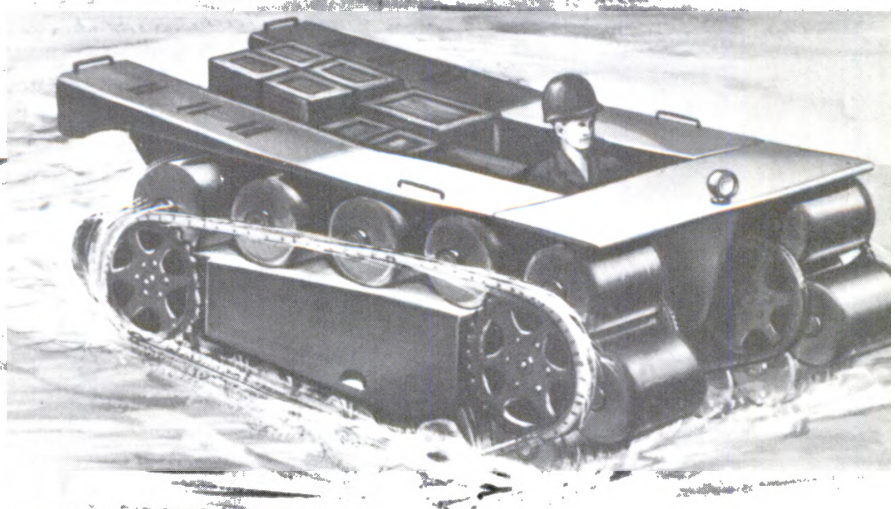
NAVAL RESEARCH

REVIEWS

JULY 1962



The New Tower in Buzzards Bay

Over the past several years, the Woods Hole Oceanographic Institution has endeavoured to conduct studies of wind and waves from a steel tower in Buzzards Bay, Massachusetts, near the institution. But each time a tower has been erected for this purpose, storms have washed it away before its work has been completed. Recently, WHOI, with support from the Office of Naval Research, set up a third tower in the same area. By providing a stable platform from which wind and waves can be measured accurately, it will help oceanographers find out how waves develop and how the sea state is related to changing wind conditions.

The present tower was designed to take much more punishment from the sea than its two predecessors, built in 1959 and 1960. It stands on four legs of eight-inch steel pipe driven some 35 feet into the bay bottom. Circular flanges welded to the lower ends of the legs help to anchor them. In order to reduce interference with the wave patterns, the bracing is designed so that there are no cross members from eight feet below mean low water to the platform, 14 feet above.

On the platform are mounted the instruments and the radio and power supply. Information concerning waves is obtained by measuring the changing resistance of a fine stainless steel wire suspended from an arm extending to the southwest of the platform--in the direction of prevailing winds and the open ocean. Another wire, encased in a tube, provides data on tidal changes which are needed for correcting the wave measurements. The tower is also being equipped with a 40-foot boom from which additional wires can be suspended so that wave direction can be measured. Instruments for making other measurements may be placed on the tower in the future.

An article on a larger, more elaborate tower, set up off the coast of southern California, appears in the May 1962 issue of Naval Research Reviews.

"Airoll":

