U.S. Office of Naval Research

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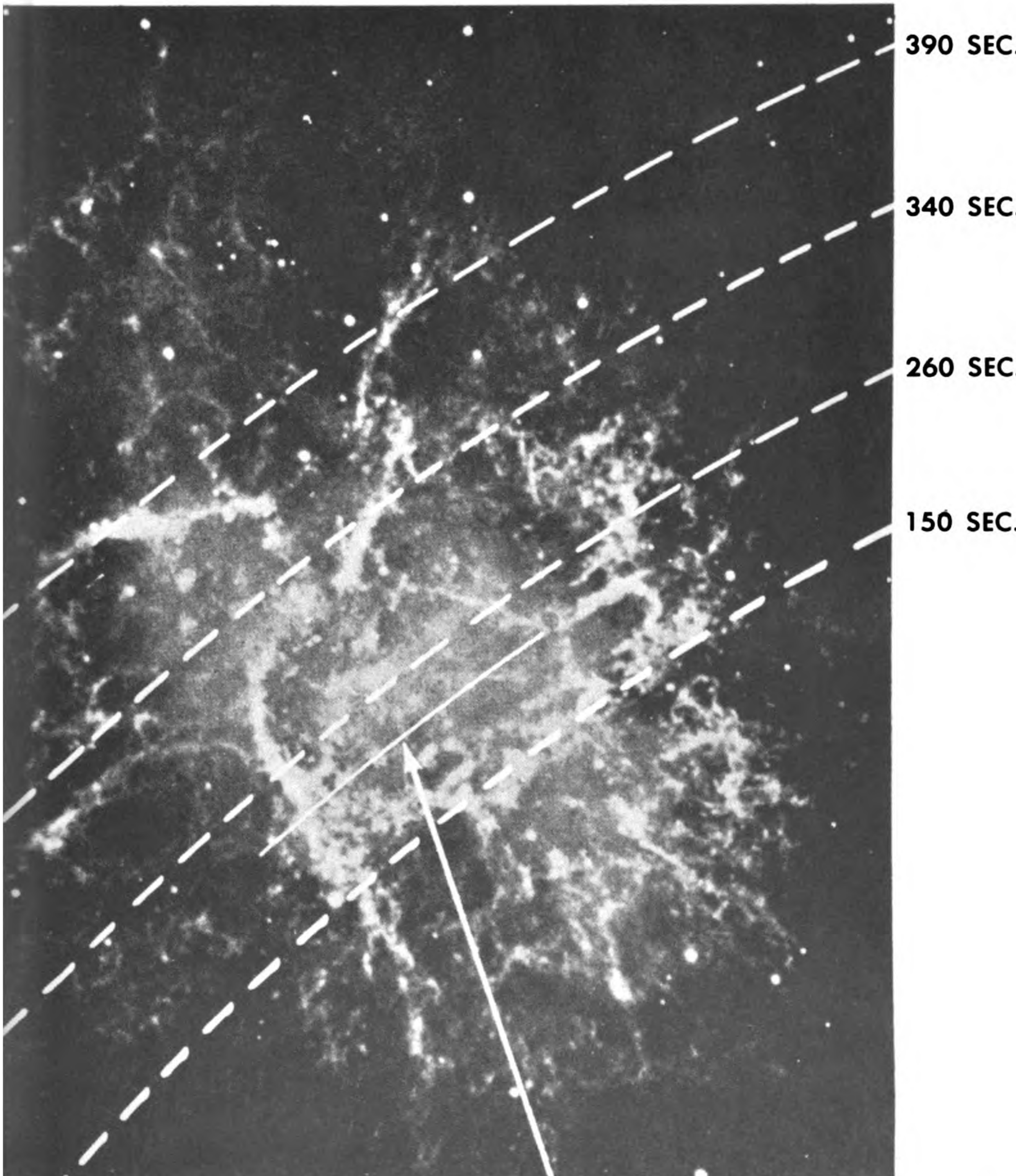
AUGUST 1964



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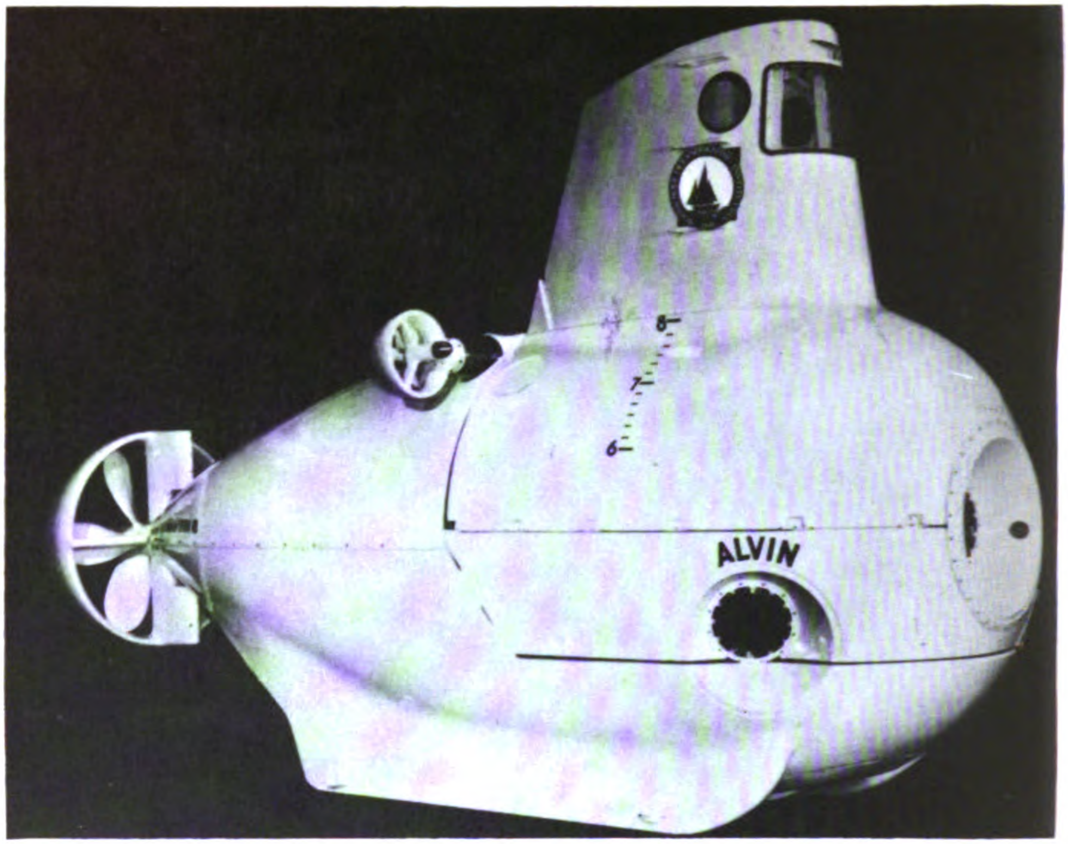

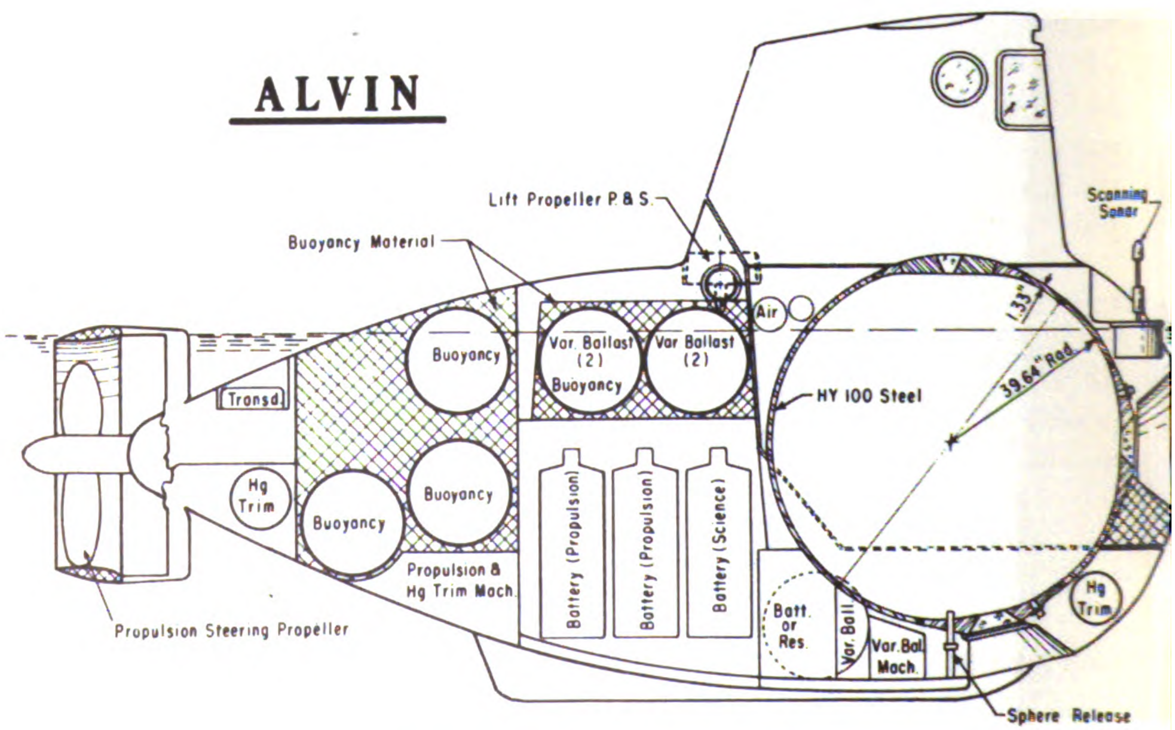

Longitudinal section of ALVIN

ALVIN's World

Hon. James H. Wakelin, Jr.
Assistant Secretary of the Navy
(Research and Development)

Over these past years, I have witnessed tremendous progress and accomplishment in the scientific endeavors made in support of the National Oceanographic Program. Of special interest has been the increased emphasis on the exploration of the deep ocean—the last true frontier on this planet.

Shortly after I took office, the bathyscaph TRIESTE made its historic 35,800-foot dive to the bottom of the Marianas Trench off Guam. Although this was a record dive and a notable "first," we of the Navy recognized that the event, in itself, made only minor contributions to science; it was important, rather, as one in a series of controlled tests designed to prove TRIESTE's capabilities for deep-ocean research. I think this point was lost to many people at that time. Coming as it did on the eve of manned exploration of space, the feat itself attracted more interest than its true meaning in terms of the future scientific investigation of the sea.

