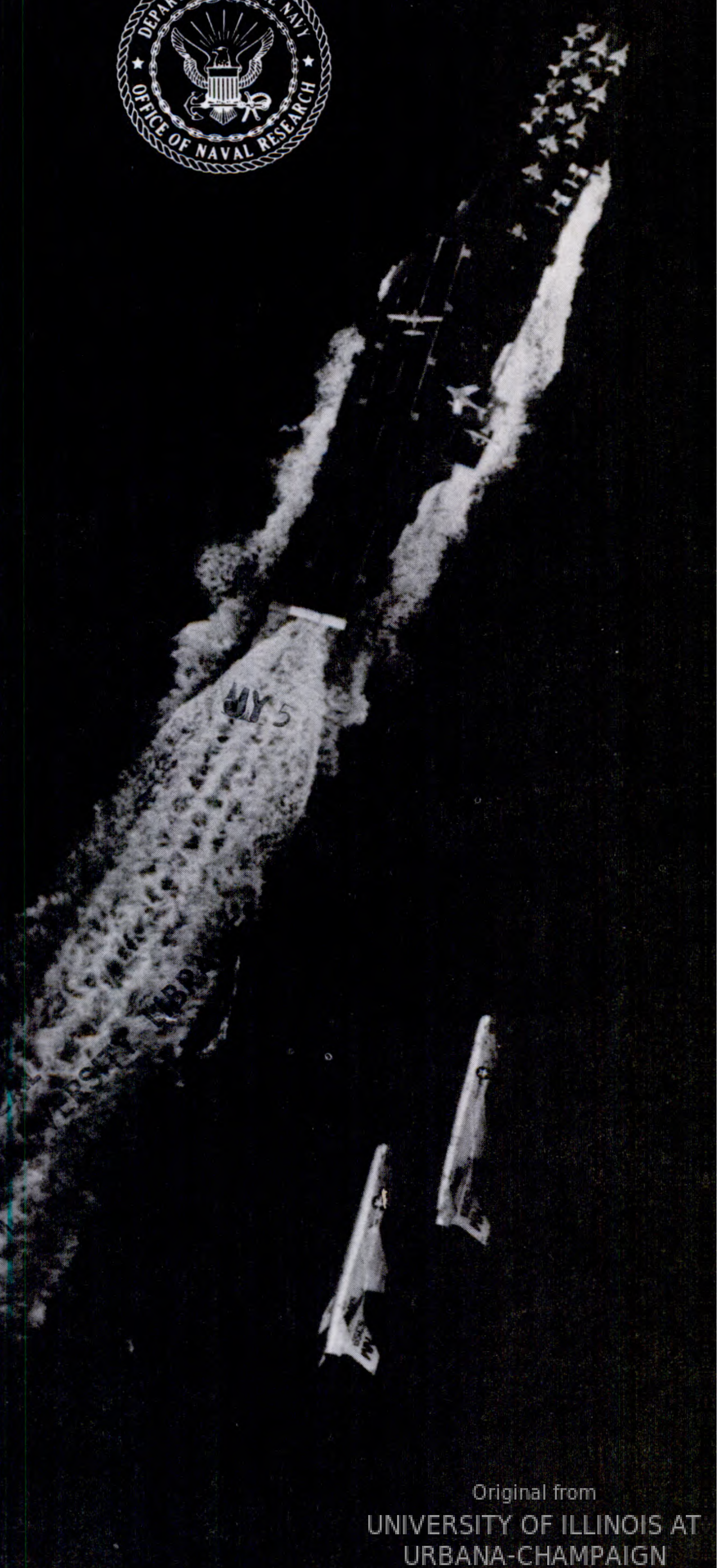
NAVAL RESEARCH

REVIEWS

JUNE 1962

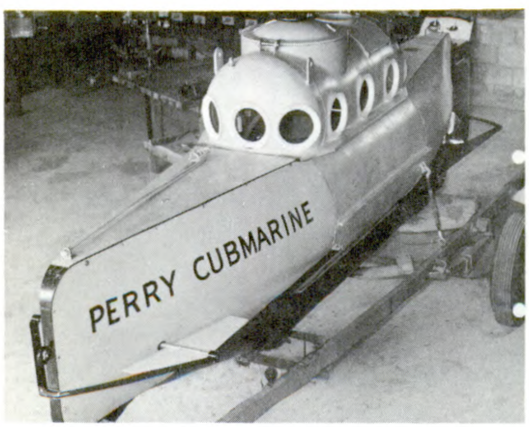


Little Sub to be Evaluated as Hydrobiological Vehicle

For certain studies of marine life, the Office of Naval Research is considering the feasibility of a tiny "dry" two-place submarine appropriately called the "Cubmarine." The boat, which is 18 feet long and only 5 feet 7-1/2 inches high, hatch to keel, might be useful for a wide range of hydrobiological investigations.

Through use of such a vehicle, bottom communities at medium depth might be examined in the undisturbed state to obtain a true picture of the distribution of the various biological populations and their behavioral interactions. Sharks rank high among the fishes which could be studied by means of a small submarine, particularly to ascertain how they are affected by various repellents and to observe at close range their reactions to various stimuli. The effects of seasonal changes and of storms on bottom sediments and on the biota might also be investigated.

The Cubmarine appears to be particularly well suited for these tasks because of its small size, maneuverability, hovering capacity, relatively long range (20 miles), and its depth submergence capability (230 feet maximum). Also, being a two-seater, a trained operator can occupy one of the seats, thus leaving the scientist-passenger entirely free to make observations. Another important feature, from the hydrobiologist's point of view, is the good visibility afforded by the boat's 12 portholes,

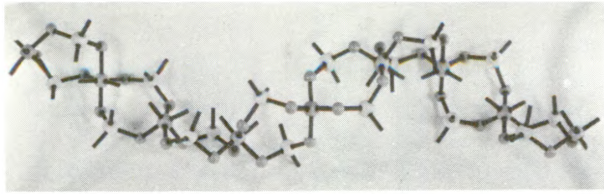


Cubmarine No. 3 in "drydock." Photo by Bill Allison.

all but one of which is 7 inches in diameter. The sub is also potentially useful in many ways because of its 8-hour staying power, which permits continuous scientific observations to be made for long periods. Furthermore, lights and cameras can be attached to the sub, and other adaptations made which will allow installation of various collecting devices. Other features of the little boat are its strength, capable of withstanding 100 pounds per square inch of pressure, and its speed, which is 5 knots submerged and 6 knots on the surface.

The Cubmarine was designed and built by the Perry Submarine Builders, Inc., of West Palm Beach, Florida, and has been leased for operation to the Geraldines, Ltd., Annapolis, Maryland.

Basic Research in Inorganic Polymers



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A large segment of engineering science today is faced with the perplexing problem of obtaining materials capable of withstanding service conditions involving extreme heat. To find the solution to these problems, an accelerated search is being made by both military and industrial research activities for materials capable of performing special functions at ultra-high temperatures.

The Chemistry Branch of the Office of Naval Research is sponsoring a basic research program in inorganic polymers from which it is hoped there will ultimately be developed some new principles and systems for the preparation of useful plastics, elastomers, and rigid compositions suitable for high temperature applications. This paper is intended primarily to describe the early results of the program and to provide a general review of the subject.

THE THERMAL BARRIER

The tremendous impact which the development of advanced supersonic-speed weapons systems has exerted on present-day materials technology is evident in the surge of requirements for materials capable of withstanding service conditions of unprecedented severity. Until a few years ago, conventional materials were adequate to meet the demands of the military. In order to accommodate the requirements of a moderate service temperature increase (to about 500° F.), modification of materials or improvements in fabrication techniques were the principal objectives of materials research then underway. Typical of such work was the impregnation of organic plastics with inorganic (glass) fibers.

Critically needed for current military applications are high-temperature plastics, elastomers, and semi-rigid materials exhibiting performance characteristics far beyond those of materials known today. In the immediate future, the requirements for high temperature materials will be based on performance at temperatures in the vicinity of 1000° F. for extended periods. It is anticipated that this temperature will be increased to 2000° F. and even higher in the near future. In order to meet this problem with full force, dynamically bold and imaginative research must be undertaken to assure that the desired materials will be available at the moment new requirements are established.

Traditionally, the design engineer of the last decade could fit his blueprints to the properties inherent in the materials available to him. Today, the situation has changed—the engineer finds he must adjust his design to accommodate materials with properties which fall short of his needs. He is forced to introduce modifications in design in order to insulate or protect the very materials he must use. Serious limitations are thus imposed on the performance of the system because of added bulk and weight. More significant, costly complications are introduced into systems which would otherwise be simple in construction.

LIMITATIONS OF TODAY'S MATERIALS

In the vast storehouse of today's commercial materials, there are a large number of products which, under certain use conditions, could survive temperatures in excess of the ranges presently under study. Titanium alloys melt above 3000° F. A new ceramic product will remain intact at 5000° F. Tungsten metal melts at about 6000° F. However, for operating temperatures above 1000° F., none of these materials will have high strength and ductility, and they will not have corrosion resistance. One metal whose strength meets almost all requirements in the 1500° F. range is columbium (niobium). Unfortunately, at high temperature, columbium oxidizes very rapidly.

There is no known organic plastic today that will resist deformation at 572° F. Even at 212° F., the temperature of boiling water, many of these plastics begin to soften or lose their shape. Only the glass-fiber-filled phenolics are capable of withstanding 450° F. for extended periods of service. Cellulosic plastics decompose at temperatures lower than the boiling point of water. A maximum service temperature of 140° F. is prescribed for the polyvinyl plastics where the material is under continuous stress. The polyacrylics, polystyrene, polyethylene, polycarbonates and polyamides are better for higher temperature use (in increasing order), but none will survive 500° F. service. The best synthetic lubricant known today will carbonize very rapidly at 300° F. with the resulting loss of its lubricating properties. Rubber compositions are very sensitive to temperature changes. The best high-temperature rubber today fails at 350-400° F. Neoprene rubber drops from a tensile strength of 3000 psi at 75° F. to only 400 psi at 200° F.

In some isolated applications, these thermal instabilities can prove useful. Plastics are used as ablating materials in missile nose-cones. They are intentionally destroyed at the expected white heat to serve primarily as a heat-dissipating medium for the missile.