A Superior System of Vehicle Locomotion

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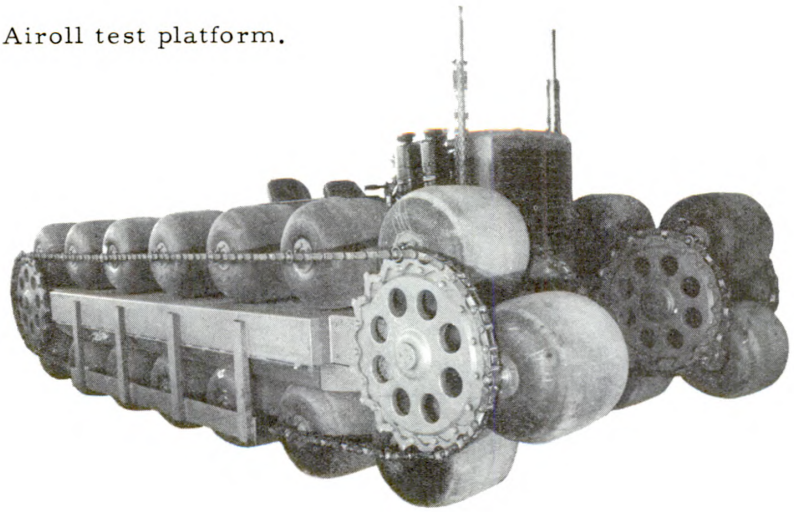
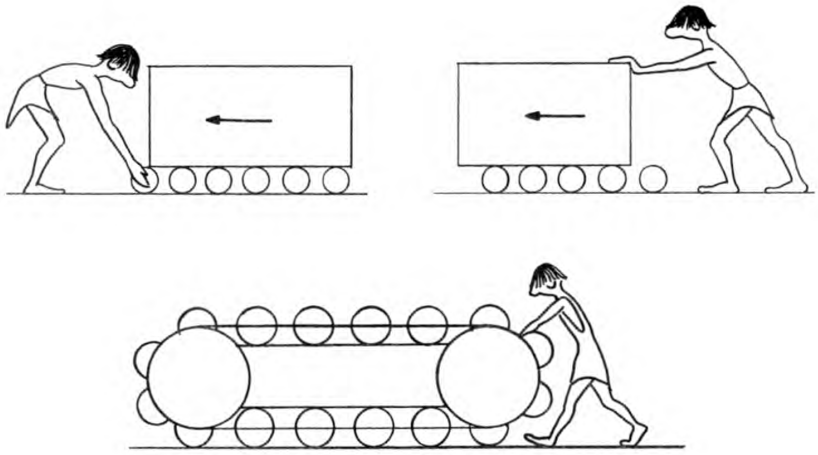
Surface and
Amphibious Programs
Office of
Naval Research

An entirely new concept for transporting men and equipment through deep mud, heavy snow, and watery swampland—terrain heretofore impassable to vehicles—has been successfully developed for the Navy. The new system of locomotion for the first time successfully mates the track and the wheel, combining the free-rolling resilience of the pneumatic tire with the maximum mobility afforded by a laterally rigid track. The concept, called Airoll, was conceived and developed by the Ingersoll-Kalamazoo Division of the Borg-Warner Corporation under a contract with the Office of Naval Research.

The operation of the Airoll principle can be described in simple terms by a few sketches (next page) portraying a box being moved over a series of free-rolling cylindrical forms. The two sketches at top show the box being pushed. It can easily be seen that this arrangement has one important disadvantage—the operator must continue to move each by-passed roller from the rear of the box to the front so that the roller will once again be in the line of travel. The third sketch shows how this problem can be solved: by attaching a number of rollers to a linked chain, which is carried on large sprocket wheels at each end of the box. When the sprocket wheels are turned, the chain and rollers begin to revolve, and the box to move. The chain continues to revolve, thereby moving the by-passed rollers from the rear to the front of the box.

Airoll test platform.





Demonstration of Airoll principle.

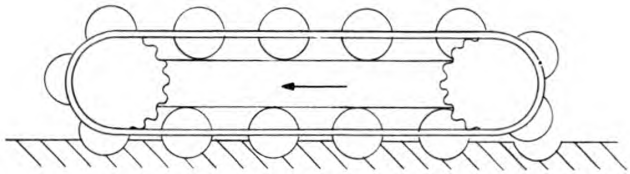
Instead of rollers, the Airoll system utilizes two series of low-pressure pneumatic tires, one on each side of the vehicle platform. The tires of each series are mounted on two chains which rotate about a driving sprocket wheel and a return idler sprocket wheel. The suspended weight is thus distributed over a series of tires that are compressed between the hull bottom and the ground. The tires, being wide and soft, readily absorb bumps, thereby eliminating the need for the conventional spring suspension system and its components.

The Airoll moves both by a combination of two entirely different modes of propulsion and by one or the other of these modes separately. In the first mode of propulsion the tires roll over the earth, which means that the track and platform move at different speeds relative to the ground. In the second mode, the tires do not roll over the earth; the vehicle moves forward by the laying of its tracks in the manner of a conventional tracked vehicle, the track and platform moving at the same speed relative to the ground. The change-over from one mode of propulsion to the other occurs automatically, according to terrain conditions. Intermediate stages of operation, in which the two modes of propulsion operate at the same time, also exist.