I emphasize this past history because I think too often we tend to stress the spectacular—the record altitudes and speeds, the *machine* rather then the intended *purpose* of the machine. This inclination is not unique to deep submersibles. All of us have witnessed the spectacular growth of aeronautics from the propeller-driven aircraft of World War II to the manned space flights of today. Like millions of Americans, we have followed eagerly the achievements of a rapidly accelerating technology—a technology that hopefully will put our astronauts on the moon within the next decade. But our attention tends to be focused on the hardware, on the pilot, and on the "firsts." All too often the intended purpose of the mission is forgotten.

I, for one, do not subscribe to the apparently sacrosanct belief that the mountain should be climbed because it is there, that a certain altitude or depth should be achieved because no man has previously flown or plunged so far. I believe that tools are developed to achieve a purpose. In a day when the development of tools demands such tremendous national resources, this purpose must be responsive to the interests of the Nation and its people.

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*A slightly modified version of the address given by Dr. Wakelin at the commissioning of ALVIN at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, June 5, 1964.

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ALVIN is one such tool. Although its designed depth of 6,000 feet is considerably less than that of TRIESTE, the speed, endurance, maneuverability, and range of ALVIN, plus its self-contained ballast system, permit us to call it a submarine. It will be the first deep-diving submarine to go into operation anywhere.

The men who are privileged to dive in ALVIN will see things that will undoubtedly make news for many years to come. But those of us in the Navy, industry, and at Woods Hole who helped conceive and bring her into being will be more concerned, I hope, over its impact on scientific research, particularly basic research important to the national interests. Our purpose is to advance man's knowledge of the sea; ALVIN is but one means to this end.

We have other objectives in the oceans besides research that demand tools for use in the deep-sea environment. Deep-diving military submarines are expanding the potential arena of naval warfare. We must understand this new and demanding environment. We must also be able to live and work in it.

The tragic loss of the submarine THRESHER emphasized the pitiful inadequacy of our present technology to plumb the ocean's depth and perform useful work on the ocean's floor. Ship-lowered cameras, precision depth recorders, and other advanced oceanographic instrumentation were mobilized behind the search. But, in effect, we were groping blind from the surface. I know I speak for many of the men who joined the search for the THRESHER when I say that we were especially frustrated at our inability to employ the best sensor of all—the mind and eyes of man.

Eventually we were able to bring TRIESTE into the search. Her dives demonstrated clearly the advantage of selective, personal observation. Observers were able to confirm and photograph the location of structural parts of THRESHER on the ocean floor. In one of its dives, the bathyscaph used its mechanical arm to retrieve a length of copper pipe bearing markings which definitely established that it came from THRESHER.

But TRIESTE was not designed for search and recovery. It is in reality a slow, awkward, deep-sea elevator having little horizontal mobility, which greatly limits its area of coverage. Clearly, a new-generation deep-diving submersible must be perfected for this specialized work.

In April of last year, the Secretary of the Navy convened a group of prominent submarine officers, marine engineers, and oceanographers to prepare recommendations on what capabilities the Navy would require to locate, identify, rescue, and salvage objects of all sizes at any depth on the ocean's floor. In late May, the Secretary approved the recommendations of this group. Soon to be launched will be a program to advance our technology sufficiently to perform a variety of military missions in the deep ocean. The Special Projects Office will spearhead this effort;

its past accomplishments on the POLARIS project augurs well for the Navy's new deep-submergence program.

I would like to emphasize here that the vehicles and techniques presently under consideration by this group will not be developed primarily for oceanographic research. Certainly, the program will be of tremendous interest to the scientific community; in fact, we are depending in large measure on its support. But here again we are speaking of tools and purpose. Our main purpose in this respect is submarine rescue and salvage, and I think it would be unfortunate to confuse this purpose with oceanographic research.

On the other hand, I am confident that the technology resulting from the Navy's deep-submergence program will profoundly affect the development of structures, materials, and techniques needed to build the many tools of oceanographic research and ultimately those tools and engines needed for exploitation of the ocean's abundant living and mineral resources. I have in mind deep-diving submersibles to perform geological and geophysical exploration, to drill oil wells, and to mine minerals over the 71 percent of the earth's surface covered by ocean; tools to build underwater structures, such as tunnels, cables, and perhaps eventually villages beneath the sea; and deep diving submarines for tracking and observing commercially valuable fish, for fishing and aquaculture, and even for expanding our already flourishing sea-borne commerce.

Such predictions, no matter how fanciful they may seem today, will require expanded knowledge of the sea. This knowledge can be developed only through scientific research. The job is so big that vehicles needed for research must be designed and built for this specific purpose and no other.

The first such vehicle is ALVIN. With ALVIN we can greatly accelerate the exploration of the vast ocean depths. Nearly one half of the water volume of the ocean and neighboring seas will be accessible to the scientists who will use her. This area includes most of the life of the sea. ALVIN will be capable of exploring one-sixth of the ocean's bottom—an area almost equal to the surface of the moon.

ALVIN will help solve many of the practical problems long tolerated but never really accepted by the sea-going scientist. I understand there is a saying among biologists that towing a sampling net through the ocean is like running madly through an open field blindfolded holding a butterfly net above one's head. ALVIN will put the biologist where he belongs—in the center of the marine environment with his net and eyes open. Here he will be able to observe directly the concentrations and behavior of marine populations. The interaction of animal life and the environment can be studied throughout the water column.

Ideally, the marine geologist would like to do on the sea floor what he does on land—walk or fly over areas of interest, collect specimens, and

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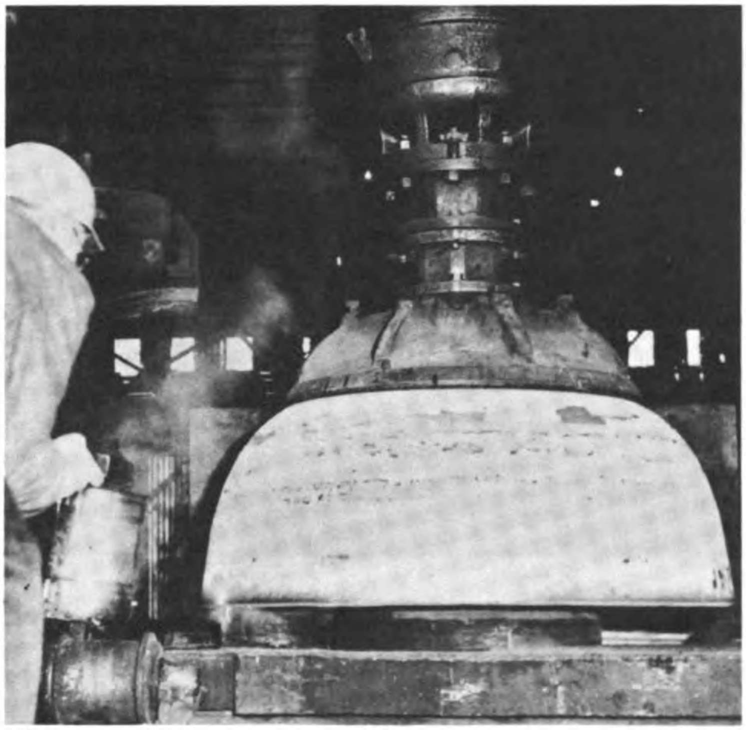
What Makes ALVIN Run

When the deep-submergence research vehicle ALVIN was commissioned at Woods Hole, Massachusetts, last June, one sixth of the ocean bottom—an area almost equal to that of the surface of the moon—was opened to exploration by man. The kinds of investigations ALVIN will make in that realm and the significance of those undertakings to the Navy, the scientific community, and the Nation are discussed by Assistant Secretary of the Navy (R&D) James H. Wakelin, Jr., in the preceding article. Described in the following paragraphs is the vehicle itself—its major features, instruments and equipment, method of operation, safety provisions, and the testing program, which is now underway.

The commissioning of ALVIN on June 5 marked the successful fulfillment of efforts on the part of many people in research laboratories, industry, and the Navy to provide marine scientists with a means of descending safely many thousands of feet into the ocean to view objects of interest first hand. The need for such a vehicle has been recognized for some time by the Navy, oceanographic institutions, and by other organizations. In 1962, therefore, the Office of Naval Research provided inspiration and funds for the design and construction of ALVIN for use by the Woods Hole Oceanographic Institution to facilitate its investigations, which are supported largely by ONR. The Bureau of Ships assisted in the preparation of performance specifications for ALVIN, and the Applied Sciences Division of Litton Industries (formerly the Electronics Division of General Mills, Inc.) designed and built the craft.

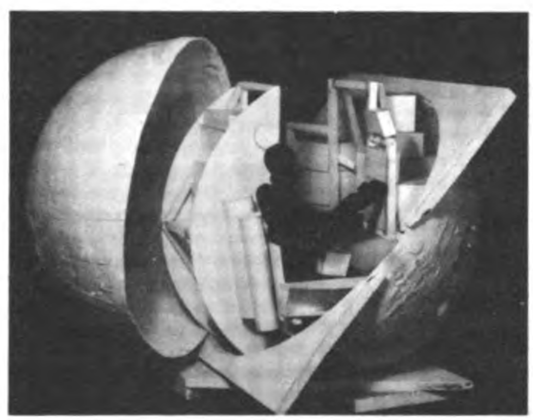
Major Features

ALVIN is 22 feet long, has an 8-foot beam, displaces 13 long tons, and has a draft of 8-1/2 feet when riding on the ocean surface. It has a top speed of about 8 knots, a cruising speed of 2.5 knots, and a range of 20-25 miles. ALVIN was designed to operate at a depth as great as 6,000 feet, with a safety factor of 1.8, although the personnel sphere has significantly greater depth capability. The pressure sphere, which is slightly less than seven feet in diameter, is made of HY 100 steel 1.33 inches thick. There is room in the sphere for a pilot and one observer and for instrumentation and life-support equipment sufficient to sustain the crew for 24 hours or more. Four viewing ports permit the pilot and observer to see ahead of and beneath the vehicle. The only openings in the hull are the hatch and an emergency sphere release; all other connections between the inside and outside of the sphere are electrical, with the wires passing through specially designed fittings. The power for the vehicle comes from three conventional lead-acid



One of the half spheres which make up the "heart" of ALVIN—the compartment which operator and scientist will occupy on ALVIN's deep dives—is shaped on a giant potter's wheel. Two heads welded together form a 6-foot, 10-inch cabin capable of withstanding pressures greater than 2700 pounds per square inch.