MATERIAL REQUIREMENTS

Materials needed for high temperature applications encompass a broad variety of material states. Exclusive of metals, alloys, and ceramics, the materials being sought include hydraulic fluids, high and low viscosity lubricants, adhesives, elastomers, sealants, structural plastics and transparent plastics. Some specific examples are:

- Elastomers operable without failure at 500° to 600° F., and at a projected future level of 1000° F. and beyond.

- Insulating sheathing for high-temperature electrical wiring.

- Transparent plastics for canopies for supersonic aircraft.

- High temperature component wafers for micro-modularized electronic systems.

- Rigid adhesives for bonded structures of aircraft frames.

- Re-entry bodies and nose-cones using rigid plastics containing refractory fillers.

- Rigid plastic compositions transparent to radar and infrared radiation.

Materials are being sought which, in addition to stability to high-temperature oxidation and corrosion, will have optimum mechanical properties (strength, ductility, toughness), desirable physical properties (density, electrical conductivity or resistivity, expandibility, contractibility), and good fabrication properties, the last property to assure ease of workability and assembly at normal temperatures. Radiation resistance can be important, but present emphasis in the Chemistry Branch research program is on thermal stability.

SCIENTIFIC EFFORT OF ONR CHEMISTRY BRANCH

The research program of the Chemistry Branch of ONR is geared to provide a sound theoretical basis for the guidance of the Navy's high-temperature materials development effort. Improved theory is important because it provides the means whereby time-consuming, empirical formulation along "trial-and-error" synthetic routes can be avoided. New concepts may also serve to point the way to "tailor-made" materials. Among the goals of this program are these capabilities: to predict the products of untried chemical reactions, to direct the course of chemical reactions, to utilize to greatest advantage certain external effects on chemical reactions and, most important, to readily synthesize compounds (and, later, polymers) containing heretofore unknown bond types and arrangements. The program includes studies which will provide a better understanding of the balance of properties of specific elemental bonds and the exploitation of these principles in selecting components needed to impart specific properties to a material composition. Also under study is the correlation of many variables, such as coordination number, oxidation state, electronegativity, and steric hindrance with thermal stability.

Polymer Physics—The limits set by forces operating in polymers at the atomic and molecular levels are still not fully understood. It was only recently that polymer chemists were able to learn about these forces as they occur in naturally occurring high polymers (wood, leather, rubber), and they are just beginning to gain insight into how the chemist can improve on nature. By varying chain-length, or modifying degree of branching or extent of cross-linking, new materials can be produced with combinations of properties different from, and occasionally superior to, those of the natural products. Inherent in this research is the search for new knowledge concerning intermolecular attractions, properties of crystallites, and the thermodynamics of large molecules. This theoretical approach should furnish new information on bond strength and stability and perhaps direct clues to specific molecular structures which will resist the rigors of high temperature. Learning why materials behave as they do under extreme environments is one possible result. To gain such knowledge, the Chemistry Branch is sponsoring a program involving the physics of polymers, including investigations in polymer characterization, and physical properties of macromolecules.

Quantum Chemistry and Bonding Theory—This part of the Chemistry Branch program represents the most theoretical approach in the research effort toward high-temperature materials. Through the application of quantum and statistical mechanics to atomic and molecular structures, it is anticipated that new basic theories of chemical binding, chemical interactions, and chemical kinetics will be advanced, pointing the way to potentially fruitful areas for more applied research.

Spectroscopy—Research in spectrographic methods, especially nuclear magnetic resonance and electron paramagnetic resonance, is an important part of the ONR Chemistry Branch research program. By means of physical analytical techniques, it is possible to identify structural features of molecules incapable of detection by usual chemical analysis. The course of chemical reactions can be closely followed, and unstable or short-lived intermediates can be seen and identified.

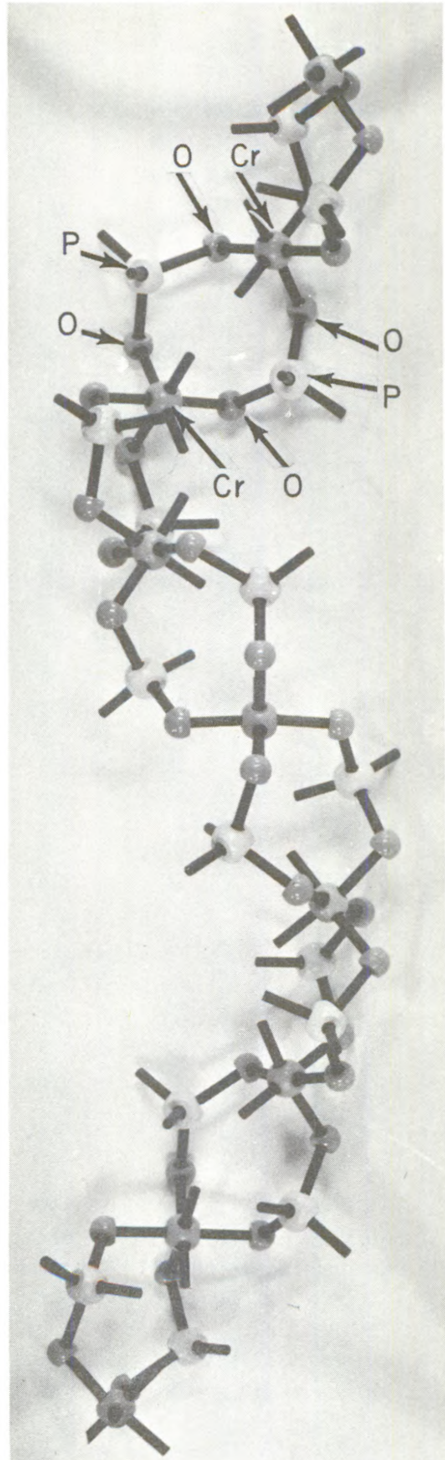
INORGANIC POLYMERS

Inorganic polymers, like organic polymers, are aggregates of giant, chain-like molecules which contain atoms of inorganic elements, rather than carbon, in the principal chain or backbone.

Although a number of so-called inorganic polymers have been known for a number of years, notably the silicones and the ferrocenes, these are in the true sense semi-inorganic since they contain a large proportion of organic moieties.

ONR Research—As part of the inorganic polymer research program, the synthesis of compounds containing novel types of inorganic bonds is being vigorously investigated. Considerable emphasis is placed on certain areas which show promise from fundamental considerations. This effort is a coordinated study of the synthetic chemistry of candidate high-temperature compounds. Theoretical and real inorganic polymer chains are being studied which, in addition to high temperature stability, might exhibit some degree of flexibility, contain side groups of size and number to impart elasticity, contain active sites on the principal chain or on side groups to permit cross-linking or further polymerization, contain acid or base sites for curing by means of ionic linkages.

Of all the chemical compounds now known to science, none exceeds the thermal integrity of the transition metal borides, carbides, nitrides, phosphides, and oxides. Silicon tetraboride and titanium diboride are refractory products of fusion synthesis and exhibit a marked degree of thermal stability. Using such structures as models, it might be possible to modify the inorganic molecule to achieve flexibility, ductility, and other properties which contribute to workability, at the sacrifice of some thermal stability. This approach seems to hold promise greater than that of working up from the less stable familiar polymers to the desired thermal stability.



Whereas there are only about 80 metals, there are tens of thousands of compounds containing metallic elements possessing mechanical and dielectric properties quite unlike those of the metals. These compounds have the potential for development into materials having useful combinations of characteristics for high-temperature utilization. Particularly interesting is the element boron because of its light weight and unusual thermal stability. However, since boron lacks sufficient toughness and hydrolytic stability, ONR is sponsoring research aimed toward modifying its properties by chemical bonding to other elements.

PROGRESS

One result of three years of synthesis exploration at Pennsalt Chemicals Corporation is a new family of polymers* which contain only chromium, oxygen, and phosphorus in the main double chain. A model of this chain is shown in the photograph.

Each eight-member ring is linked together at four transpositional points on the chromium atom to form a double-chain polymer. Preliminary studies show that the compound itself resists degradation at 600° F. So far, research

*For a complete chemical description see Journal of American Chemical Society, v. 84, p.1749 (1962).

has yielded polymers containing 18 ring-units. It is expected that further polymerizations will yield polymers containing 100 or more ring-units. Three important points characterize this polymer:

- The backbone is entirely inorganic

- Chromium atoms are held together by double oxygen-phosphorus-oxygen bridges

- The backbone tends to form a spiral

The first two points are expected to contribute thermal stability, whereas the third imparts some degree of elasticity. Systematic variation of the side groups on chromium and phosphorus (presently organic) are under investigation to determine their effect on stability, molecular weight, and mechanical properties. The ultimate goal is a completely inorganic composition.

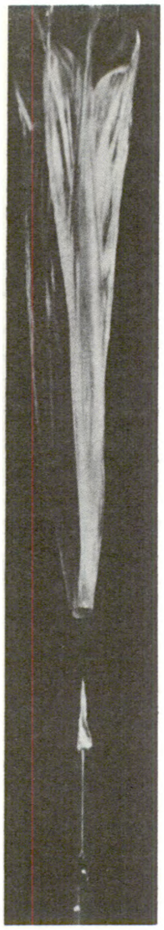
Another result of the research at Pennsalt is the production of layer fluoaluminates consisting of the negatively charged AlF_4 tetrahedra interleaved in infinite sheets by positively charged rubidium or potassium metal to maintain electrical neutrality of the compound. The system KF/AlF_3 contains the interesting compound $KAlF_4$, which melts without decomposition and has other properties suitable for the growth of large single crystals. Electrical measurements on $KAlF_4$ show that dielectrics exhibiting low loss in the frequency range 10 kilocycles to 40 megacycles can be prepared. Dielectric strength is at least equal to naturally occuring mica.

OUTLOOK

It is too early to evaluate the accomplishments achieved under the ONR program in inorganic polymers. The chemistry of inorganic polymers is in its infancy, as evidenced by the fact that heretofore no single volume or text book has appeared in which this subject is treated with sophistication. Just this year, a book setting forth the state of the art of inorganic polymers will be published as the initial offering in this field.

By and large, we believe that, notwithstanding the experimental difficulties experienced in the initial phases, we are on a sound approach. Much has been accomplished and much is to follow. Success will be realized when newly developed concepts and exciting new chemistry prove useful in the later production of high temperature materials capable of satisfying every requirement prescribed for them by the designers of future weapons systems.

DR. H. D. CRANE of the Stanford Research Institute received the "Outstanding Paper Award" at the International Solid State Circuits Conference held at the University of Pennsylvania in February. Dr. Crane's paper, entitled "The Neuristor," was based on research sponsored in part by the Office of Naval Research. It was presented at the 1961 Conference.