The first mode of propulsion usually applies to operation on level or moderately firm terrain. The tires are made to roll beneath the platform by the tangential force applied by the platform. In this case the friction between the platform and the tires is greater than the total rolling resistance between the tires and the ground. With this mode of operation the system has a property which sets it apart from other propulsion systems: the speed of the vehicle exceeds that of its own track; in fact, the speed of the vehicle is approximately twice the speed of the track (see explanation in box on next page). This unique feature permits the design of a vehicle capable of attaining almost any reasonable speed on firm terrain, and it makes this possible without the drawback of excessively high track speeds.

The second mode of propulsion is effected when the Airoll crosses soft ground or snow. The vehicle then operates by laying tracks and

moving forward by the pressure exerted by the tracks against the ground. This function occurs automatically when the tires sink into mud, sand, or snow. The vehicle is then geared to the ground and the tires act as cleats. The following sketch describes this mode of operation:

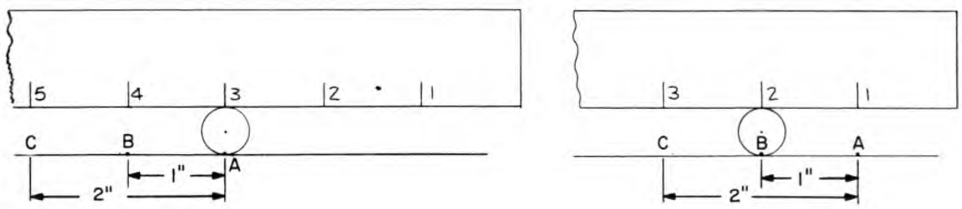


The tires may or may not turn, depending upon the friction between the vehicle bed and the tires and between the terrain and the tires. Thus, should the mud be fluid, the snow prove slippery, or the sand sufficiently loose, the tires are in effect lubricated and capable of turning in the depressions they have made, and the vehicle bed is capable of rolling over their uppermost surfaces. However, should the frictional quality of the soil or mud prevent the tires from rotating within the depressions, then the vehicle bed will skid along the upper surfaces of the tires.

If the vehicle moves on into water, it becomes amphibious. Flotation, which is provided by air in the many large tires and by air compartments in the platform, is such that the upper portion of the track is above the water line. As the lower portion of the track moves to the rear of the vehicle, the tires function as paddles, propelling the vehicle by the reaction to the mass of water moved.

WHEEL AND TRACK SPEEDS

The reason why the Airoll vehicle can travel at twice the speed of the tracks is explained by the two diagrams below. The upper rectangle represents a ruler being moved from right to left on a free roller, or wheel. It will be seen that as the roller moves 1 inch from point A to point B on the ground, the bearing surface of the ruler also moves 1 inch, from 3 to 2, in relation to the roller. But in relation to the ground surface, the 3 mark on the ruler has moved from A to C, or 2 inches.



To determine how well the Airoll locomotion system functions in mud, sand, and snow, and on firm ground as well, a special test platform was built. This machine, pictured below, weighs about 19,100 pounds and is 23 feet long and 15 feet wide. It is powered by an engine that develops 185 brake horsepower at 2800 r.p.m. Of the several kinds and sizes of tires that were evaluated, Goodyear Terra Tires, 24 by 24 by 6 inches, inflated to 8 pounds pressure, were found to provide the best overall performance. The test platform utilized a total of 32 of these tires, 16 of them mounted on each track.

The experimental platform was subjected to severe service tests by the contractor and by representatives of the U. S. Army Corps of Engineers of the Waterways Experiment Station, Vicksburg, Mississippi. The test sites, in addition to the Vicksburg area, included Fort Custer

Military Reservation near Battle Creek, Michigan, chosen for its "bottomless" mud swamps; the Warren Dunes State Park near Bridgman, Michigan, for its large sand dunes; and Camp Hale, high in the Rocky Mountains, Colorado, for its deep snow. After the tests in Mississippi and Michigan, the Corps of Engineers reported that the system "can travel on soft muck and wet fine-grained soils negotiable by no known military vehicle of equal weight." The report also noted that the Airoll system can "achieve greater travel efficiency on most soil conditions than conventional tracked vehicles."