In this model of ALVIN's pressurized compartment, the two half spheres making up the compartment are opened to show positions of operator and equipment.



batteries located in external packages that may be dropped in an emergency.

The vessel is driven by three propellers, which are controlled by a "joy stick" inside the sphere. On each side of the craft is a small "lift" propeller that is rotatable so its thrust can be directed up or down, ahead or astern. A large propeller, located at the stern, can be turned from side-to-side to steer the vehicle in the same manner that an outboard motor is turned to steer a conventional small boat. The two lift propellers are separately reversible to provide increased maneuverability; the vehicle can turn on its own axis by reversing one and going ahead on the other. The propellers are driven by reversible hydraulic motors powered by hydraulic pumps which are powered by electric motors encased in oil. All of these components are located outside of the pressure sphere.

To control fore and aft angles of the vehicle, a mercury trim system has been installed. This system consists of two trim tanks, located near the bow and stern, which are normally half full of mercury and half full of oil. The tops and bottoms of the two tanks are connected with piping so that as oil is pumped from the top of one tank to the top of the other, mercury is forced from the bottom of the second tank into the bottom of the first tank. Thus, fore and aft trim angles as large as 30 degrees can be applied.

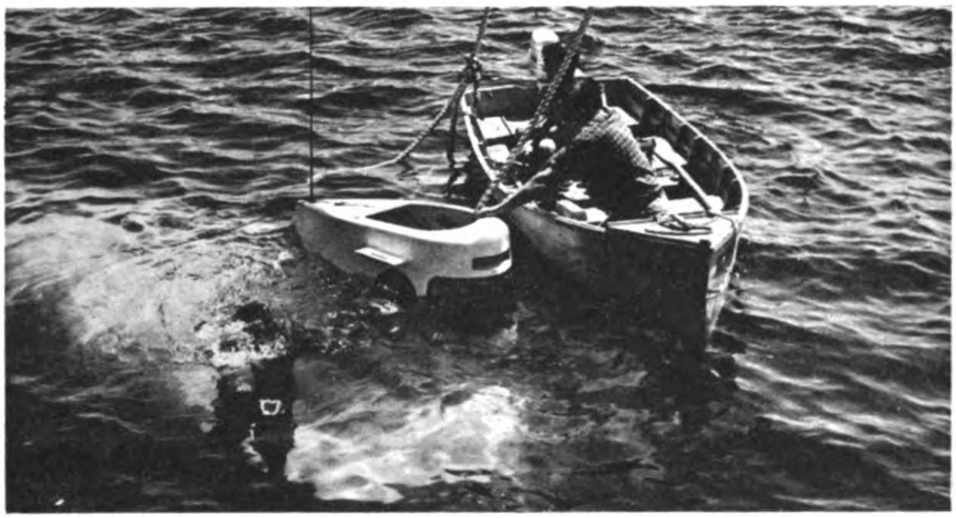
To compensate for differences in the weight of personnel and instruments and for changes in the density of sea water, a variable ballast system is included in the vehicle. This system utilizes interconnected pressure-proof aluminum spheres and collapsible rubber bags that are filled partly with oil. As oil is pumped from the spheres into the rubber bags, the amount of sea water actually displaced by the vehicle is increased (and thus the buoyancy is increased) while the weight of the vehicle remains the same. The effect is to make the vehicle "lighter." When oil is pumped from the collapsible bags into the spheres, the vessel becomes heavier. It is therefore possible, within the weight limitations of the system (about 600 pounds), to adjust the vehicle for neutral buoyancy throughout its operating-depth range. The craft also has an air system for blowing the main ballast tanks on the surface to provide freeboard and surface stability.

Instruments and Equipment

Instruments and equipment carried aboard ALVIN are used for the control and navigation of the vehicle and for scientific observations.

The control and navigation instruments are the gyro compass and gyro repeater, a back-up magnetic compass, battery voltmeters, ammeters, and ground detector; indicators for depth, speed, list, trim, and variable ballast; a doppler navigation system; and, to be installed in the future, a dead-reckoning tracer. An atmosphere-analyzing system that includes CO_2 and O_2 monitors as well as pressure, temperature, and humidity indicators has been installed also.

An up-and-down-looking echo sounder will give both height above the bottom and depth below the surface. To avoid obstacles, the pilot will not only keep watch at the viewing windows, but will also monitor a scanning sonar set and a closed-circuit TV system. A sonar telephone



ALVIN is operated on ocean surface during recent test.

system will provide voice or code communication with the mother ship, and a marine-band radio telephone will be available for communication when ALVIN is on the surface.

Scientific equipment placed aboard ALVIN for a particular dive will depend, of course, on the special interests of the scientist-observer. The vessel is designed to be versatile with respect to the weight, space, and power requirements of the portable scientific equipment, so that the needs of scientists working in different disciplines can be met. Remaining on the vehicle most of the time will be a remotely controlled mechanical arm and associated sample trays or jars, a precision graphic recorder for the echo-sounder system, underwater cameras and associated strobe and incandescent lights, tape recorders, a precision frequency source for conversion from direct current to 60- and 400-cycle alternating electrical power, and movie and still cameras.

Support Equipment

ALVIN has been designed to operate with a minimum of assistance from large vessels. It will require a mother vessel, however, to lift it out of the water and to provide facilities for charging the batteries and air flasks, for replenishment of the life-support system, and for long-range communications. A catamaran barge utilizing two Navy-surplus floats, each 96 feet long and displacing 400 tons, is being built for this purpose. The barge will have a platform which can be raised to lift the vehicle from the water, and it will have sufficient deck space to mount three portable vans. One of these vans will house diesel generator sets, electrical switchboards, and air compressors. The second van will contain a machine shop equipped with a lathe, drill press, grinder, welder, and miscellaneous tools, as well as spare parts. The third van will house an electrical and electronics repair and test shop; this van also will be used as a dark room and as the communications center. So equipped, the catamaran will not require the services of a large research vessel. Even towing to the operating area can be done by an ordinary tug.

Safety Provisions

Built into ALVIN are certain features which will enable the occupants to return safely to the surface in the event of an accident or malfunction. Each of the three batteries can be dropped to reduce the weight of the vehicle. The trim-system mercury can be jettisoned. The mechanical arm can be detached at the shoulder if it becomes hopelessly entangled. And as a last resort, the pressure sphere, itself, can be disconnected

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The Study of Nerve Conduction by Means of a Psychosis-Producing Drug *

Leo G. Abood

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University of Illinois College of Medicine

One of the unique characteristics of the nervous system is its extreme sensitivity to virtually every type of chemical compound. The capacity of a nerve cell to transfer, receive, and store information by way of physico-chemical events is dependent upon a precisely controlled balance of many of the cell's own chemical substances. Any disturbance of this chemical balance can modify neural function and, thereby, the behavior of the organism.

Among the many ways of disrupting this chemical balance is through the administration of chemical agents (drugs) which have been specifically designed to interfere with the action of certain functionally important chemical substances normally found within the cell. A useful technique for investigating these interfering substances is to prepare a compound that is only slightly different chemically from the natural agent to be inhibited. When this poison is administered, the body attempts to use it in some physiological process, which is then disrupted because of the chemical difference. One natural agent of interest in this connection is acetylcholine, which is an ester of acetic acid and an amino alcohol, choline. Acetylcholine is regarded as a chemical transmitter in the nervous system, since it facilitates the conduction of electrical impulses (messages) from nerve cell to nerve cell or from nerve cell to an effector organ.

The author and Dr. John H. Biel, also of the College of Medicine, University of Illinois, have synthesized a group of esters which were expected to enter the brain and to interfere with the action of acetylcholine.† The agents were found not only to interfere with the action of acetylcholine, but also to produce hallucinations, delirium, con-

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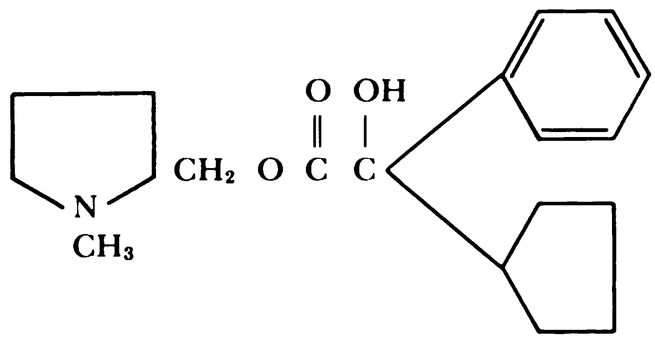
*The research described in this article received support from the Office of Naval Research.

†"Anticholinergic Psychotomimetic Agents," Int. Rev. of Neurobiology, Vol. 4, p. 217, 1962, L. G. Abood and J. H. Biel.

fusion, loss of memory, and a variety of other symptoms which resembled psychoses or schizophrenia; in other words, the agents were "psychotomimetic." Many hundred varieties of these agents were synthesized. An example is PMCG:



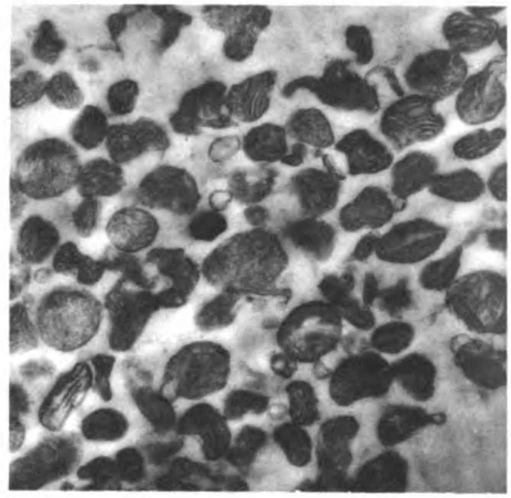
N-methyl-2-pyrrolidyl methyl cyclopentylphenyl glycolate

Like acetylcholine, it is an ester made up of an amino alcohol (pyrrolidyl methanol) and a glycollic acid. At a total dose of a few milligrams, PMCG will produce in man a psychotic state lasting for many hours, and at high doses (10 mg) the episode may be characterized by a complete loss of contact with reality and by hallucinations (visual, auditory, tactile, and olfactory) that may persist for days.