Skyhook's Fort Churchill Launchings—1962

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Nuclear Physics Branch
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Office of Naval Research

The Navy and the National Aeronautics and Space Administration will launch about 22 large Skyhook balloons from Fort Churchill, Manitoba, on Hudson Bay, this summer to obtain information on the composition, energy spectra, and other characteristics of cosmic rays and to test experiments to be conducted in a satellite at a later date. The first flight was scheduled to take place about June 15.

The balloon operations will be carried out as part of Project Skyhook, a continuing Office of Naval Research program of cosmic-ray research using high-altitude balloons (Naval Research Reviews, October 1961). ONR is providing logistic and administrative support for the current series of balloon-borne experiments, 19 of which will be financed by NASA, and three by ONR. The flights will be made to conduct investigations for NASA's Goddard Space Flight Center, Greenbelt, Maryland; the Enrico Fermi Institute of the University of Chicago; and the Universities of Rochester, Minnesota, and California.

Data will be collected at altitudes ranging from 125,000 to 150,000 feet. Five of the NASA launchings will be made to enable scintillation counters to measure the energy spectrum and composition of low-energy primary galactic cosmic rays, and two others will be made to dispatch emulsions to about 150,000 feet to observe heavy nuclei in primary cosmic rays. To attain the high altitude, polyethylene balloons having a capacity of six-million cubic feet will be used. Three additional NASA flights will serve to test a low-energy positron detector to be flown later on a satellite called EOGO (Eccentric Orbiting Geophysical Observatory).

The Enrico Fermi Institute, for which five instrument payloads will be lifted by balloon to an altitute of 125,000 feet, is interested in measuring the energy spectrum of incident protons and electrons. Again, scintillation counters will be used. The information obtained will supplement—and enable correlations to be made with—information recorded by Project Skyhook during the last two summers.

The relative percentages of helium 3 and helium 4 in primary cosmic rays will be the subject of experiments conducted for the University of Rochester. To make this determination, two balloons will be sent aloft. They will carry special emulsions upon which the primary cosmic rays are expected to leave revealing traces.

Dr. Kinsey Anderson of the University of California has prepared experiments which will contribute to the study of solar cosmic rays and galactic protons and alpha particles of low energy. Dr. Anderson hopes to include in his payloads a new large-area solid-state detector. Two balloons will lift instruments for the University of California experiments.

Three cloud chambers will be carried to high altitudes as part of experiments prepared by Dr. James Earl of the University of Minnesota. The objective will be to collect data on cosmic-ray electrons and other particles. Dr. Earl will utilize two types of cloud chambers--multiplate and magnetic.

Logistic support provided by ONR for the 22 Skyhook flights will be extended to include a series of high altitude balloon journeys to be made for the University of Minnesota and sponsored by the National Science Foundation. The Minnesota group plans to launch about 30 balloons, all smaller than the "Skyhooks." Most of them will be sent aloft during periods of increased solar activity. Information obtained by the payloads will be telemetered to Fort Churchill. The payloads will then be considered expendable, no attempt being made to recover them. Of primary interest to the Minnesota scientists are the solar components of primary cosmic rays which increase significantly during periods of solar flares. This increased flux could present a radiation hazard for future astronauts.

The launching operations for the 22 Skyhook flights will be performed by Raven Industries, Sioux Falls, South Dakota, under contract to ONR. Canadian and American personnel stationed at Fort Churchill will assist. The joint Canada-U.S.A. research facility on Hudson Bay was chosen as the launch site because the cosmic flux at that latitude is much greater than in the United States owing to the effect of the earth's magnetic field. It is also just about as far north as balloons can be launched with prospects for recovering their payloads remaining good.

The Project Skyhook series of flights and other balloon launchings made under the auspices of ONR at Fort Churchill this summer will total about 50.

Test Mines Recovered by Acoustic Method

An acoustical method of recovering test mines as long as two years after they are planted on the ocean floor a mile under the surface has been successfully tested by the Naval Ordnance Laboratory, White Oak, Maryland. By means of three small explosive charges, fired in a preselected time sequence from a plane or a ship, any one of 15 moored mines and its mooring cable can be raised without affecting the other 14. The method was developed to facilitate recovery of the mines for the evaluation of new components tested in them.

The key to the new method is a unit called an Underwater Coded Command Release System (UCCRS) which is composed of a receiving hydrophone, several batteries with an expected life of two years, a time coder ~~and~~ an explosive driver. These units are fitted into the anchor of each of 15 test mine assemblies which are planted as a group in deep water. Each mine assembly has an inert mine case, a mile-long mooring cable rolled on a drum and an anchor.

When it is desired to raise a specific mine in the group, explosive charges are detonated on the surface in the proper time sequence as far away as a mile from the dummy mine field. The resulting acoustical signal, received by the hydrophone in the UCCRS unit of the designated mine assembly, causes the corresponding time coder to generate an output pulse which fires the explosive driver. This unlocks a pawling device on the mine mooring cable drum and permits the mooring cable to pay out and the buoyant mine case to rise to the surface for recovery.

Video-Acoustic Study of Marine Animal Sounds

The behavior and sounds of deep sea creatures which hamper sonar and other acoustic operations are now being monitored and recorded by scientific personnel at the world's first permanent deep water biological acoustic-video research station. Operated under a Navy contract by scientists from the Institute of Marine Science, University of Miami, this station consists of hydrophones installed on the ocean floor in the Florida Straits. It is cable-connected to the Lerner Marine Laboratory, an affiliate of the American Museum of Natural History, on the island of Bimini in the Bahamas. Investigators also hope to obtain visual data by adding an underwater television camera to the system.

The study, a part of ONR's hydrobiology program, is intended to acquire data on marine animals which interfere with the operation of sonar equipment by creating "false target" problems. The marine animals under study are those which either live in the Florida Straits or migrate along the Gulf Stream. Part of the project concerns the sound producing or sound scattering and absorbing properties of these creatures.

Initially, studies will be made of the general background noise as picked up on the recording tapes. Installation of the TV camera is expected to permit observation of those animals which come within the range of the camera. Many animals, such as snapping shrimp and barnacles, emit sounds which greatly increase the total sound level. Others make sounds which may be confused with sounds produced by surface or underwater vehicles.

Later studies will attempt to identify and analyze individual sounds emitted by particular animals under natural conditions and to lure them into areas being photographed. Sound samples will be taken at various depths and comparisons made with tapes obtained from test animals. Both the hydrophone-cable assembly and the camera would be operating continuously.

Direct observations will also be made by scientists in glass bottomed boats and by SCUBA divers. Another means of checking findings will involve catching the animals on lines or in nets. In addition, chemical and biological stimuli will be tested for their effectiveness in eliciting sound or other behavioral responses.

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"Pilot Error"

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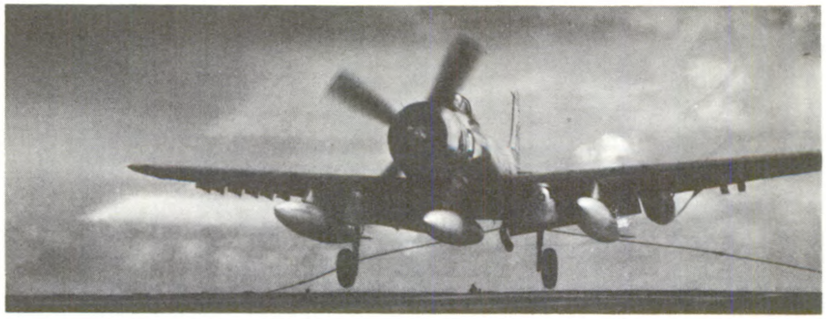
In spite of the remarkable advances made in the fields of aircraft design and human engineering, aircraft accidents continue to occur, in some respects at a surprisingly high rate. The earliest solution to the accident problem was to ground flying machines during periods of severe weather because of their fragile structure. But as passenger, freight, and mail schedules, as well as military activities, became more demanding, the airplane had to fly in all kinds of weather. So a new approach was taken—to insist that supports be strengthened, fabrics improved, the power plants made more reliable, and that further research and testing be done on wing configurations and load factors. In other words, the emphasis now was placed on making the aircraft safe.

Then we began to hear the words "pilot error." Engineers had become convinced that their contribution had been adequate, so they credited many of the accidents that continued to occur to mistakes made by pilots. Unfortunately, "pilot error" was accepted as a "cause" for accidents, and for a while little was done to search beyond it. When this search was made, the internal environment of the airplane, particularly the cockpit, came under study. Now consideration was given to display-control relationships and to such factors as the eye movements required by particular instrument locations. Some major questions that were asked at this point were what instruments were watched and for how long, and where should they be placed for ready reference.

The location of controls and the shapes of handles concerned the investigators next, as they discovered through analyses of accidents that man did not learn new tasks as rapidly as new types of aircraft required him to learn them for safe operation. Simulators and procedural trainers became a dominant part of training in this period, and new meanings were given to such words as "learning," "set," and "transfer of training." Now for the first time we were dealing with psychological needs independent of the instruments which were posing problems.

As our technology advanced and both the ceiling and the speed of aircraft were increased, man's physiological needs were carefully scrutinized to avoid accidents from such causes as excess "g" forces and oxygen deficiencies. The flight surgeon now came into his own, finding a new world to explore in low-pressure chambers, centrifuges, and pressure suits. As the pace accelerated, the job of keeping man in the picture, as error-free as possible, became a real challenge.



Exoskeletons and various other support systems were designed for him, which, although advantageous in many ways, introduced new problems. They caused delays in the pilot's response time, they obligated him to spend too much time with controls, they caused glare, they limited his mobility, and in other ways they became a potential source of accidents in themselves.

The pattern of accidents which continued to occur was such that we were soon led back to problems arising from information displays. Only now, instead of concerning ourselves with the questions "where" and "how" information should be fed to the pilot, we gave more thought to "what" and "why." Displays that might have been misread were revised, and more information was integrated before being displayed.

Today our pilots enjoy what appears to be the ultimate in working conditions. They have excellent command of information about their aircraft and its situation, they perform many of their tasks easily because they are equipped with power-boosted systems, they have an almost unobstructed view of the aircraft's surroundings, they are well protected physically by automatic pressure suits, and when conditions warrant they can escape their ship instantly by means of built-in ejection equipment.