In the tests conducted at Camp Hale, the vehicle operated without difficulty in snow which in places reached a depth of 40 inches. As a matter of fact, the Airoll, which packs its own roadway as it moves over the snow, increased its traction as the snow deepened. However, because of the loss in engine power in the high altitude at Camp Hale, the engine was unable to spin the tracks under load. Therefore, the maximum drawbar-pull that could be measured was at power stall, where the coefficient was 0.43. This coefficient is the ratio of drawbar-pull to weight of vehicle. With sufficient power it was estimated that the drawbar-pull performance would exceed by 75 percent that of the Weasel, a conventional tracked vehicle used in the tests to provide a basis for comparison. In spite of the limited power of the test engine, the Airoll demonstrated its excellent traction and maneuverability by climbing artificial snow mounds up to 12 feet in height and with a slope of 60 percent, and by making turns in deep snow with less difficulty than is experienced by the smaller Weasel.

In moving the experimental Airoll vehicle to the various test sites it was often necessary to travel for short distances on improved roads. This aroused little concern over the possibility that the Airoll's tracks would damage the pavement, because unlike the conventional vehicle, whose track cleats are metal plates that tend to dig up the pavement, the Airoll's cleats are soft rubber tires that roll smoothly over such a surface. Therefore, permission to move the vehicle over the highways was readily obtained.

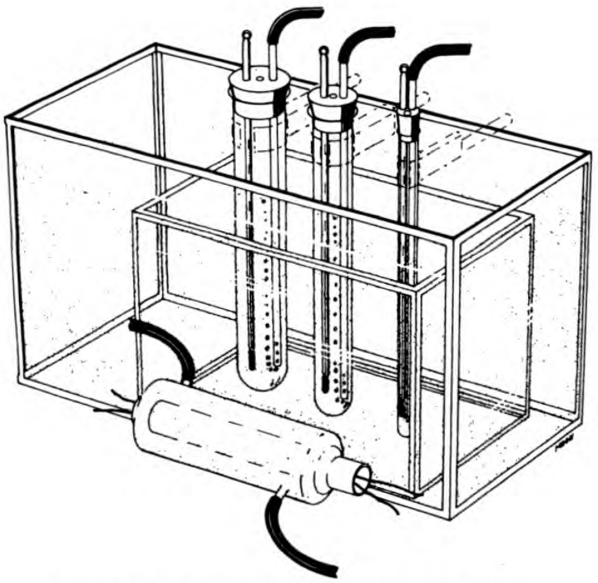
Test platform negotiates sand, snow, and mud.

Eight prototype amphibious airoll vehicles have been ordered by the Marine Corps for use as personnel or weapons carriers. These machines, which are now being manufactured by the Ingersoll-Kalamazoo Division of Borg-Warner Corporation, will have a payload capacity of approximately 1250 pounds, will be 14-1/2 feet long, about 8 feet wide, and nearly 7 feet high. They will be powered by standard automobile engines of about 80 horsepower, which will give them a top speed in water of about 10 miles per hour and a maximum speed on firm, level terrain of about 40 miles per hour.

The research phase of the work leading to the perfection of the Airoll system was supported by the Office of Naval Research, beginning in 1958.

The Fourth Symposium on Naval Hydrodynamics will be held August 27 to 31 at the Statler-Hilton Hotel in Washington, D. C. Hydrodynamics problems falling under the general topics of propulsion and hydroelasticity will be discussed by authorities from many research institutions in the United States and foreign countries.

The symposium is being sponsored by the Office of Naval Research, assisted by the Webb Institute of Naval Architecture, Glen Cove, Long Island, N. Y. The three previous hydrodynamics symposia--in 1956, 1958, and 1960--were also sponsored by ONR. Chairman for the fourth meeting will be Mr. Ralph D. Cooper, Head of the Fluid Dynamics Branch, Office of Naval Research.



Illumination of algal suspensions contained in 1-, 2-, and 3-inch diameter tubes.