Much of our effort has been devoted to elucidating the mechanism of action of agents similar to PMCG; in particular we have focused our attention on the structural components of the nerve cell where the drug collects. Such studies require the use of radioactive PMCG as a tracer; they are made possible by the development of new techniques for isolating such subcellular components of nerve cells as mitochondria, synaptic nerve endings, myelin fragments, and other functionally discrete cytoplasmic elements (see Figures 1-3). It appears as if the major portion of the drug is bound to the mitochondria (Figure 1), which are the units of the cell involved in the production of ATP (adenosine triphosphate), a substance responsible for the generation of bioelectric phenomena in the nerve cell. Most of the remaining portion of PMCG is attached to the synapses (Figure 2) and fragments of the myelin sheath covering the nerves (Figure 3). Because PMCG associates readily with fatty substances, it was presumed that the agent was associated with the phospholipids, which contain fat and which are major constituents of mitochondria and nerve membranes of importance in the regulation of biological permeability and transport.

The most widely accepted theory of nerve conduction is the so-called Hodgkin-Huxley ionic hypothesis, which explains the transmission of nerve impulses by assuming a rapid, reversible change in the cell's

Figure 1—An electron micrograph of mitochondria isolated from rat brain. The mitochondria consist of an outer double membrane and an inner membrane, which is enfolded to give the striped appearance. The cellular enzymes responsible for oxidation and energy production are contained within these membranes. Both the organization of the enzymes and the structure of the membrane are dependent upon the high phospholipid content of the mitochondria. The mitochondria are from 1 to 3 micra in diameter.



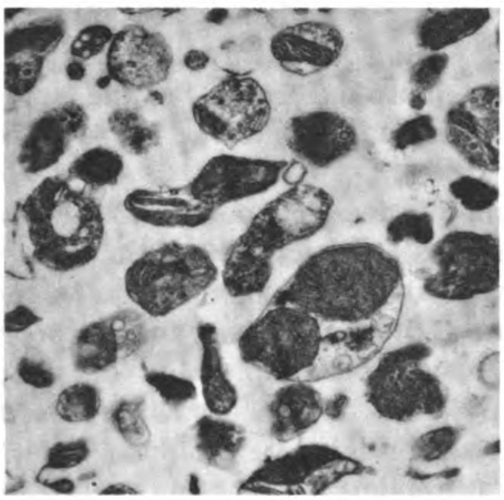
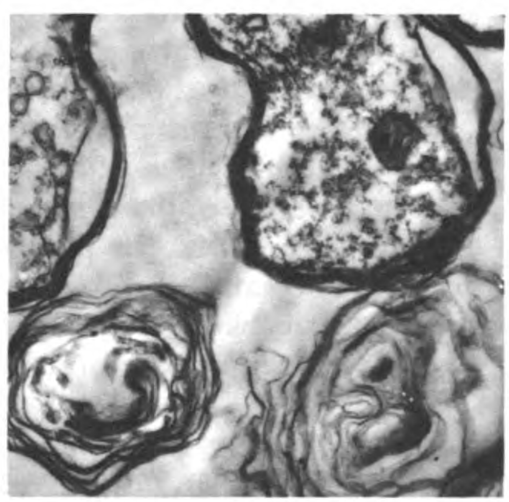


Figure 2—An electron micrograph of synapses, or nerve endings, isolated from rat brain. Occasionally an ending may contain a mitochondrion. The many small particles are called synaptic vesicles. Acetylcholine and other chemical transmitters are believed to be stored in the vesicles, where they are secreted during the passage of the nerve impulse. A single nerve cell may have many hundred synapses, each representing the terminations of another nerve cell.

Figure 3 — An electron micrograph of fragments of myelin and other fibrous substances (axons and dendrites). Myelin is a protective membrane surrounding the fiber of many cells. It is comprised largely of phospholipids and cholesterol.



permeability to external sodium ions; this change occurs continually along the length of the nerve fiber. One of the substances believed to be involved in the initiation of the impulse is calcium (Ca^{2+}), which may be responsible for the maintenance of a permeability barrier to sodium when the nerve cell is in the "resting" state. A temporary, reversible displacement of Ca^{2+} from its bound site—a process which may be initiated by an electrical charge gradient—might leave the membrane "pores" unprotected, permitting the entry of sodium down a very large electrochemical gradient.

A better understanding of the role of Ca^{2+} in regulating membrane permeability can be gained by studying its action on simpler physicochemical systems which may serve as models for the nerve membrane. One such system makes use of an interfacial or surface monomolecular film, which is formed by spreading a known amount of a lipid (in benzene) on the surface of an aqueous solution. Among the physical properties of such films which can be measured quantitatively are surface pressure, surface tension, surface viscosity, and surface potential. When a divalent cation, such as Ca^{2+}, is introduced into the aqueous solution, it combines rapidly with the phosphate groups of the phospholipid molecules in the surface layer and pulls them together to make a tighter, more impenetrable film.

Ca^{2+} and PMCG can interact with an interfacial monolayer as follows: The individual molecules of lecithin or stearic acid orient themselves at the interface in an array with some degree of parallelism. In the presence of Ca^{2+}, which can combine with two adjacent anionic polar groups, the film is more condensed, less permeable, and the lipid molecules tend to become parallel. When either Na^+ or K^+ is present alone, only a monomeric unit can form; bridging of the polar groups does not occur, hence there is less tendency towards parallelism. An agent such as PMCG, which possesses two highly lipophilic heterocyclic groups (phenyl and cyclopentyl) and a strong cationic group (N), will interact with the lipid monolayer in the same manner. The kinds of molecular forces involved are (1) electrostatic attraction between N and polar groups of the lipid, (2) hydrogen bonding, and (3) van der Waal attraction* between the long chain residue of the fatty acid and the heterocyclic groups of PMCG. The net result of these forces is the formation of a surface film having characteristics similar to those observed in the presence of Ca^{2+}.

By interaction with the phospholipid matrix of the excitatory membrane, PMCG can alter the permeability characteristics of the membrane and, hence, its bioelectric properties. For example, it can be shown that when an isolated frog sartorius muscle is immersed in a bathing solution

As a result of the various arrangements of atomic nuclei and electrons with molecules, there occur cohesive electrical forces (van der Waal) tending to pull molecules together.

devoid of Ca^{2+}, its resting bioelectric potential begins to decrease, and the muscle behaves as if it were being stimulated. Presumably, the membrane structure becomes less organized, or looser, so that the external Na^+ penetrates more readily. The potential can, however, be restored by the addition of either a small amount of Ca^{2+} or PMCG, and in this respect the two substances are similar in their action.

If we now consider that the bioelectric properties of a nerve cell are regulated by a displacement and recombination of Ca^{2+} at the cellular surface, or membrane, it is possible to understand how an agent which simulates the action of Ca^{2+} can affect the cell. The central nervous system is extremely complex and contains millions of groups of cells which vary considerably in their dependence upon Ca^{2+} and, consequently, in their sensitivity to the psychotomimetic agent, PMCG. It is likely that PMCG acts only in certain regions of the brain to induce a psychotic-like state, yet its presence can be detected in virtually every part of the brain when it is administered to an animal. Perhaps, PMCG acts first and most effectively in those areas of the brain which are particularly responsive to Ca^{2+}.

This explanation of how PMCG can act upon the nervous system is oversimplified, but may be assumed to be correct. However, it is probable that other mechanisms are involved. Earlier it was mentioned that acetylcholine acts as a chemical transmitter in the nervous system and that it is related to PMCG. Instead of acting like acetylcholine, however, PMCG actually prevents the action of the transmitter by competing for its receptor or active site. Undoubtedly, at least some of the bizarre effects of PMCG upon the brain can be explained on the basis of the "anticholinergic" property of PMCG; but, our knowledge of the role of acetylcholine as well as other chemical transmitters upon brain function is extremely obscure.

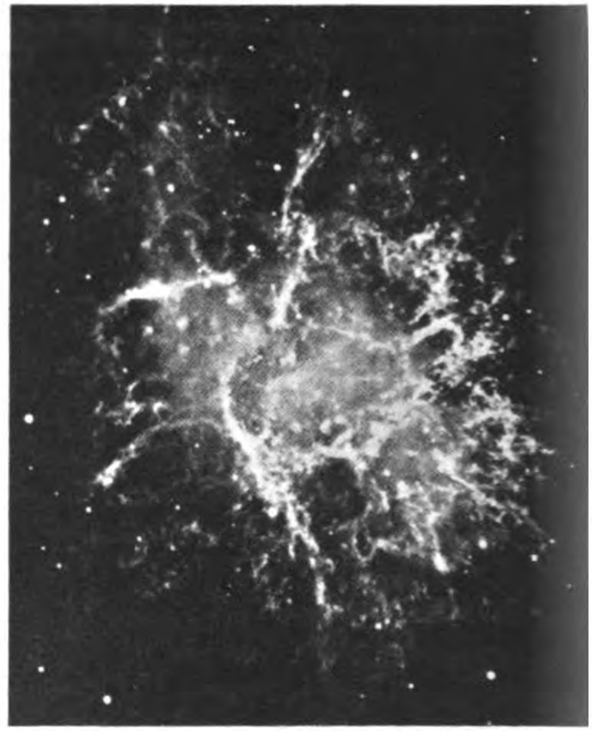
Studies of this kind not only lead to an understanding of the mechanism of drug action, but, what is more important, aid in the understanding of the basic processes of nerve conduction. Measurements of bioelectric phenomena made by sensitive electronic instruments are a reflection of a complex array of physico-chemical events involving ion movements and rearrangements of complex macromolecules. By determining how and with what macromolecules of the excitatory apparatus a pharmacological agent interacts and by relating this information with the attendant physico-chemical and bioelectric phenomena, we have an additional, powerful tool for probing into the most complex of biological systems.

A symposium concerning the application of microcircuits to very large computing systems ("Microelectronics and Large Systems") will be held November 17 and 18, 1964, in the auditorium of the Department of the Interior Building, Washington, D.C. It will be co-sponsored by the Office of Naval Research and the Univac Division of Sperry Rand Corporation.

X-Ray Emission from the Crab Nebula

A Diffuse Source is Observed

S. Bowyer
E. T. Byram
T. A. Chubb
H. Friedman
E. O. Hulburt Center for Space Research Naval Research Laboratory



Photograph of the Crab Nebula.