In view of these remarkable advances, it may seem paradoxical that accidents continue to occur because of "pilot error," even in "perfect flying weather." One is tempted to ask if the pilot is too well protected, too comfortable, and if the weather can sometimes be too good. If true, it certainly is a new "twist" in the accident story—one we would not even have dreamed of 10 years ago.

If the pilot's present conditions are not the best, then what conditions are? It is impossible here to give even a rough estimate; we can say only that a pilot's performance falls off as the demands upon him become more extreme, but that he senses changing situations relating to most of his tasks and automatically compensates for them. Important in this connection is the fact that he will not compensate for a change if he does not sense it. In other words, full attention to the job is essential. As obvious as this fact is, we are still a long way from achieving full attention.

For the pilot to remain alert, he must be subjected to changing stimuli. This need has been demonstrated time and again—by psychologists through the monitoring of tasks performed by human subjects and through experiments in which subjects are deprived of certain sensations (Research Reviews, April 1958); and by physiologists through neurological studies, particularly by the association of electroencephalograms and stimulation.

Another facet to this problem is that a man may become oblivious to stimuli which he actually receives if he anticipates a certain outcome of events to which the stimuli apply. In this case, he behaves according to a preconceived notion of what will happen rather than according to the facts of the situation. Many studies have been made of this so-called anticipatory behavior, particularly by the British. These investigations have shown, for example, that an individual viewing a radar scope may anticipate when a pip on the scope will intersect a certain track or the perimeter of the scope, and he will base his action—which may be the firing of a weapon—on his anticipation rather than on what he continues to perceive. Obviously, condiserable inaccurate combat tactical control can result from such action.

To illustrate this behavior in terms with which most of us are familiar, consider a situation involving two automobile drivers who are approaching each other on intersecting roads. During the few seconds that elapse before the cars pass, each driver will perform an amazing number of calculations based on what he perceives, such as the following:

- Relative speeds of the two cars
- His speed relative to the speed limit
- Road conditions
- Other traffic in the vicinity
- Conversation or activity in the car
- His acceleration and deceleration capabilities

"A pilot on the 'almost home' leg of a flight may set himself up for an accident by relaxing prematurely, assuming that he 'has it made.'"

At some point, each driver will decide either that he can or cannot beat the other car across the intersection. He will then have made an anticipatory judgment. If he has decided to go ahead, he will probably cease perceiving and cease checking on whether his original estimate or anticipation was accurate. If he is tired, or talking to friends in the car, he is even more likely to cease these activities. He will continue to cross the intersection on the basis of the information available at that last point of reference—and he just might make it.

Let us change the scene now. Two cars are again approaching the intersection, but this time the drivers do not make anticipatory judgments. What conditions would have to exist to cause a driver to be so cautious? Here are a few:

- He is a new driver
- He is driving a new car
- He is in a strange territory
- Something is wrong with his car
- The road is wet or icy
- Visibility is poor
- The other car is a fire engine, ambulance, or police car

The difference in accident potential between the two situations is obvious. The chance that a driver will use poorer judgment in the first example exists because conditions allow him to be less attentive. He is driving the same old car and expects it to respond in the usual way. He is driving over what he believes to be the same old route, and he expects that it has not changed in any way. "Ideal weather conditions"

The flight surgeon found "a new world to explore in low-pressure chambers, centrifuges, and pressure suits."

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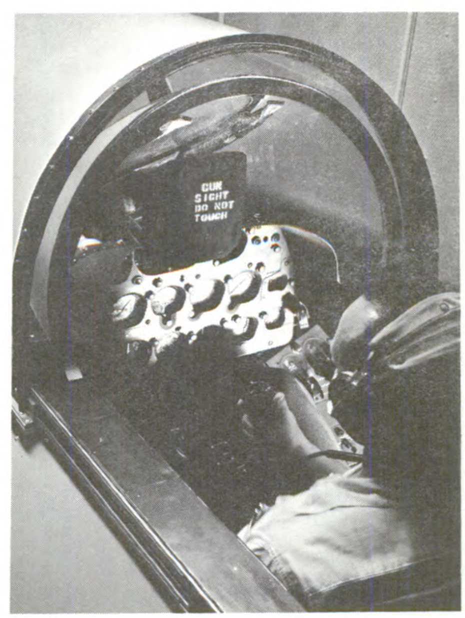


prevail, so he expects nothing unusual to happen. Therefore, if some of his estimates or anticipations are faulty, if some of the things he thinks will hold constant vary, or if he fails to take some variable into consideration, he is in trouble.

The extrapolation to aviation is obvious. A well known example is the landing of propeller aircraft aboard carriers. To land safely a pilot must "cut" his motors at a precise moment. If he bases this action on anticipation rather than perception, an accident is more likely to happen. Similarly, a pilot on the "almost home" leg of a flight may set himself up for an accident by relaxing prematurely, assuming that he "has it made." He will anticipate conditions that will exist the rest of the way instead of taking account of them moment by moment.

An accident stemming from such behavior always gives rise to the comment, "I don't see how it could have happened." There will be the sudden appearance of an aircraft on the flight path or some other variable which the pilot probably could have known about had he been attentive. But he had set his course, anticipated his procedure, and "tuned out" his personal input channels. One would not expect a pilot to turn off his radio after receiving his landing instructions, because he would know he might be given new instructions. Nevertheless, accident records prove that pilots have done so. More commonly, however, they turn off their personal psychological channels involved in flying.

Over-reliance upon instruments also contributes to the premature closing of psychological channels. This is so true in shipping today that the term "radar-aided collision" has appeared. A critical analysis of aircraft accidents—particularly involving aircraft having highly sophisticated control systems—would surely reveal a counterpart in flying.

There will be times, strange as it may seem, when pilots involved in accidents could have avoided them if their working conditions had not been so good—for example, when the weather is marginal rather than "perfect," forcing them to give more attention to their tasks. These will be literally senseless accidents because they will be caused by sensory systems that have been prematurely closed. Only by becoming more conscious of the need for the pilot to verify his situation continually will we begin to find the specific causes of such accidents. Our next goal will be to find ways of improving the pilot's situation by making it less "perfect." In other words, we will seek ways of keeping man alive by keeping him alert. This will be aviation's counterpart to the "right turns only" design of modern superhighways.

Among the Honored

MR. WILLIAM S. PELLINI, Superintendent of the Metallurgy Division of the Naval Research Laboratory was presented the American Society of Naval Engineers' Gold Medal Award for 1961 at the Society's annual banquet held last month in Washington, D. C. Mr. Pellini was cited for his exceptional contributions to naval engineering in the field of metals. These have resulted in the establishment of classic guide lines for the choice of the best metals for engineering structures and machinery components.

Brain-Wave Modification by Flicker

Willard D. Dahl
Applications Research Division
Naval Research Laboratory

For many years physiologists have been aware of the electrical activity of the nervous system and brain. By attaching a pair of electrodes to the surface of the head and amplifying the potential difference between the electrodes, a recording known as an electroencephalogram (EEG) may be made of the electrical "brain waves." The EEG waves have been classified as alpha, beta, etc., rhythms, according to certain characteristics of the waveforms, mainly frequency. The rhythm dominant in most normal human subjects, which has a frequency between 7 and 13 cycles per second, and a magnitude on the order of 25 to 50 microvolts peak to peak, is called the alpha rhythm.

The nature and origin of the alpha rhythm are not completely understood, and much experimental work is being performed to explain them. One of the approaches to the problem has been an attempt to correlate the EEG response with various kinds of stimuli, and with overt behavior, with and without stimulation.

Particularly interesting results are often observed when the stimulus is a flickering light. For example, persons afflicted with epilepsy frequently experience seizures when exposed to such a light. The flicker causing a seizure may be produced either experimentally in the laboratory or it may occur under natural conditions, as when sunlight shining through a row of trees falls intermittently on a person driving along a highway. As a result of this effect, the use of the EEG in conjunction with intermittent photic stimulation has become an important clinical procedure in the diagnosis of epilepsy, brain lesions, and other pathological conditions.

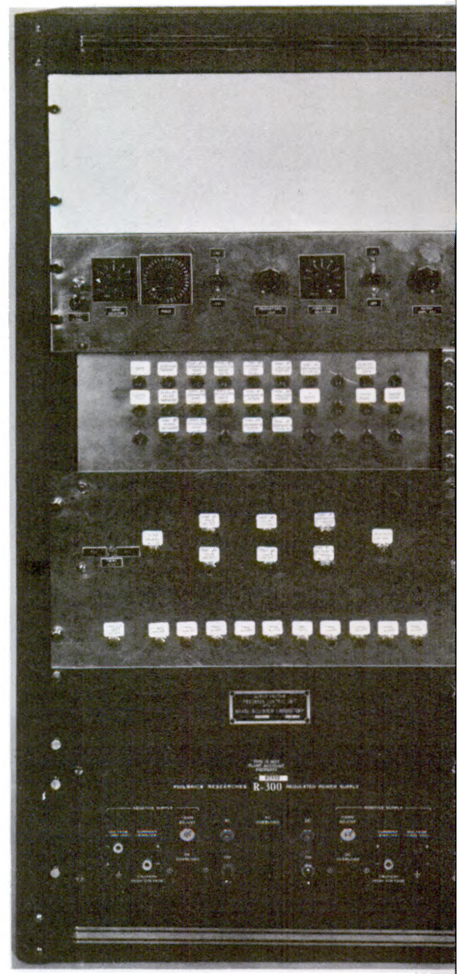
When a normal human subject is exposed to flicker at a frequency that is about the same as his natural alpha rhythm, it is often possible to cause the alpha rhythm to synchronize with the flicker. If the flicker frequency is then increased or decreased, the alpha rhythm follows, maintaining synchronism. When this procedure is successful, the

subject's alpha rhythm is said to be "driven" by the stimulation.

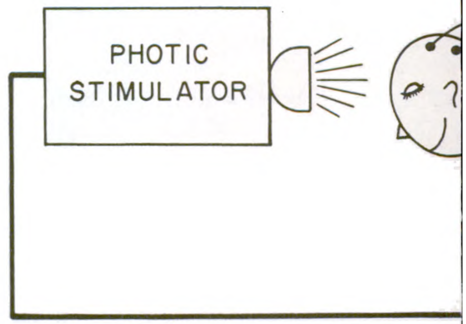
As one might expect, the relationship between behavior and the alpha rhythm, in the presence of flicker, has military implications. For example, under certain conditions, sunlight shining through the rotating blades of a helicopter produces a flicker in the alpha frequency range (or some multiple thereof). Similarly, bursts of gunfire can occur in the alpha frequency range, providing a repetitive auditory stimulation and possibly some photic stimulation. In both situations, rhythmic low-frequency tactile stimulation is produced by means of vibration. Thus from the military viewpoint—as well as the clinical viewpoint—further study of the relationship of alpha rhythm and behavior is desirable.

