC 1-2
102nd Air Control and Warning Squadron
1930, 1st and 3rd Wednesday
LCDR Warren M. Hagist

SOUTH CAROLINA

Clemson
NRRC 6-11
103 Physics Building, Clemson College
1930, Wednesdays
CDR Tate J. Lindsey

Aiken
NRRC 6-13
Red Cross Building, Laurens Street
1900, 2nd and 4th Thursday
CAPT Loren T. Palmer

SOUTH DAKOTA

Brookings
NRRC 9-11
Room 330, Agricultural Hall, South Dakota State College
2000, 2nd and 4th Wednesday
(Varied dates during July and August)
LT Ernest J. Hugghins

Rapid City
NRRC 9-11P
Chemistry Building
1930, 1st and 3rd Wednesday
LCDR Clyde L. Harbison

TENNESSEE

Oak Ridge
NRRC 6-3
Room 217, Oak Ridge High School
1930, 2nd and 4th Wednesday
CDR Charles O. Smith

Nashville
NRRC 6-18
Physical Education Department, 21st Avenue South, Peabody College
2000, 1st and 3rd Monday
CDR William D. McClurkin

TEXAS

College Station
NRRC 8-3
Biological Science Building, Texas A & M College
1930, 2nd and 4th Monday
CAPT Richard H. Ballinger

Houston
NRRC 8-4
USNRTC
1930, alternate Wednesdays
LCDR James D. Wyant

Austin
NRRC 8-5
Experimental Science Building 137
University of Texas
1900, Mondays
CDR Jim T. Barton

Dallas
NRRC 8-12
USN&MCRTC, 9638 Bachman Boulevard
2000, 1st and 3rd Tuesday
LT William F. Ekern

UTAH

Logan
NRRC 12-7
Room 212, Union Building, Utah State Univ.
2000, 1st, 2nd, and 4th Thursday
LCDR Lloyd E. Rich

VIRGINIA

Newport News
NRRC 5-1
USN&MCRTC, Warwick Road and 75th
1930, 1st and 3rd Tuesday
LCDR Harold L. Dehoff

Blacksburg
NRRC 5-2
310 Agricultural Building, Hutcheson Hall
VPI Campus
2000, Mondays
(No meetings in July and August)
LCDR David P. Barnett

Richmond
NRRC 5-5
Tumor Clinic-Medical College of Virginia
1700, 2nd and 4th Monday
CDR Charles M. Preston

Dahlgren
NRRC 5-12
Naval Weapons Laboratory
1930, 1st and 3rd Monday
CDR John J. Glancy

WASHINGTON

Seattle
NRRC 13-1
USN&MCRTC
1930, 1st, 2nd, and 3rd Monday
CDR Julius Rockwell, Jr.

Richland
NRRC 13-2
Community House
1900, 2nd and 4th Tuesday
CDR William A. Burns

Pullman
NRRC 13-3
Room 412, Holland Library, Washington State University
1930, 2nd and 4th Monday
CDR Irven O. Buss

WEST VIRGINIA

Charleston
NRRC 5-6
USN Reserve Training Center
1930, 1st and 3rd Thursday
RADM Edwin N. Blackwood

WISCONSIN

Milwaukee
NRRC 9-4
USN&MCRTC
2000, 2nd and 4th Tuesday
LCDR John R. Calkins

Madison
NRRC 9-14
119 Babcock Hall, University of Wisconsin
1930, alternate Mondays
LT Earl A. Edwards, Sr.

If you desire a copy of this article for your own file and reference, or if you desire additional information on the Research Reserve Program, send a government postcard request or letter request to: Chief of Naval Research (Code 120), Navy Department, Washington 25, D.C.

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*Articles are arranged chronologically under the ONR division or laboratory having cognizance of the research described.

†Written by the editorial staff of Naval Research Reviews or adapted from anonymous sources.