The February 1964 issue of NAVAL RESEARCH REVIEWS *included an article entitled "The X-Ray Sources in Scorpius and the Crab Nebula," which was based on a study of data obtained from x-ray detectors carried above the atmosphere by rockets. In the article, the authors, who are listed above, indicated that the x-ray sources could be neutron stars – the highly compressed cores that may remain after the explosion of the outer portions of supernovae. Another rocket flight, made last July 7, coincident with the lunar occultation of the Crab Nebula, has provided more data on which to base a definition of one of the x-ray sources. A discussion of the new information in terms of neutron stars is given in the following article.*

On July 7 at 3:42 in the afternoon, an Aerobee rocket was launched from the Naval Missile Test Facility of the White Sands Missile Range to observe the lunar occultation of x-ray emission from the Crab Nebula. The experiment was a follow-up of measurements made a little more than a year ago that revealed two unexpectedly strong sources of x-ray emission in the galaxy – one located in the Scorpius region and the other centered on the Crab Nebula. Because of the strength of these emissions and because no visible object or radio source could be identified in the source regions (characteristics which are in accord with neutron-star theory), the authors proposed that both x-ray sources could be neutron stars.

A lunar eclipse of the Crab Nebula occurs approximately every nine years. The eclipse of July 7 covered the nebula at the rate of 1/2 minute of arc per 1 minute of time. Since the nebula measures 6 minutes of arc in diameter, to observe a full eclipse of the nebula would require 12 minutes of rocket x-ray measurements above the atmosphere. The Aerobee rocket affords only 5 minutes of time above 100 km. The timing of the experiment, therefore, was adjusted to observe the eclipse of a central portion of the nebula with a diameter of about 3 minutes of arc. The rocket was equipped with a stabilization system to orient the x-ray telescopes toward the Crab and maintain their positions steady during the course of the occultation. If a neutron star existed in the center of the Crab, an abrupt disappearance of x-rays, within a fraction of a second of time, would occur upon occultation. A gradual disappearance of x-ray emission would negate the neutron-star theory for the Crab and would indicate an extended cloud source of x-rays.

The Aerobee launch was accomplished on schedule, exactly as planned. The stabilization system* and all of the associated measurement instrumentation worked perfectly.

As the central region of the nebula was occulted, a slow decrease in x-ray emission was observed. The width of the x-ray source was about 1 minute of arc, which is roughly 1 light year at the distance of the Crab. The spectrum of the x-ray emission is of the type that would be associated with an extremely hot cloud of gas – one having a temperature in excess of 10-million degrees. Various possible explanations for the origin of this cloud can be offered. It is possible, for example, that during the stellar explosion that occurred 900 years ago, not only did the outer layers of the star explode to form the visible nebular shell of the Crab, but the core itself exploded, filling the inner region with a super-hot gas. A second possibility is that radioactive products of the original explosion, with half-lives of several hundred years, are still supplying heat to the cloud. Still another hypothesis is that a shock wave emanates from the explosion point and that x-rays are emitted from the heated interstellar gas behind the shock. More refined spectral tests, expected to be made in the future, should help to confirm or negate these hypotheses.

The Crab Nebula

On the 4th of July, 1054 A. D., a spectacular new star appeared in the constellation of Taurus the Bull. An entry in the records of the Royal Observatory of Peking described its brightness as comparable to that of Venus. For 23 days it could be seen in daylight, and it remained visible at night for more than a year. No western astronomer seems to have observed it and, in fact, no similar supernova was observed

*The gyro-referenced jet-controlled Aerobee stabilizer (ACS) was developed by Space General Corporation under a NASA contract. The Naval Research Laboratory is indebted to NASA for the release of one of its ACS units for this experiment.

until 1572, when Tycho Brahe noted an explosion in the constellation Cassiopeia. Only 32 years later, in 1604, another supernova was discovered by Kepler, but since then none has been seen in the Milky Way galaxy.

At the present time, in the position recorded by the Chinese, there is an object known as the Crab Nebula, a luminous mass of tangled gaseous filaments with a quasi-elliptical shape, about 6 light years across the major axis and 4 light years across the minor axis. Comparison of old and recent photographs show that the nebula is expanding at the rate of 700 miles per second. Dividing its maximum diameter by the rate of expansion, we find that the object has been expanding from a central point for about 900 years. There can be little doubt that the Crab Nebula is the debris of the stellar explosion seen by the Chinese in 1054 A. D.

The Crab is about 5000 light years distant from us. From the Chinese description, its maximum brightness must have equalled that of all the stars in the Milky Way.

Even though supernovae appear very rarely in the Milky Way galaxy, there are many other galaxies to watch that are not too distant to reveal supernovae. In 1885 a new star appeared in Andromeda, our nearest neighbor galaxy. Astronomers Baade and Zwicky, during the past quarter century, organized systematic searches of several hundred nearby galaxies and discovered more than 50 supernovae. Present estimates indicate that they occur on an average of about 1 every hundred years per galaxy.

Types of Supernovae

Supernovae appear to fit into two broad classifications – type I and type II. The three supernovae observed visually in our own galaxy belong to type I, which comprises the brightest supernovae – those reaching absolute magnitudes of −18 or −19. After 100 days, the luminosity of type I supernovae decreases by about 4 magnitudes and then decays further exponentially. The "half-life" of the luminosity during the exponential decay is roughly 40 to 100 days. The gaseous envelope may contain about 1/10 of a solar mass and is ejected at a velocity of 1000 – 2000 km/sec. Hydrogen is scarce in the shell. Supernovae of type I are found primarily in populations of old stars. Type II supernovae are rich in hydrogen. They occur predominantly in the arms of spiral galaxies, where new stars are formed. The mass of exploding material is several tens of solar masses, and the expansion velocity is of the order of 5000 km/sec. Supernovae of type II are not as bright as those of type I, probably because most of their energy is released in the far ultraviolet.

Joseph Nemecek, right, chief designer of the delicate counter system utilized on July 7 to measure the x-ray emission from the Crab Nebula, checks the cover doors of the instrument package with Dr. Friedman. The instrument package was carried by rocket to an altitude of almost 144 miles.

Dr. Herbert Friedman, Superintendent of the Naval Research Laboratory's Atmosphere and Astrophysics Division, examines the honeycomb-like grids used to narrow the field of view of rocket-borne x-ray counters. In this photograph the protective doors are removed.

In both types of supernovae, the explosion energy is supplied by the fusion of nuclear fuel. There are two possible routes to explosion: (1) the explosion of unstable nuclear fuels when the temperature rises beyond the critical threshold; and (2) implosion of the core accompanied by explosion of the outer shell. The first type of explosion may be characteristic of type I supernovae. It fits the theoretical model of stars whose masses are slightly greater than the solar mass. When the explosion occurs, it may shatter the entire star. The implosion-explosion model is appropriate to very massive stars, of the order of 30 times the solar mass. Most of the mass explodes, but a core of one or two solar masses may remain compressed as a neutron star.

The exponential drop in the light curve of the type I supernova has been attributed to the decaying energy supplied by the spontaneous fission of Cf254, which has a half-life of 55 days. For the radioactive source to be adequate to supply the energy during the exponential decay, about 5×10^{-5} solar masses of Cf254 would have to be produced in the flare-up. That this build-up is possible was demonstrated in the first hydrogen bomb explosion of November 1952, in which Cf254 was produced by the capture of 16 neutrons in uranium 238 within only microseconds of time.

The x-ray intensity now being observed from the Crab is about 10^{36} ergs/sec. Estimates of the radioactive energy release 1000 years after the explosion are about 10^{37} ergs/sec. It appears that sufficient radioactive energy may be present to maintain the high temperature of the gas cloud from which the x-rays emanate.

It is surprising that the kinetic energy content of the Crab Nebula today is still about 10^{48} ergs, as compared to 10^{51} ergs, which was released in the original explosion. At this slow rate of loss of energy, the original hot gas of the exploding star may still be preserved in the inner region of the nebula. The temperature of this region may still be well above the 10 million degrees required to explain the x-ray spectrum.

The Nature of the Scorpius X-Ray Source

The absence of a neutron star in the Crab does not preclude the possibility that the Scorpius source is a neutron star. The Scorpius region is rich in B-type stars, which characterize the vicinities of type II supernovae. Unfortunately, a lunar occultation of the Scorpius source will not occur for at least another 10 years. It is possible, however, to design a mechanical occultation device for a rocket that can define an upper limit to the source diameter, of about 1/10 of a minute of arc, which is at least 10 times smaller than the x-ray source in the Crab. If the diameter of the Scorpius source is found to be less than

10 times that of the Crab, it would not be positive proof of an x-ray star but would certainly favor the neutron-star hypothesis. An attempt to perform this experiment will be made next winter.

ALVIN's World – Continued from page 3
study and map significant features and phenomena. ALVIN is the first step toward eliminating present blind, hit-or-miss methods of bottom sampling. The geologist, instead of groping awkwardly from a rolling platform thousands of feet above his rock dredge or poking random holes in the ocean floor, will finally be able to make discriminating, personal observations. Samples can be collected with ALVIN's mechanical arm, and photographs can be taken with its cameras.

The vessel also promises to be of great value in physical oceanography. The speed and direction of undersea currents can be measured more accurately. As ALVIN drifts slowly downward through the water column or uses its propellers for vertical movement, scientists can obtain continuous profiles of temperature, salinity, and other water characteristics. Other potential uses of ALVIN, some of which cannot now be anticipated, will be made as this research tool extends the eyes and ears of oceanographers to the unexplored regions of the ocean's deep frontier.

ALVIN and the deep-diving research vehicles that will undoubtedly follow her promise sufficiently exciting dividends that I have requested the Interagency Committee on Oceanography, of which I have been privileged to be chairman for the past five years, to prepare a plan that will allow our member agencies to apply this unique tool to problems important to national security and welfare. I believe our optimism is well founded. Future development and wider use of the deep-diving research vehicle will depend in large measure on operational experience and research results. ALVIN, as a new research tool, is expected to play a major role in providing this essential experience while advancing the science of the sea.

As we inaugurate this great new adventure into the realm of the unknown beneath the sea, we should recognize especially the imaginative planning and determined efforts of the several organizations that have turned ALVIN from a concept into a reality. The Office of Naval Research, Woods Hole, the Bureau of Ships, and Litton Industries and its several subcontractors all have made some vital contribution.

To all of the men who have helped plan, design, and construct ALVIN, we can say that you have done your job magnificently. To the men who will operate this pioneer submarine and conduct its research program, we wish you well and note with a touch of envy the exciting challenges that await you in the ocean's deep frontier.

The Solion - A Liquid-State Device

Joseph L. Collins

Defense Research Laboratory
The University of Texas

The name "solion" is a contraction of the phrase "solution of ions." It refers to a class of liquid-state electrochemical devices which can be used as signal-processing systems and transducers. Not only are they quite versatile, but they have the advantage of an indefinite life expectancy, since the chemicals used are regenerated.