Experimentation to obtain alpha-rhythm driving by means of photic stimulation has been performed in many laboratories. However, successful driving has been reported to occur in only about 30 percent of subjects on whom the procedure is attempted. Part of the difficulty may have to do with the phase during the alpha wave at which the stimulus occurs. In other words, even though the two frequencies may be matched, the phase of the stimulus may not be conducive to driving. This suggests the following hypothesis: "If a photic stimulation is applied at the proper time during each cycle of the alpha rhythm, the alpha rhythm will be reinforced."

Equipment known as an Alpha Rhythm Feedback Control Unit has been designed and constructed by the Naval Research Laboratory to aid in determining the validity of the hypothesis. The input signal to this equipment is obtained from an EEG amplifier—the same signal that is recorded as the electroencephalogram. The output is a pulse which triggers a 10-microsecond flash of blue-white light, one flash occurring during each cycle



Alpha Rhythm Feedback Control



Closed feedback loop for pres

of the input signal. The flashes can be set by the operator to occur at any desired phase of the input cycles, even though the alpha-rhythm frequency may vary.

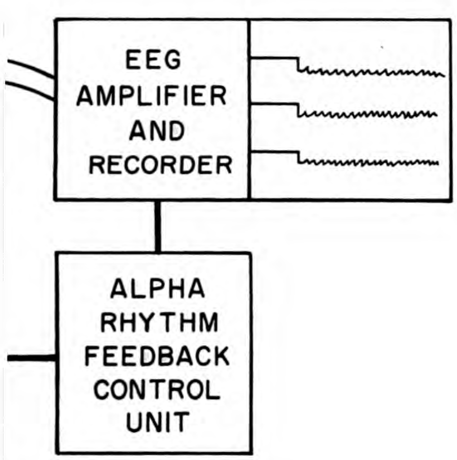
Since the effect of the photic stimulation is to modify the alpha rhythm, and the stimuli are derived from the alpha rhythm itself, a closed feedback loop is formed (shown pictorially below). This closed loop, combined with the capability of presenting the stimuli to the subject at any predetermined time during each alpha cycle, is expected to provide the means to test the validity of the hypothesis.

The equipment has undergone testing at NRL using simulated brainwaves, and has been delivered to Baltimore City Hospital, where experiments with human subjects will be performed. Installation of the equipment has been completed and a preliminary operational test has been performed, using a volunteer hospital patient. The results of this run are considered to be inconclusive, especially since the subject had exhibited no apparent alpha rhythm during many EEG experiments conducted previously. Experiments involving subjects with more typical alpha rhythms are scheduled to begin in the near future.

Determining the Sensitivity of Explosives

A new experimental technique which is expected to lead to better control of explosives has been developed by scientists at the Naval Ordnance Laboratory, Silver Spring, Maryland. The technique permits direct observation of the behavior of explosive materials in the previously unexplored temperature range of 300 to 1,000 degrees centigrade. This heat range is critical, because the investigators believe that the most important single indicator of the relative impact sensitivity of an explosive material is its rate of decomposition at high temperatures.

Utilizing a "hot tube," upon which the new technique relies, the decomposition rate is determined by recording the length of time required for an explosive placed in the tube to explode after being heated to a specific high temperature. The tube is made from thin stainless steel that hypodermic syringes are made from. Its main advantages over other types of tubing are that it can be heated to high temperatures almost instantaneously by electrical means, and its temperature at the time of explosion can be determined readily.



photic stimulation to a subject.

Training Simulators at NTDC

Public attention has been focused during the past decade on the development of new complex weapons such as guided missiles and nuclear weapons, and on the advances made in supersonic flight, nuclear-powered ships and aircraft. The magnitude of the effort of the military services in the development of such weapons and vehicles has made it necessary to find new and more effective ways of teaching their operation and maintenance to previously unskilled personnel, since the successful utilization of any weapon depends ultimately on the capability of the human operator.

The Navy Training Device Center, ONR's laboratory at Sands Point, Long Island, exists for that very purpose—to provide tools to train more people in more complex skills and techniques in shorter time than ever before. Under the Commanding Officer and Director, a Navy captain, the Center's operation is carried out by key military and civilian administrative personnel. This staff includes the Army Participation Group, which consists of an Associate Director and Army training officers representing the various branches of the Army. In addition to the military officers and a number of Navy enlisted men, TDC is staffed by approximately 700 civilian scientists, engineers, educators, psychologists, technicians, equipment and training specialists, artisans, craftsmen and clerical workers.

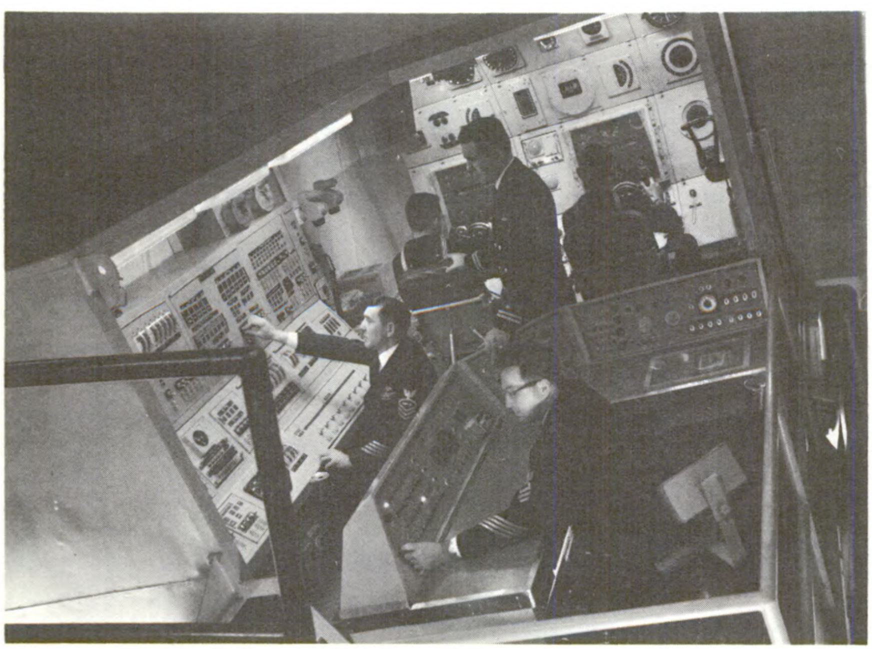
The Training Device Center began its operations in 1941, spending its early years in what was formerly an automobile display room and garage at 610 H Street, N. E., in Washington, D. C. It was created by RADM J. H. Towers, Chief of the then Bureau of Aeronautics, as a Special Devices Desk in the Bureau's Engineering Division, with the overall mission of developing special devices for training. To head this unique organization, RADM Towers brought in CDR Luis de Florez, USNR, in civilian life an internationally known engineer already credited with inventing two devices which would prove very helpful to the allied forces—an anti-aircraft gunsight and a flame thrower. De Florez was just the type of enterprising man the infant SDD needed—a man who, at the age of 51, had just won his Naval Aviator wings at Pensacola, completing the 11-month course in just 7 weeks.

When all Navy research was combined under the Office of Research and Inventions in May 1945, SDD, which had become a full-fledged division of the Bureau of Aeronautics, became part of the new organization. Negotiations were completed in August 1945 for relocating SDD at the former Guggenheim Estate, near Port Washington, New York, to allow space for expansion. Shortly thereafter SDD moved to its present site. When, by act of Congress, the Office of Research and Inventions became the Office of Naval Research in 1946, SDD was renamed the Special Devices Center. On April 30, 1956—exactly 15 years to the day after its creation—the Training Device Center assumed its present name.

The Training Device Center has pioneered in the building of simulators for use in a "synthetic" training system. In World War II, training under supervision using operational equipment was found too costly, time consuming and too hazardous for inexperienced personnel. By using simulators, the savings in money, time and lives has proven substantial. For example, it cost about $600 an hour to train the 9-man crew of a patrol plane when an actual aircraft was being used. Using a flight simulator, the cost was brought down to approximately $64 an hour, and personnel were trained in half the time required in the actual aircraft. It has also been well established that the use of trainers saves lives. During World War II, the Center produced some bombing trainers for the Army Air Force. A later report stated that in just one year the trainers had saved an estimated 119 lives which would normally have been lost in routine flight training accidents. Also, more than $28,500,000 was saved in operational equipment costs.

The conclusion of World War II meant no letup in TDC's activities. The last decade has seen the arrival of nuclear power for an atomic Navy, guided and ballistic missiles, and a whole new arsenal of weapons for peace. Through visionary planning and imaginative technical

The men aboard this diving trainer are learning to maneuver the GEORGE WASHINGTON class nuclear-powered submarine. The 9-ton compartment rolls and pitches in precise response to the actions of the crew.



capability, the Center has kept pace with these new deveolpments by evolving a whole series of training simulators. It has designed, produced in quantity through industrial contracts, and distributed thousands of different types of training simulators to the Armed Forces in addition to supplying simulators to allied military organizations under the Mutual Defense Assistance Pact.

A simulator is a machine which presents the full combat environment to a trainee, enabling him to perform a complete combat procedure. These simulators are designed to teach men to fly, to shoot, to operate radar, and to perform the numerous technical tasks of a modern Navy. They may vary in weight from an ounce to tons and in cost from a few cents to hundreds of thousands of dollars. They may be as simple as a hand-held device or as intricate as devices which utilize analog and digital computing machines. But they are all designed to serve one purpose--to insure more effective training.

One of the weapons of the modern-day Navy is the Polaris Missile—the most useful mobile deterrent weapon system the world has ever known. This weapon can be launched from long-range, world-girdling Fleet Ballistic Missile (FBM) submarines while completely submerged.