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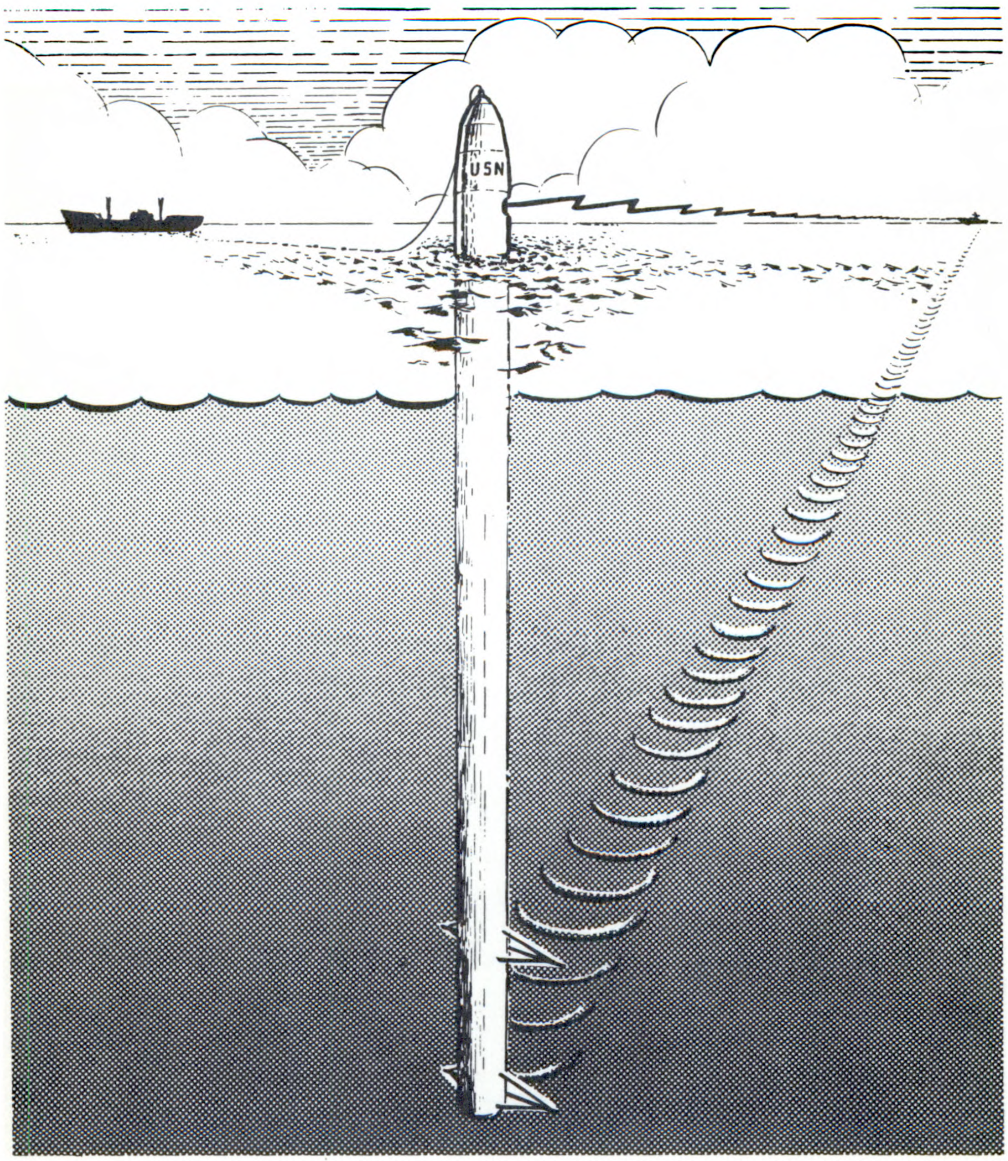
U.S. GOVERNMENT PRINTING OFFICE: 1961 O - 622087



This is the Navy's proposed Seagoing Platform for Acoustics Research (SPAR) in its vertical "listening" position as it receives both underwater SONAR signals and above-water radio signals from the transmitter pictured on the horizon at the right. On the left is SPAR's tending towship linked to the research vessel by a half-mile of power supply and tow cables (see p. 22).

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. The issuance of this publication approved by the Secretary of the Navy on 1 March 1961.

Not the warp and woof for a Scottish plaid, but a portion of the memory unit of the FX-1 computer (see page 20).