The solion electrochemical system is similar to an electrolysis system; that is, it contains a soluble chemical which can exist in two different oxidation states. Usually the solion consists of iodine and potassium iodide, dissolved in water, and platinum electrodes. According to a relationship discovered by Walter Nernst, the relative amounts of I_2 and I^- (said to be in the 0 and -1 oxidation states, respectively) depend on the voltage applied to the system. If the voltage is changed, electrons are transferred between I_2 and I^- by a complex process, so that the ratio of the new concentrations satisfies a well-known equation. It is the movement of these ions that produces an electric current. Let us now examine the process of current generation in greater detail.

Consider the electrochemical diode, as in Figure 1. A pair of inert metallic electrodes is immersed in an electrolyte solution, and a variable-voltage battery, used as a power source, is connected as shown. Before the voltage is turned on, the I_2 and I^- ions are in a state of equilibrium. As the battery voltage is increased, however, the I^- ions travel to the anode and give off electrons; that is, they are oxidized. This process produces the current measured in the external circuit. The circuit is completed by transferring electrons to the reduced ion at the cathode.

On first inspection, this system would seem to require that a game of "musical chairs" be played among the electrons and the different charge carriers in solution. To understand how useful applications can be made from it, it is necessary to understand the three different forces causing ions to move in solution. The first process is migration, which we have just discussed; it is produced by the electrical potentials at the electrodes. The second is diffusion. Since a chemical reaction is taking place, there is a concentration gradient between the layer of solution just around the electrode and the bulk of the solution. Hence, in just the electrode region, there is a movement of ions from the regions of high concentration to the region of low

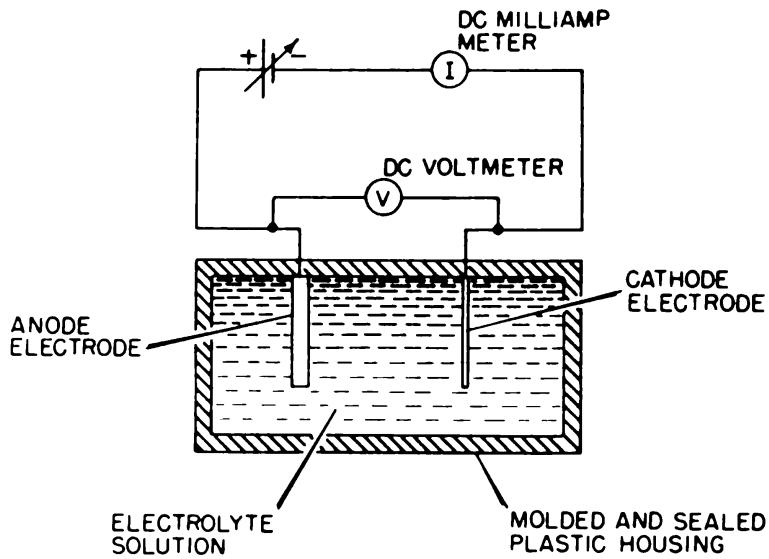


Figure 1 — Schematic of a simple solion diode.

concentration. The last process can be called convection; it includes such external factors as temperature changes, shocks, and stirring which cause the ions to move. The current which is produced by any given voltage depends on these factors. In general, as the voltage is increased, there is at first a short lag representing the initiation of electrolysis. Then the current starts to increase linearly with voltage; this part of the current-voltage curve is said to obey Ohm's Law. Finally, between 0.1v and 0.9v in the iodine system, the current becomes constant and independent of voltage. This steady-state is due to the fact that the rate of electolysis is limited by the rate of migration and the even slower rate of diffusion. We say that the cell is now "saturated." As long as fresh ions are not forced into the electrode regions, the "background" current will not change. But, as we pointed out above, the process of convection also influences the current. The problem is to utilize the "modulating" effects of temperature and/or flow of the solution to design applications for the solion.

Of the numerous applications that have been made of the solion, the most important is as an infrasonic pressure transducer. One design, such as that shown in Figure 2, is used as a flow detector. In this device the volume within the cell is filled with electrolyte. If the cathode electrodes are porous, fluid flow between the two chambers can be produced by applying a net differential pressure between the plastic diaphragms. Hence, this application makes use of the modulating effects of mechanical fluid flow, rather than temperature change. The output signal, which is derived across the load resistors,

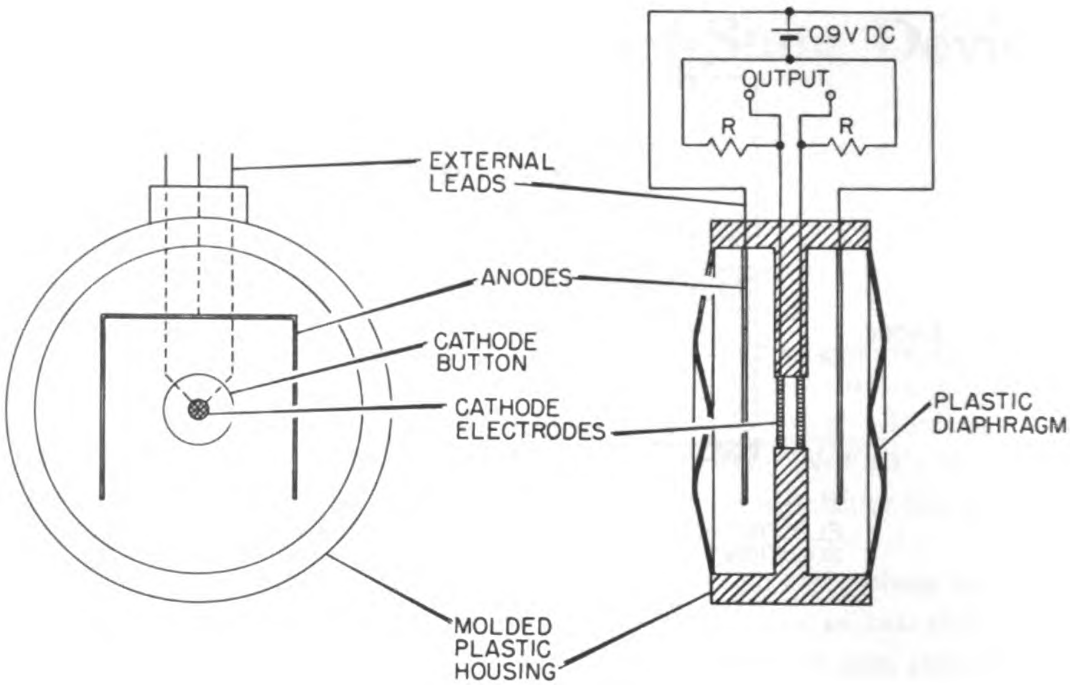


Figure 2 – Schematic of a solion flow detector.

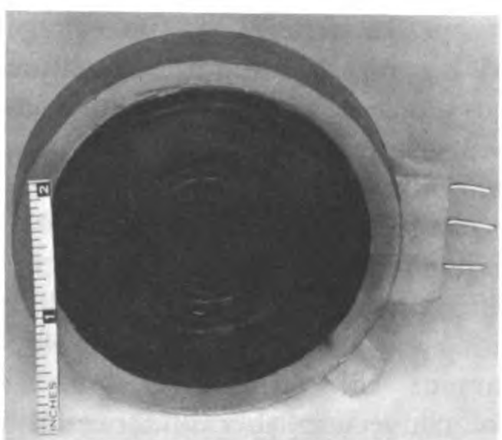
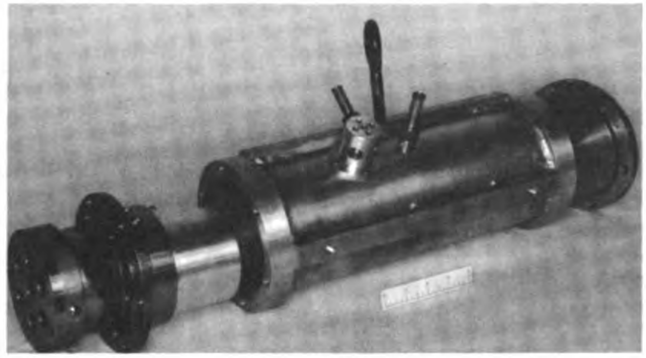


Figure 3 – A solion flow detector.

"R," is a voltage which is proportional to the applied pressure. Figure 3 is a photograph of the actual solion flow detector.

Transducers of design similar to that shown in Figure 2 have been used as oceanographic instruments for measuring sea and swell pressure effects on the ocean bottom. An instrument of this type is shown in Figure 4. The hydrophone and its case are placed on the sea bottom and the signal is transmitted to shore or ship by an electrical cable. One advantage to this system is that electronics are not required.

Figure 4 – The pig – an oceanographic instrument designed to measure sea and swell pressure noise.



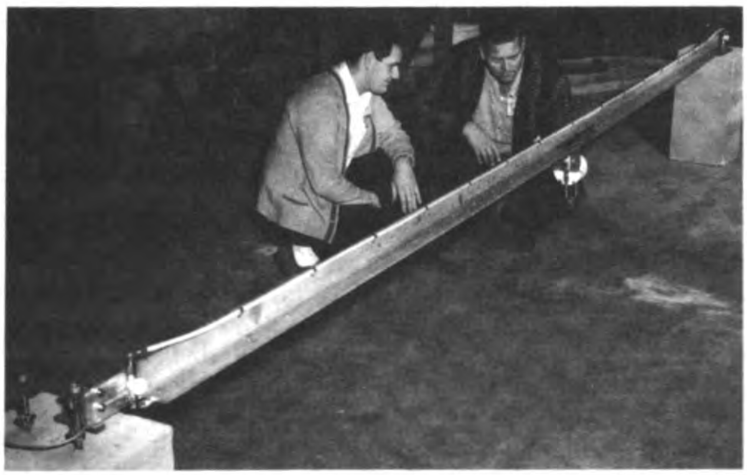


Figure 5 – A solion horizontal-component seismometer.

The soloin flow detector has also been used as an ultra-sensitive microbarograph for the measurement of small changes of barometric pressure. At present this device is being applied to study the ambient low-frequency atmospheric background noise produced by weather as well as by man-made devices.

In another application, the solion flow detector serves as a seismometer. The basic design of a horizontal-component solion seismograph is shown in Figure 5. The rigid beam supports a horizontal plastic tube which is filled with fluid and coupled hydraulically to the solion transducer. Any horizontal motion along the length of the beam produces fluid flow through the solion and, therefore, an output signal proportional to the ground motion. A high sensitivity coupled with stability at low frequencies has been achieved.