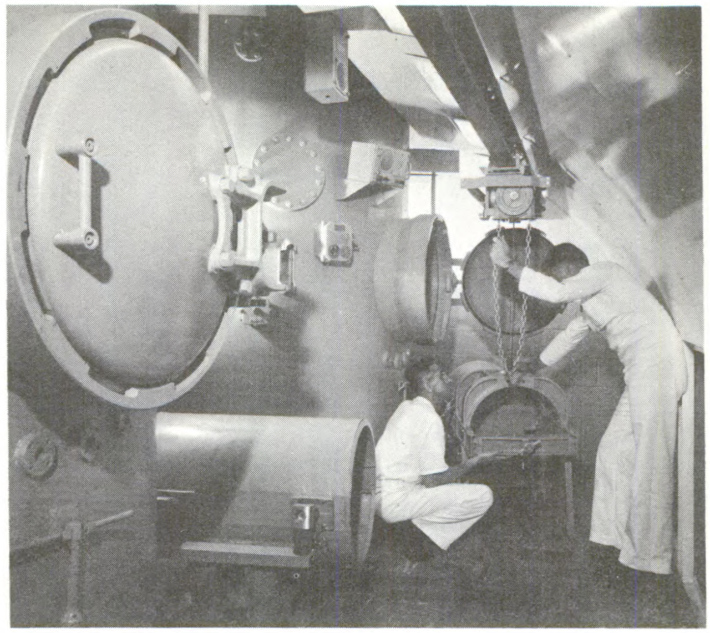
Each FBM submarine has two crews—the Blue and the Gold--in order to keep the submarine operative at all times. To maintain the proficiencies of the Blue-Gold crews while they are in refresher training status and to train new personnel, the Fleet Ballistic Missile Team Training Facility has been developed by TDC and installed in Robert H. English Hall, a three-story brick building at the U. S. Naval Submarine School, New London, Connecticut.

The Facility consists of two major areas, the first of which realistically simulates critical areas of the GEORGE WASHINGTON class submarine, including the Missile Control Center, Missile Compartment, Navigation Center and Diving Trainer. These compartments are completely activated by computers.

The second major area of the Facility consists of three attack centers which realistically duplicate in function and appearance the attack centers of certain nuclear submarines--GEORGE WASHINGTON, SKATE and THRESHER. Officers and men in these attack centers have the capability of conducting independent attacks on separate targets, attacks in consort, and attacks against each other. Also included in this area is a tactical display room which includes two command centers and an adjoining section arranged in a theatre-like fashion. A large screen and status boards display information pertaining to exercises in the attack centers. The tracks of the ship involved in a problem are continuously recorded and displayed on the screen and the movements of the target ship can be controlled from a master instructor station. Any or all three attack centers may be inserted into the problem and their tracks similarly recorded and displayed.

The students in the diving trainer have the realistic impression of being aboard the submarine. Their surroundings look, feel, sound and respond just like those of the real submarine. However, if the students

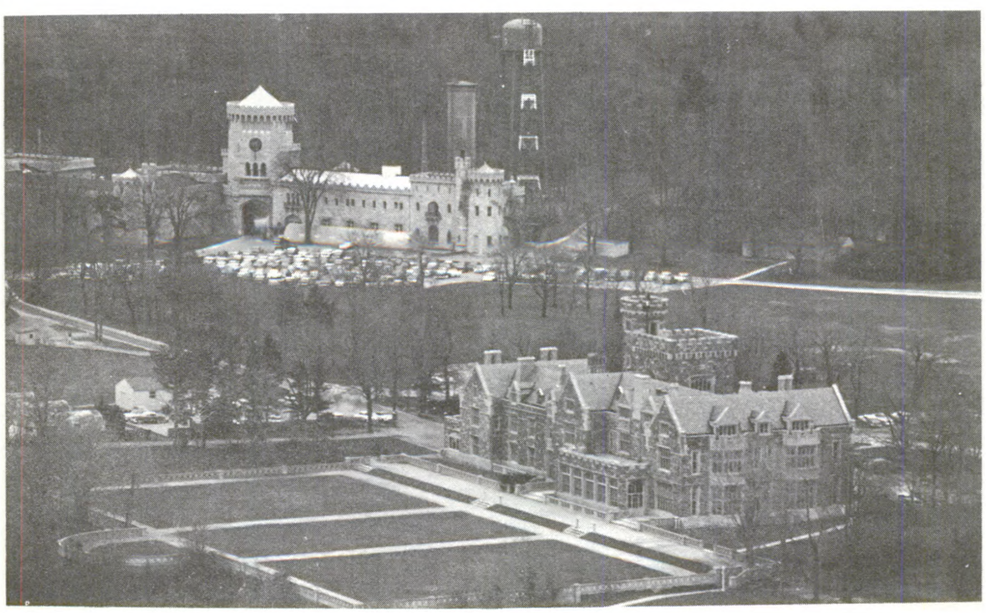
In a few weeks these men will handle the real guidance packages for Polaris missiles. In this simulator, they are perfecting their skills in readying the Polaris missile for flight.



do not take the proper action in handling emergencies, such as flooding compartments, there is no real danger. The instructor merely freezes the trainer, describes the mistake to the students, and says, "Okay men, let's try it again—the right way." The students resume their posts and go through the entire problem over and over until they have mastered it.

Students in the missile control center and missile compartment practice the complex individual tasks and teamwork required to launch Polaris missiles. The simulators enable crews to assume the various readiness conditions and to go through count-down sequences that they must be familiar with but cannot practice on the actual submarine.

Administration and Engineering Buildings at NTDC.



The Center's program includes responsibility not only for research and development, but also for production, installation, maintenance and modification of simulators used in all types of military training installations. Although some of the prototype research and development work is done in the Center's own shops and laboratories, a large portion of the work is completed through contracts with private industry, colleges and universities, and other research groups. By expanding the Center's own facilities and experience, these organizations aid in a specific phase of a project or accomplish it in its entirety, from blueprint to finished product.

Industry may develop a prototype or furnish a complete production run. Educators and psychologists in America's leading universities may be called upon to relate pertinent data to a project or carry on original research studies. Military personnel aboard Navy ships and at shore installations and other Department of Defense activities thoroughly test and evaluate training equipment. This combination of facilities and resources provides a powerful task force for the advancement of training-device technology.

Once a prototype has been developed and evaluated, the training demands of many activities may require production in quantity. With funds usually provided by the sponsoring agency requiring the training device, the Center's production engineers and contract negotiators coordinate their efforts to design and build the desired training device through contracts with private industry.

In order to help the Center maintain effective contact with training commands and fleet operational units, regional offices and area representatives have been established in strategically-located geographic areas. The regional offices are located at Norfolk, Pensacola, Great Lakes, San Diego, and Honolulu. Area representatives are located at Naval Air Stations in Seattle, Corpus Christi, Jacksonville, and Quonset Point. In addition, a TDC liaison office is located in ONR, Washington, and a Training Device Department is maintained within the ONR Branch Office, San Francisco. Services of training specialists, engineers, and equipment specialists are available upon request to assist in any problem of installation, utilization, or maintenance. Funds are also available to develop and fabricate small devices and aids needed locally.

By keeping in constant touch with the pulse of operational planning, the Center is able to keep abreast of technological advances and achievements and to anticipate the need for advanced training systems. Training systems being created at TDC will play an important part in preparing personnel of our Armed Forces for the vital roles they must assume in today's space age.

DR. JOSEPH M. KRAFFT of the Naval Research Laboratory has been selected by the Washington Chapter of the American Society for Metals as the recipient of its 1962 Burgess Prize Award. The award was presented last month, at the meeting of the Chapter, in recognition of Dr. Krafft's outstanding contributions to the understanding of the effects of high strain rates and metallurgical factors on the plasticity and fracture of metals.

Research Notes

Snakebite Survey*

If a given number of Marines are maneuvered around several hundred acres of temperate-climate woods, swamps, and pastureland, the chances are good that sooner or later some will be bitten by poisonous snakes. What are their chances for survival? To find out, a survey was conducted in seven counties of eastern North Carolina by the Naval Medical Field Research Laboratory at Camp Lejeune. Apparently the feared rattlesnake, copperhead, and moccasin (see photo) are less dangerous than is commonly supposed.

The survey was made by going to nine hospitals in the area and checking the records of snakebite cases over a nine-year period. By this method 121 case-histories were compiled, 75 of which involved patients who were victims of poisonous snakes, with another 38 in which the case could not be diagnosed as poisonous or nonpoisonous. In addition to the hospital survey, 19 local physicians were interviewed as to their experiences with snakebite, including the first-aid measures applied initially by amateurs, and the methods of treatment employed professionally. Altogether, these physicians had dealt with 1475 snakebite cases over lengths of practice ranging from 8 to 45 years.

Some 48 of the case records showed the length of time between the bite and treatment. While 33 of these patients managed to get professional help within an hour, 8 had to wait up to two hours, and 7 considerably longer. Yet of the total of 121 cases only three died, and two of them had other disabilities which probably contributed to death. The shortest time between bite and death was 18 hours. So the cinema and TV stories of people being bitten by snakes, and expiring dramatically a few minutes later, are not supported by fact—not with the pit vipers encountered in North Carolina, anyway.

A disturbing note was brought out by the survey, however: the lack of uniformity in methods of treating snakebite. The immediate employment of incision and suction—recommended by most first-aid manuals, including the Boy Scout Handbook—was used in only 34 cases, and tourniquet in 23. At the professional level, the most consistent treatment was the use of antivenin (57 cases). There was some use of ACTH and Cortisone, singly or in combination, (15 cases), antibiotics (15 cases), antihistamines (5 cases) and tetanus injections or booster shots (21 cases). But in spite of the nonuniformity of treatment, less than a third of the victims had to be hospitalized—a statistic that bears out the local doctors' opinion that copperheads (which caused the majority of the bites studied) rarely produce serious envenomation.

*Abstracted from a Naval Medical Field Research Laboratory report (Camp Lejeune, N. C.), by T. W. Merriam, Jr., LT, MC, USNR.

New Achievement in Study of "Weak Interactions"

Recently another major advance was reported in the pursuit of understanding of the so-called "weak interactions." As in the past, the advance was achieved independently by research groups utilizing the synchrocyclotrons at Columbia University and the University of Chicago. The design and construction of the two synchrocyclotrons were financed by the Office of Naval Research and most of the research conducted with these accelerators has also been sponsored by ONR and the AEC.

The weak interactions constitute one of the four fundamental types of forces known to physicists (the others are gravitational, electromagnetic, and the strong nuclear force). The weak forces make their presence known by the fact that they cause most of the elementary particles of matter to decay into other more stable particles. Very little was known about these forces until 1956, when Professors C. N. Yang and T. D. Lee made the revolutionary proposal--based on a study of the available evidence--that the weak interactions do not have mirror symmetry (see insert). The new proposal was soon verified, and it has led to a succession of crucial breakthroughs. Consequently, more is now known about the weak forces than about the strong nuclear forces—which have been intensively studied for a long time.