All of the devices illustrated are applicable to the basic field of geophysics, where the solion transducer is best suited for the lower frequencies associated with geophysical phenomena. Other solions have been designed to operate at much higher frequencies, but in general not above about 30 kc. Their low-frequency response extends into the thousands-of-seconds-per-cycle periods.

The characteristics of the solion might be summarized as follows:

1. Very low power consumption – operated from a 0.9v battery.
2. Excellent remote operating features.
3. Extreme sensitivity as a flow detector.
4. Responds well to very low frequency signals.
5. Good stability and reliability characteristics.
6. All parts constructed for rugged use, except the diaphragm, which is susceptible to puncture.

The research leading to the development of the solions described here was sponsored by the Bureau of Naval Weapons and the Office of Naval Research.

What Makes ALVIN Run – Continued from page 8

from the rest of the vehicle; it is positively buoyant and therefore will rise to the surface.

In case a fire breaks out in the sphere and produces noxious fumes, or if the occupants must escape the vessel in relatively shallow water, self-contained underwater breathing gear (SCUBA) is stored for each occupant. Chemical fire extinguishers are carried also.

Testing Program

All of the vessel's components that will be subjected to sea pressure have been tested in pressure chambers to well below the design operating depth of 6,000 feet (2,750 pounds per square inch). These components include the pressure sphere and its windows, electrical penetrators, hatch, and release mechanism; the aluminum spheres required for additional buoyancy and for the variable ballast system; the plastic buoyancy material required for additional lift; and other containers subject to sea pressure. The electrical motors, batteries, switches, pumps, hydraulic motors, and valves, all of which are oil-compensated to ambient sea pressure, have been operated in a test tank at 5,000 pounds per square inch (equivalent to an ocean depth of about 11,000 feet).

A thorough check of all systems was made before ALVIN was first placed in the water, late in June. During these initial sea trials, ALVIN made a successful manned surface run and shallow dive. As the trials continue, at greater depths, the systems will continue to be checked. At the same time, pilots will be trained to handle the vessel under all conditions expected to be encountered.

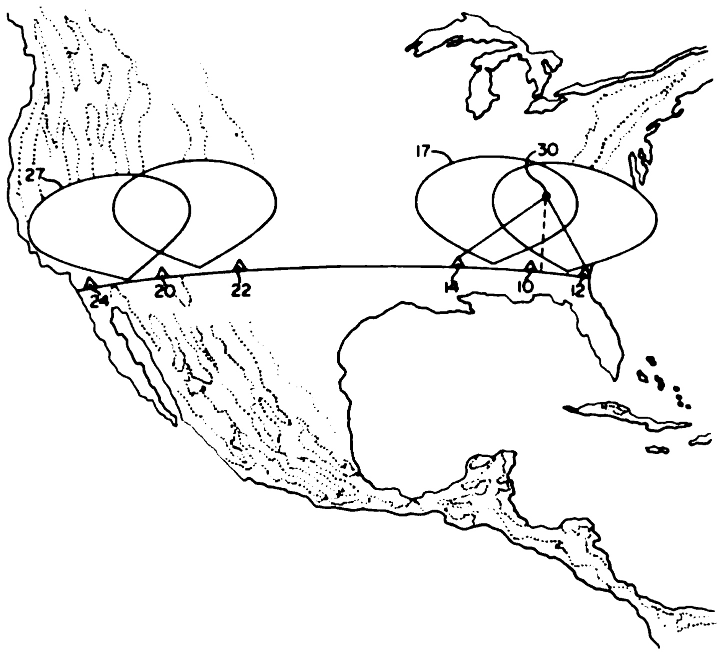
The testing and training will culminate late this summer in dives to ALVIN'S design depth of 6,000 feet.

INVENTIONS

Satellite Detection

A significant Navy inventive contribution to the Nation's space and air-defense programs is covered in a patent issued recently to Roger L. Easton of the Naval Research Laboratory. It is a system for detecting passive satellites and determining their orbital parameters. From a rather modest beginning, the system has become an important part of the North American Air Defense Command's Space Detection and Tracking Network.

Basically, the problem overcome by the invention is the detection of fast-moving objects of small size at distances ranging from 90 to 20,000 miles. The satellite locations are pinpointed by a network of integrated transmitting and receiving antennas erected at sites spanning the United States. The radio beams transmitted by each station are fan shaped, creating a fence of electromagnetic energy in space. When



Pictorial illustration of the space surveillance system, showing the general arrangement of the transmitting and receiving sites. Numbers 10 and 20 represent transmitting stations, and numbers 12, 14, 22, and 24, receiving stations. As the satellite, 30, repeatedly crosses the fence, 17 or 27, in successive revolutions, the computer accumulates these observations and continually refines the orbital elements stored in the computer memory.

energy reflected from a satellite is detected at one or more receiving stations, interferometer techniques are applied to determine the angles of arrival of the reflected signals. From these data and from calculations made by triangulation, the satellite's position is ascertained. These data then are fed to a computer, which compares them with the orbital data on satellites detected earlier to determine whether the object has appeared previously in space or is a new satellite.

The patent, No. 3,122,741, entitled "Device for Detecting Objects in Space," was issued on February 25, 1964.

Thermonuclear Power Generation

Also among the patents issued recently to scientists who have made inventions while working at the Naval Research Laboratory are those covering two concepts of Dr. Willard H. Bennett, a former employee of NRL. One of these inventions is entitled "Device for Thermonuclear Generation of Power," Patent No. 3,120,475, which was issued on February 4, 1964.

In some respects, the configuration of this invention resembles the "Störmertron," which Dr. Bennett utilized to demonstrate phenomena associated with magnetic storms. The device comprises an evacuated spherical or oblate chamber of insulating material that is capable of withstanding high temperatures. One electrode extends over the inner surface of the chamber, and the additional electrodes are located in conically shaped end housings at the outer extremities of the longitudinal axis of the chamber. The chamber is positioned between the pole pieces of a magnet so that the lines of force are symmetrical with the longitudinal axis of the chamber. Ions within the chamber are curved into orbits about the magnetic lines of force and are mixed with electrons near the longitudinal axis. Thermonuclear power is generated by ion collisions, the reaction being sustained by the electrodes at the ends of the chamber, which force the ions and electrons back into the chamber.

Re-Entry Simulation

The second patent issued recently in Dr. Bennett's name is No. 3,121,329, entitled "Simulation of Re-Entry Conditions." The apparatus provided by this invention produces streams of ionized gas at speeds traveled by orbiting satellites. Re-entry experiments are performed within an evacuated space simulating environmental conditions of the upper atmosphere and outer space.

Continued on back cover (inside)

On the Naval Research Reserve

Office of Naval Research Seminar

The Sixteenth Annual Naval Reserve Research Seminar, sponsored jointly by the Office of Naval Research and Naval Reserve Research Company 5-8, convened on June 8, 1964, in Washington, D.C. In attendance were 77 Navy, 23 Army, and 6 Air Force Reserve officers. The objectives of the seminar were to inform these officers of recent developments in the Navy, to cover as much as possible of current research being conducted by the Navy, and to encourage them to apply their knowledge to the solution of future Navy problems.

The seminar program was under the general direction of CDR F. H. Langdon, USNR, Training Officer, ONR. CAPT James R. Patton, Jr., USNR, a member of NRRC 5-8, served as seminar chairman.

Following the check-in, RADM L.D. Coates, USN, Chief of Naval Research, welcomed the attendees and gave a most informative talk on Naval research. Other opening-day speakers were RADM Noel Gayler, USN, Director, Development Programs Division, Office of the Chief of Naval Operations, who spoke on "Research and Development Concepts in OPNAV"; Dr. Chalmers W. Sherwin, Deputy Director of Defense Research and Engineering (Research and Technology), who discussed "Research and Development Management in DOD"; and RADM W. I. Martin, USN, Assistant Chief of Naval Operations (Air), who gave a presentation on "Sea-Based Tactical Air."

During the remainder of the first week a number of other outstanding speakers from the Office of Naval Material, OPNAV, ONR, and BUWEPS briefed the Reserve officers. Also, at the annual seminar luncheon, which was held at the Arlington Hall Station Officers' Club, RADM H. S. Monroe, USN, Assistant Chief of Naval Operations (Naval Reserve), gave a very interesting talk on the history and value of a strong Naval Reserve.

The technical sessions, held during the second half of the seminar, covered research in information systems, environmental sciences, psychological sciences, and air programs. ONR "chairmen for the day" were Mr. Richard Wilcox, Head, Information Systems Branch; Miss Evelyn L. Pruitt, Head, Geography Branch; Dr. James W. Miller, Head, Engineering Psychology Branch; and CAPT C. W. Griffing, USN, Director, Air Programs. The presentations were uniformly excellent and were followed by stimulating question periods.

The two field trips conducted during the seminar – to the Goddard Space Flight Center of the National Aeronautics and Space Administration during the first week and to the Naval Research Laboratory during the second week – were thoroughly enjoyed by the participants. The tour of NRL received many commendatory comments for the fine program briefs that were presented and for the interesting facilities that were shown.

On the final day, separate sessions were held for the Navy and for the Army in order to brief the officers on the current status and plans for the future of the Reserve component in each service. The seminar concluded with a talk by Dr. Paul Conroy, Chief of Professional Training, U.S. Information Agency, Department of State, on the subject "Soviet Impressions of American Life."

Thirteenth Annual Training Device Seminar

The Thirteenth Annual Research Reserve Training Device Seminar was conducted at the U.S. Naval Air Station, New York, by personnel from the U.S. Naval Training Device Center, Port Washington, from May 25 to June 5, 1964. The general theme of the seminar was "Recent Technological Developments and Their Application to the Training Device Program."

The attending officers were welcomed to the seminar by CAPT C. O. Holmquist, USN, Commanding Officer and Director of NTDC, and CAPT J. J. Hinman III, USN, Commanding Officer, Naval Air Station, New York.