A suitable elementary particle to use for investigating the properties of weak interactions is the muon. This particle, which interacts by means of the weak force, but not by the strong nuclear force, can be produced efficiently with the ONR synchrocyclotrons at the University of Chicago and Columbia University. Scientists at these two institutions have performed a succession of brilliant experiments that have contributed much to our present understanding of the weak interactions. Largely as a result of the work since 1956, we now believe that all of the observed weak interactions are governed by the same law; in other words, the strength of the force and its mathematical structure are the same in all weak interactions.

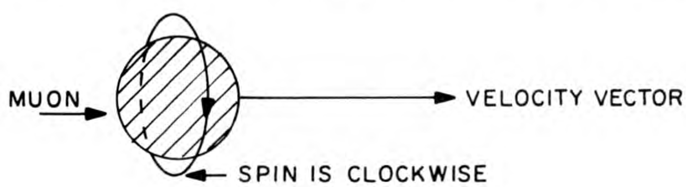
The newest advance in the muon investigations made at the two universities is the experimental observation of muon capture by the proton—also a result of the weak force. Inasmuch as essentially all observations made previously of weak interactions were of decays of particles, the new observation provides a means for testing the validity of the current theory in a new realm of phenomena. There have been some previous measurements of muon capture in complex nuclei, but they are not as easily interpretable as capture by the single proton.

Both the Columbia and Chicago experiments required years of preparation, in large part because of the necessity for preparing targets of pure hydrogen. If deuterium or any other impurity is present, the muons are preferentially absorbed by the latter, thus masking the reaction of interest. The Chicago group, lead by Roger Hildebrand, observed the muon capture in a liquid-hydrogen bubble chamber having fewer than 22 parts per million of deuterium; and the Columbia group, under Leon

Lederman, observed the reaction with counters surrounding a liquid-hydrogen target containing fewer than 1 ppm of deuterium. The concentration of deuterium in naturally occurring hydrogen is about 150 ppm. Another experimental problem that had to be solved was to obtain a beam of pure muons. The secondary beams produced by these synchrocyclotrons usually contain a large number of pi-mesons as well as muons, and since the former interact with protons by means of the strong force, almost all of them would be captured by the protons. On the other hand, only a small fraction of incident muons are absorbed because of the weakness of the interaction. Thus, it is essential to remove all pi-mesons from the beam. The measured capture rates in the two experiments are in agreement with each other and are in agreement with the rate predicted on the basis of the currently held model of the mechanism of the weak force. However, the experimental accuracy of both experiments can be improved considerably.

Mirror Symmetry

The meaning of the statement, "the weak interactions do not have mirror symmetry" (see adjoining article), can be illustrated by considering the process by which the observed muons are produced. The collisions of the circulating protons in the accelerator with target nuclei produced pi-mesons directly (by means of the strong nuclear forces). The pi-meson is unstable under the actions of the weak force, and in a mean time of about $2(10)^{-8}$ seconds it decays into a muon plus another kind of particle. One of the intrinsic properties of the muon is that it spins about an axis; and the unique property of the force which caused the decay is that the muon preferentially spins in one of the two possible senses. Thus, when a negatively charged pi-meson decays into a negatively charged muon, the latter usually which spins clockwise as it moves forward, in the manner of a right handed screw (see diagram).



One observes fewer mouns coming out of such a decay in the manner of a left handed screw; that is, spinning counter-clockwise looking along the direction of advance. If the weak force had mirror symmetry, one would have observed 50 percent left handed and 50 percent right handed muons. Since 1956, a large number of observations have been made of other weak interactions, all of which have exhibited mirror asymmetries. On the other hand, all observed reactions induced by the three other forces of nature do have mirror symmetry--anyone of those reactions and its mirror image occur with equal frequency.

Incidentally, the realization that the muons coming out of the synchrocyclotrons were polarized (more spinning in one direction than the other) was the key factor that made possible many of the crucial experiments performed at Columbia and Chicago.

A by-product of these experiments is that they provide a unique method for probing atomic and molecular structure using muons. One of the interesting molecular effects is the triggering of fusion reactions of deuterium nuclei as a result of their being bound to the same muon. Both laboratories are continuing their experiments to improve the accuracy of measurement of the basic capture, and to learn more about the molecular phenomana.

"Post" Profiles ONR Scientist

Dr. J. F. Saunders, Head of the Medicine and Dentistry Branch of the Office of Naval Research, will be featured in a forthcoming issue of the Saturday Evening Post in the section entitled "People on the Way Up." This section contains profiles and photographic studies of young Americans who have shown unusual promise in various careers. Included in the series are profiles of men and women working in many different fields, such as in science, entertainment, and sports. Dr. Saunders is the first ONR scientist, as well as the first Navy scientist, to be featured.

An article written by Dr. Saunders—"The Future of Tissue Transplantation"—and a short account of a recent contribution he made to the long-term preservation of whole blood, appear in the May 1962 issue of Naval Research Reviews.

Yacht to Join Oceanographic Expedition

The former Presidential yacht USS WILLIAMSBURG will be equipped to participate as a biological research vessel during the International Indian Ocean Expedition. The 1900-ton twin-screw yacht is expected, with minor modifications, to serve well in her new calling. After refitting at the Philadelphia Navy Yard, the WILLIAMSBURG will be moved to Woods Hole, Mass. She will make trial voyages this fall or early winter and will sail for the Indian Ocean in January 1963.

One of the main purposes of the International Indian Ocean Expedition is to develop additional marine food supplies for the heavily populated countries of that region which have protein-deficient diets. Present plans call for about 150 marine biologists to participate in this effort. They will rotate in groups of 25 or 30 per cruise, each of which will last from two to three months through 1964. The undertaking will be supported primarily by the National Science Foundation.

USS WILLIAMSBURG

The WILLIAMSBURG was originally built as a yacht in 1930 for H. J. Chisholm. At the outbreak of World War II she was taken over by the Navy and operated as a gunboat until 1945, when she was reconverted to a yacht for the use of President Truman. In 1953 she was decommissioned by President Eisenhower. The ship is 243 feet long, has a 36-foot beam, and a draft of 16 feet.

One of the major participants in the Expedition will be the Office of Naval Research, which is sending a number of ships to the region. Other countries, including Japan and Australia, are also contributing to the international effort.

Among the Honored

The annual Howe Memorial Lecture of the American Institute of Mining and Metallurgical Engineers was given this year by PROFESSOR MORRIS COHEN in New York. The invitation to give this lecture is the outstanding honor extended in the United States to persons working in the field of metallurgy. In his talk, Dr. Cohen acknowledged that his studies on the strengthening of steel, for which he was honored, had been supported by the Office of Naval Research. Professor Cohen has also been invited to give the Hadfield Lecture, an English equivalent of the Howe Lecture.

DR. HOWARD SCHACHMAN of the University of California has been presented the American Chemical Society's Award in Instrumentation. The award was made at the Society's spring meetings held in Washington, D. C. The award address concerned absorption and interference optics in ultracentrifugation. Dr. Schachman's research has been supported by the Office of Naval Research for several years.

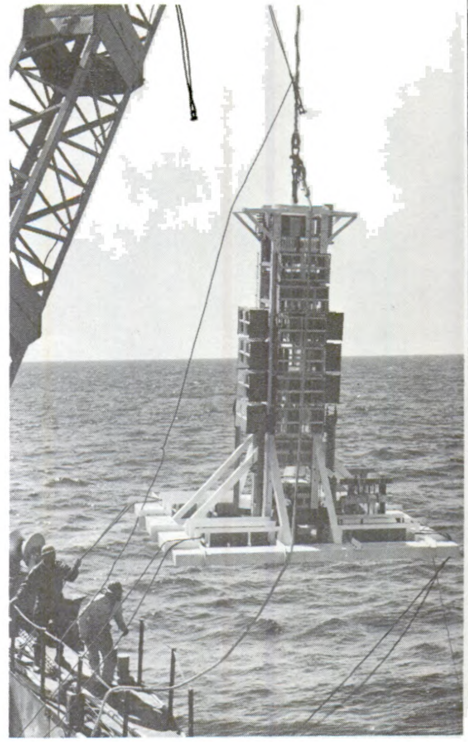
DR. SHIELDS WARREN, Director of Research and Chief of Pathology at the New England Deaconess Hospital, is the recipient of the 1962 Albert Einstein Medal and a $5,000 award for distinguished devotion to science in pursuit of problems in the fields of radiation, biology and medicine. Dr. Warren has been under contract to the Office of Naval Research since 1953. As part of his ONR-sponsored work, he pioneered in applying the polaroid color-translating ultra-violet microscope to problems in biology and medicine.

Test Station Installed on Ocean Floor

A 7,000-pound complex of testing racks, materials, and instruments—the first member of a Navy family of experimental stations designed to test the reaction of materials to long-term exposure in various marine environments—was lowered recently to the ocean bottom off the coast of southern California. The device, called a Submersible Test Unit (STU), was placed on the edge of the continental shelf at a depth of 5,300 feet. It will remain there for six months, then be retrieved. Subsequently, other "family members" will be placed on the ocean bottom at depths of 6,000 and 12,000 feet for periods of 6, 12, and 24 months.

The experiment, conducted by the Naval Civil Engineering Laboratory, Port Hueneme, Calif. (Naval Research Reviews, March 1962), is part of an extensive effort by the Navy to develop techniques for testing materials and equipment on the sea floor in deep water.

Included in the specimen load of the first STU were samples of 191 metals, 56 nonmetallic materials, 11 electrical conductors, and 14 wire ropes and cables. Eight of the wire-rope specimens were stressed to 20 percent of their ultimate tensile strength. The effects of the physical, chemical, and biological environment on the deterioration of the specimens will be investigated.



Test unit on way to 5,300-foot ocean depth.

While the STU was being installed, the bottom waters and sediments were sampled to determine their physical properties and chemical and biological composition. Also, a deep-sea camera was lowered to obtain photographs of the ocean floor at the chosen location. During the STU's period of exposure, studies of the ocean-bottom environment will continue: a current meter placed with the unit will record water movements during the entire period, and periodic visits to the site will be made to monitor the chemical and physical properties of the bottom waters.