The opening address, on the role of research, was given by the Chief of Naval Research, RADM L. D. Coates, USN. Political and economic aspects of the current world situation were presented by Mr. George A. Beebe, Director, Institute for International Order, New York City. Military aspects of the present world situation were discussed by MAJ J. W. Seigle, USA, Department of Social Sciences, U. S. Military Academy, West Point. Following these talks, the role of the modern Navy with respect to its operational, equipment, personnel, and training problems and its required applied research and development were discussed by CAPT E. A. Parker, USN, Assistant Director of Progress Analysis, Office of the Chief of Naval Operations. Surface and subsurface operational problems were stressed by CAPT J. H. Carmichael, USN, Acting Director, Fleet Operations Division, CNO, and CDR John C. Fry, USN, Oceanographic Division, CNO; and aerospace problem areas were discussed by CDR R. J. Dunn, USN, Air Training Support Branch, CNO, and CDR W. S. Houston, USN, of the Office of Naval Weather Service. Dr. Willie Ley, author and spaceflight consultant, presented an extremely interesting discussion of theoretical problems of the space age.

Equipment, personnel, and weapons needed to meet the latest operational problems were discussed by CAPT D.G. Dockum, USN, Director of Undersea Warfare Development Division, CNO; CAPT O.F. Ramsey, USNR, Assistant Director, Research, Development, Testing and Experimentation Administrative Division, Bureau of Naval Weapons and CDR G. N. Wolfe, USN, of the Bureau of Naval Personnel.

In response to the training problem areas outlined, emphasis was given by NTDC speakers to training research, analysis, and investigation of new training techniques, in addition to direct response for specific training devices that meet the current and future needs in antisubmarine warfare, strike and air-defense missiles, computers, and various aspects of both sea and land weapon systems.

In addition to the technical topics of the seminar, the effects of leadership and moral guidance programs on Navy personnel strength and training were discussed by CAPT J. E. Godfrey, USN, of the Bureau of Naval Personnel. The important theme of leadership development was stressed. Also, CAPT D. J. Mooney, Jr., USNR, of the Office of Naval Research, discussed the latest developments in the Naval Research Reserve program.

Tours were made of the Naval Training Device Center, where the group witnessed demonstrations of training devices, and the Naval Air Station, the U.S. Naval Submarine School, New London, Conn., and the United Nations building in New York City.

Weekend Seminar Held at Dahlgren, Virginia

On the weekend of May 22-24, 1964, a Research Reserve weekend seminar was conducted at the Naval Weapons Laboratory, Dahlgren,

Preparing to board a Marine helicopter for a flight over the Naval Weapons Laboratory are Naval Reserve officers who attended the weekend research seminar at Dahlgren, Va.

Mr. J. A. Davidson (right) of the Terminal Effects Division, Warhead and Terminal Ballistics Laboratory, NWL, discusses a light-armor evaluation during the Dahlgren research seminar.

Mr. W. W. Meyers, standing, head of the Development Division of the Warhead and Terminal Ballistics Laboratory, NWL, discusses the warhead research problems being investigated at NWL.

Virginia, under the direction of Naval Reserve Research Company 5-12 of Dahlgren. CAPT William A. Kemper, USNR, commanding officer of the company, served as seminar chairman. More than 100 Reserve officers of the Fourth and Fifth Naval Districts participated in the activities.

The program opened on Friday evening with a "Welcome Aboard" by CAPT Robert F. Sellers, USN, Commander, Naval Weapons Laboratory, and the introduction to the seminar followed.

The Saturday and Sunday programs consisted of tours of the laboratory and presentations by officers of the various departments. Subjects of these tours and briefings included war gaming, the computer program, POLARIS fire control system, hazards of electromagnetic radiation to ordnance, and the Naval Space Surveillance System. The luncheon speaker on Saturday was Dr. John Lyman (captain, USNR), Program Director for Oceanography, National Science Foundation. The reservists were also brought up to date on Research Reserve matters by CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve.

Seminar on Science and the Sea

A Research Reserve seminar on "Science and the Sea" was conducted for 80 Naval Reserve officers from Naval Districts of western and central United States for two weeks, commencing June 15, 1964, in Seattle, Washington. The seminar, sponsored by the Office of Naval Research, was presented with the assistance of personnel from the Thirteenth Naval District Headquarters and the Naval Air Station, Seattle. CAPT F. A. Wiggin, USNR, Commanding Officer, NRRC 13-1, served as seminar chairman.

Topic of this year's seminar in the Thirteenth Naval District was particularly timely. RADM L. D. Coates, USN, who was then Chief of Naval Research, stated in his message to the conferees, "In the past few years a major national oceanography program involving every aspect of the sea as it affects human life has gotten underway, with the Navy taking a position of leadership. In addition, the Navy is playing a significant role in an international program under the United Nations."

The seminar was opened with welcoming addresses by CAPT R. F. Peterson, USN, Commanding Officer, Naval Air Station, Seattle; and CAPT R. E. Harmer, USN, Commandant, Thirteenth Naval District. Representing the Chief of Naval Research was CAPT J. W. Jockusch, USN, Commanding Officer, ONR Branch Office, San Francisco, who outlined the interest of the Navy in oceanography. Impressive talks on various subjects relating to science and the sea were given by authorities from the University of Washington; Oregon State University, ONR Branch Office, San Francisco; U.S. Navy Electronics Laboratory; Woods Hole Oceanographic Institution; Bureau of Commercial Fisheries; and Scripps Institute of Oceanography. Also participating in the seminar were representatives from industrial companies engaged in the field of oceanography. It was a "welcome home" for one of the speakers, Mr. Clarence F. Pautzke, Commissioner, Fish and Wildlife Service, U.S. Department of Interior. Mr. Pautzke is a captain in the Naval Reserve and was a former active member of NRRC 13-1.

Two days of the seminar were devoted to field trips to Keyport Naval Torpedo Station, Keyport, Washington; Bangor Ammunition Depot; Dabob Bay Under Water Range; and Puget Sound Naval Shipyard, Bremerton, Washington. An additional afternoon was spent at the Puget Sound Bridge and Drydock Company, where the Reservists visited the Navy/Boeing Hydrofoil vessel FRESH I.

Opening the discussion of the Naval Reserve, CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve, discussed "The Role of the Research Reserve in ONR Planning." Concluding the seminar was a Reservist well known to the northwest area, RADM Robert W. Copeland, USNR, Tacoma, Washington, who discussed "Leadership and Seapower through Research."

A social note was introduced in the two week session on Tuesday of the first week—a seminar banquet, held at the Officers Club, NAS, Seattle.

Seminar on Science and Engineering

The fifth annual Research Reserve Science and Engineering Seminar, sponsored by the Office of Naval Research, was held in Worcester, Massachusetts, June 15-26, 1964. The seminar was arranged and hosted by NRRC 1-5 of that city. LCDR L. C. Neale, a member of the company, served as seminar chairman. Sixty-four Reserve officers, including three from the Army and two from the Air Force, attended.

Opening-day speakers included RADM W. B. Sieglaff, USN, Commandant, First Naval District; LT GEN H. P. Storke, USA (Ret.), President of Worcester Polytechnic Institute; and CAPT D. J. Mooney, Jr., USNR, Special Assistant for Research Reserve, who represented the Chief of Naval Research.

Interesting and informative lectures were given on many branches of science and engineering and visits were made to activities in the area, where the Reservists observed research equipment and processes, as well as practical applications, covered in the lectures. The group was fascinated to see parts being made from metal powders (Presmet Corp.); the cleanliness and meticulous care and inspection involved in the making of drugs (Astra Pharmaceutical Products, Inc.);

Reserve officers examine metallograph machine at Worcester Polytechnic Institute. From left to right are LT J. P. Gagliardo, Commanding Officer, NRRC 1-5; LT D. H. Gilmore; LCDR C. W. Staples; and LT J. E. Thurmond.

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the amazing and ingenious uses of fiber optics and the surgical applications of laser devices (American Optical Co.); the high-temperature and wear-resistance features of ceramics and ceramic coatings (Norton Co.); the intricate, large scale models of dams and river sections used in testing to anticipate erosion of river beds and possible effects of powerhouse heat transfer in rivers (Alden Hydraulics Laboratory); and the studies of nerve cross-sections by means of the electron microscope (Clark University).

A banquet, which was held at the end of the seminar, featured a prominent guest speaker, Dr. Columbus O'D Iselin, Chairman of the Department of Theoretical Oceanography and Meteorology, Woods Hole Oceanographic Institution. Dr. Iselin gave a most informative presentation on various aspects of oceanography.

INVENTIONS — Continued from page 26

Altitude Indicating System

In the past, the measurement of an aircraft's altitude above sea level and above the ground by barometers and radar terrain-clearance sensors has not been entirely satisfactory. Barometric altitude indicators are not accurate to more than a few hundred feet, reliance on them is dangerous at low altitudes, and they do not give actual altitude above the ground. Radar terrain-clearance sensors have a tendency to follow the terrain very closely. In areas in which the terrain is uneven, the altitude shown on the indicators changes rapidly and is thus difficult to read. In addition, the radar does not provide reliable information when an aircraft is banking, climbing, or diving sharply.

S. J. Sikora of the Aeronautical Instrument Laboratory at the Naval Air Development Center, Johnsville, Pennsylvania, has developed an altitude indicating system that incorporates all of the advantages, while avoiding the disadvantages, of both the individual radar and barometric altitude units. It does this by sensing and obtaining the difference between the two measurements, adding this difference to the barometric altitude, and displaying the resulting figure in an altimeter. If the radar portion of the system ceases to function properly, the barometric altitude is revealed instantly on the indicator. A further advantage is that the indicator gives visual warning when the radar portion of the system has failed or has become unreliable.

The invention, Patent No. 3,115,628, issued December 24, 1963, is now being used in the Navy's A6A aircraft. It may also be used in other Navy aircraft.

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A 22-foot-long submarine capable of exploring the ocean to a depth of at least 6,000 feet was commissioned last June. The craft not only will open up a new realm for research, but will help chart the course for the development of larger and deeper diving submarines to be built in the future.

Understanding of the basic processes involved in nerve conduction and the mechanism of drug action has been sought simultaneously through studies conducted at the University of Illinois College of Medicine.

On July 7, during a lunar eclipse of the Crab Nebula, instruments carried by an Aerobee rocket measured the x-ray emission from the nebula. The experiment was conducted, in part, to determine if the source is a neutron star.

The name "solion" is a contraction of the phrase "solution of ions." It refers to liquid-state electrochemical devices that are both versatile and long-lived. The way in which they function and the uses to which they are put are described here.

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Photograph of the Crab Nebula. The information superimposed on the photograph and in its margins relates to observations of the x-ray source in the nebula made during a lunar occultation of the nebula on July 7. The dotted lines indicate the periphery of the moon at various times (given in right margin) during the flight of a Navy Aerobee rocket, from which the observations were made. At this scale, the diameter of the moon is 10 inches. See article beginning on page 14.