For easy installation and recovery of the unit, NCEL engineers designed a unique system—a completely submerged rigging complex utilizing buoyant polypropylene (plastic) rope, fluid-filled subsurface buoys, and an acoustic-actuated anchor release device. The upper portion of this system is far enough below the ocean surface to present no navigational hazard to passing ships. When the time comes to retrieve the STU, it will be relocated by means of precision electronic surveying and navigation techniques.

Ni Ti Nitinol—Alloy of Nickel and Titanium

Metallurgists at the Naval Ordnance Laboratory, Silver Spring, Maryland, have developed a series of alloys of nickel and titanium that are nonmagnetic, unusually corrosion resistant, and can be hardened nearly to the hardness of tool steel.

Alloys such as nickel-titanium are classed as intermetallic compounds, which have been defined in the Metals Handbook as "An intermediate phase in an alloy system, having a narrow range of homogeneity and relatively simple stoichiometric proportions, in which the nature of the atomic binding can vary from metallic to ionic." At any rate, intermetallic compound alloys have for some time been recognized as possessing unusual properties that enable some to act as semiconductors and others to resist loss of strength at high temperatures. Not much attention was devoted to their development as structural materials, however, because their high-temperature capability was believed to be inevitably coupled with extreme brittleness.

NOL's investigation was initiated because second-generation missiles and spacecraft are expected to require materials of higher strength and lighter weight capable of operating at very high temperatures.

Nitinol offers a potential solution for many troublesome nonmagnetic material applications where low permeability, strength, hardness, fabricability, and corrosion and abrasion resistance are a problem. It appears particularly useful as a material for nonmagnetic tools in mine disposal applications and in various components of magnetometers, mine laying and servicing craft where the above characteristics are required.

Scientists Exchange Weapons Knowledge

The Sixth Navy Science Symposium sponsored by the Office of Naval Research was held on May 2nd and 3rd in San Francisco, with the U. S. Naval Radiological Defense Laboratory acting as host.

Thirty-two papers dealing with weapons and weapons effects were delivered during the two-day meeting attended by 500 scientists and officers of Navy laboratories and Navy research contractors.

Speaking at a banquet on the first evening of the meeting, VADM W. F. Rayborn, USN, Deputy Chief of Naval Operations (Development), urged that more thought be given to developing systems for the Navy and that these be tailored to the capabilities of the men who must man their components.

DR. MAURICE M. SHAPIRO, Superintendent of the Nucleonics Division of the Naval Research Laboratory, has been awarded a fellowship by the John Simon Guggenheim Memorial Foundation. The fellowship provides for a 12 month period of study abroad of cosmic ray interactions at ultra high energies and of recent developments in the theory of nuclear structure.

On the Naval Research Reserve

A. Hoyt Taylor Award Presented

Dr. James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development, presented the Navy's A. Hoyt Taylor Award to Naval Reserve Research Company 3-9, Upton, Long Island, New York, during a ceremony on April 18, 1962 at the Brookhaven National Laboratory. The award, in the form of a handsome bronze plaque, was presented to the company after a reception and dinner attended by the members and their families and distinguished guests from the Navy and the Laboratory.

In his remarks, Dr. Wakelin congratulated the Laboratory reservists for being the first to win the award in competition with more than 100 other Research Reserve Companies. The award is named after Dr. A. Hoyt Taylor, a former reserve officer and naval scientist who pioneered in the development of radar. It is given, as Dr. Wakelin pointed out, in recognition of outstanding scientific work by a Research Reserve Company.

The award was presented to NRRC 3-9 for its work on a scientific study entitled "An Evaluation of the Need for Filtration Systems for Protection of Personnel in Structures against the Acute Hazards of Radioactive Contamination of the Atmosphere." It will be published shortly as a Naval Research Report.

The A. Hoyt Taylor Award is presented to CDR Jere C. Austin, USNR, Commanding Officer of NRRC 3-9, by Dr. Wakelin. Looking on is CAPT Robert A. Conard, USNR, project officer for the award-winning scientific study.

NRRC 1-3 Briefed on Mobilization

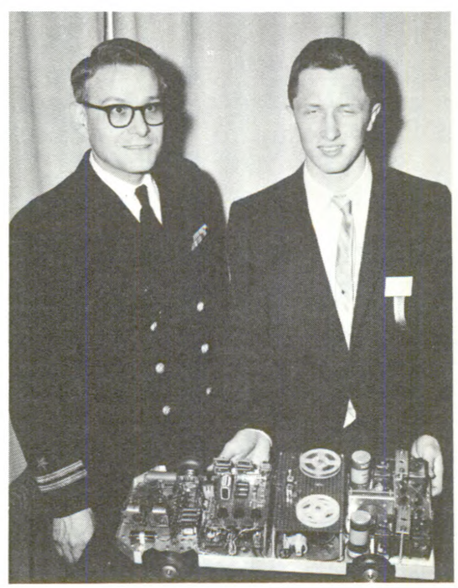
Naval Reserve Research Company 1-3, located at the University of Massachusetts, honored a visiting member of the Research Reserve office, Office of Naval Research, Washington, D. C., at its drill on April 24, 1962.

Miss Eleanor F. Kehoe, Educational Specialist for the Research Reserve component of ONR and a Commander in the Naval Reserve, on that evening addressed the local company on the subject, "Mobilization in Connection with the Research Reserve." Miss Kehoe spoke from an extensive background of experience in this area. She is presently Assistant to CAPT J. W. Jockusch, Jr., USNR, Special Assistant for Research Reserve, ONR.

Miss Kehoe and officers of NRRC 1-3. Seated: CDR William D. Scott, Commanding Officer, and LCDR Herschel G. Abbott, Administrative Officer. Standing: CAPT Richard C. Foley, CDR Edgar E. Lindsey, CDR George A. Marston, and CDR Sidney F. Wexler.

Self-Controlled Car Wins Science Fair Competition

This year's winner of the Student Science Fair of the Chicago Public Schools was John Schuldt, pictured at right at the award ceremony held on April 15. With him is a Navy representative, LT M. D. Burkhard, USNR, Commanding Officer, NRRC 9-23, Forest Park, Illinois, who served as a Fair judge. Also shown is the award-winning project—a self-controlled car with tape programming. The Fair was held at the Museum of Science and Industry, Chicago, on April 12 to 15.



LT Burkhard and Science Fair winner with an unusual car.

Seminar Held at Redstone Arsenal

Through the efforts of Naval Reserve Research Company 6-17, Huntsville, Alabama, a weekend seminar was conducted at Redstone Arsenal on May 11-13. This seminar was made possible through the joint cooperation of the U. S. Army Ordnance Missile Command (AOMC), Ordnance Guided Missile School and the George C. Marshall Space Flight Center (MSFC) of the National Aeronautics and Space Administration (NASA). CDR John D. Beal, Jr., USNR, Commanding Officer of NRRC 6-17, served as seminar chairman.

One hundred and forty-two reservists from six states and all services attended. These states and the numbers of reservists representing them were Alabama (51), Texas (22), Georgia (34), Tennessee (29), Florida (1), and South Carolina (5).

The initial meeting and registration was completed Friday evening at the Naval Reserve Training Facility. CDR Beal opened the session Saturday morning and introduced CDR E. F. Kehoe, USNR, from the Office of Naval Research and LTCOL R. J. Schofield, USA, from the Army Ordnance Missile Command. A full day was then spent at AOMC and the Ordnance Guided Missile School. Briefings on missile systems included those on Pershing, Sergeant, Nike-Zeus, Redeye and Mauler. Tours of various facilities of the Command were made to supplement material presented in speeches.

Saturday evening an enjoyable and informative dinner meeting was held at the Redstone Arsenal Officers Club. Speaker of the evening was LCDR Horace R. Lowers, USNR, Chief Engineer, AOMC. His talk was entitled, "The Solid Punch," which referred to the fueling of the missile systems.

Sunday was devoted to activities of the George C. Marshall Space Flight Center. This day's meeting opened with an excellent presentation by CAPT Bart J. Slattery, USNR, Chief of Information, MSFC, on the "Role in the U. S. Space Program." A tour of facilities followed, including the Manufacturing Engineering Division and the Test Division, where a close view of the Saturn rocket was possible. For those who were able to remain for the afternoon, a tour of Widows Creek Power Plant at Stevenson was arranged. This tour provided a view of the largest single generator in the world.

CDR Beal and the 31 members of NRRC 6-17 arranged and presented an excellent seminar for this weekend training duty. The officers left on Sunday with a feeling of genuine satisfaction of time well spent on bringing themselves up to date on this important phase of our national effort.

DR. B. R. BHUSSRY, Associate Professor of Anatomy at Georgetown University, is one of 33 scientists who received research career awards from the National Institutes of Health. A portion of Dr. Bhussry's broad program in "Sound and Altered Enamel" is supported by the Office of Naval Research.

Eighty-four foot radio telescope at Maryland Point, Md.

From Cassiopeia A. to NRL to "Century 21"

U. S. Navy scientists played an impromptu--though vital--role in the opening of the Seattle World's Fair on April 21.

This sidelight to the "Century 21" exhibition had its origin in opening ceremony plans made by Seattle Fair officials. President Kennedy was slated to open the exhibition on April 21 with a speech transmitted from West Palm Beach, Florida. The opening speech was to be followed by a signal from the American Telephone and Telegraph Company radio telescope in Andover, Maine, using radio emissions from the star Cassiopeia A. Routine pre-opening checks brought out the ominous fact that a blizzard raging in Maine was expected to interfere with the operation of the radio telescope.

Early in the evening of April 20, a call for assistance rang into the office of Secretary of the Navy, Fred Korth. Shortly afterwards, the request for help reached Ed McClain, Head of the Radio Astronomy Branch of the U. S. Naval Research Laboratory in Washington, D. C. Mr. McClain and two of his assistants, J. H. Nichols and J. E. Kenney, rushed from their homes to the Laboratory's 84-foot radio telescope 45 miles south of Washington. The installation and checking out of the necessary equipment on the huge dish was completed by 11 a.m. on April 21--just four hours before the opening of the Seattle Fair.

At approximately 2 p.m., when it was found that the Andover station would be able to operate, officials decided to assure the success of the relay by running both stations in parallel. After the President's message was transmitted to Seattle, both radio telescopes relayed the radio emissions from Cassiopeia A., thus opening the 1962 exhibition.

U. S. GOVERNMENT PRINTING OFFICE : 1962 O - 643209

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.

Navy jets circle over a carrier. See page 10 for a discussion of one type of accident which may occur as these aircraft prepare to land.

NAVEXOS P.