P. J. Hannan
Chemistry Division
Naval Research Laboratory

Experiments with Algae for Submarine Air Purification

Making the submarine atmosphere wholesome enough for crewmen to live and work in satisfactorily during long periods of submergence has been the goal of NRL's submarine habitability program since its inception. The objective has been pursued through various basic and applied research projects at NRL since the program was established in the Chemistry Division in 1929. While the results of this work have been highly successful, the need for further improvements in habitability still exists, owing largely to the emergence in recent years of the nuclear-powered submarine, with its potentiality for indefinite submergence.

Complacency with past accomplishments is not the standard of a research team that has helped to extend the underwater cruising periods of both conventional and nuclear-powered submarines. Thus, the work described here—a botanical approach to the submarine habitability problem—represents a logical sequel to former NRL studies in that its objective is a system which combines oxygen production with carbon dioxide removal, whereas the two processes are conducted separately in present submarine practice.

In nature, solar energy is absorbed by green plants and used to produce more plant material and oxygen, a process known as photosynthesis. This same energy process can be used in a submarine if plants are supplied with the proper lighting and minerals. The algae are considered most suitable for this purpose since they have a fast growth rate and their high concentration of chlorophyll provides efficient oxygen production.

POWER REQUIREMENTS

The production of oxygen may be considered as an energy process, whether the means used is based on photosynthesis (e.g., converting electrical energy to visible light, which then can be used by plants in

their production of food and oxygen) or on the electrolysis of water. Since there is an equivalence between energy and chemical species, defined by thermodynamic relationships, any system used for the production of oxygen, for instance, can be defined in terms of efficiency.

Dr. D. Burk, of the National Institutes of Health, has shown that the utilization of light energy by algae can be 100-percent efficient, i.e., all of the light energy absorbed by the algae can be accounted for in terms of production of new plant material, production of oxygen, and energy consumed in the endogenous respiration of the plants. But this efficiency can be achieved only with small cultures.

Using efficiencies normally obtained in plant growth, NRL's J. M. Leonard calculated some time ago that 500 horsepower would satisfy the power requirements of an algal system for a submarine, and this is within the capability of the nuclear submarines. The volume estimates for the photosynthetic process have varied according to the pessimism or optimism of the expert interviewed. The purpose of the present study at NRL is to determine the feasibility of the process based on results of laboratory tests of mass cultures. These experiments have included test-tube type studies in which growth rate is determined, and small pilot-plant operations in which growth rate is correlated with oxygen production and carbon dioxide removal.

The light energy for an algal system must be supplied at a rate sufficient to foster rapid growth, but the intensity must not exceed the limit at which the cells become "solarized." Each cell, if illuminated continuously, would be saturated with light at approximately 400 foot-candles. Fortunately, algal cells can tolerate rather high light intensities for millisecond exposures, so it is possible to use intensities of more than 10,000 foot-candles with dense suspensions in which the cells shade each other but are agitated to give an "on-off" sequence. Our desire to use concentrated algal suspensions, to pack as much oxygen productivity as possible into a small space, must be tempered by the realization that the bright lights needed to penetrate these suspensions might ultimately inhibit growth.

Another compromise becomes evident as the growth rate of the cells diminishes with time unless fresh culture medium is supplied. There must be a simultaneous removal of an equal volume of algal suspension; therefore the oxygen productivity of the system depends on a favorable balance of the interrelated factors of suspension density, dilution rate, and lighting intensity. These problems have been attacked in the present investigation.

The algae used in the NRL study is a species of Chlorella known as the Sorokin strain. It has a temperature optimum of 39°C, and a growth rate considerably greater than most algae. Another advantage is its ability to tolerate higher light intensities than most algae. Much remains to be known of its physiology, however, since it was discovered rather recently, in 1951.

THE PROBABLE DESIGN

The present concept of a gas exchanger is a large tank containing a suspension of green algae, and illuminated with lights set in the suspension. Blowers must be used to force the ship's air through bubblers in the bottom of the tank, then through a heat exchanger (probably in the hull of the ship), and finally through a dehumidifying unit before it is circulated back into the ship.

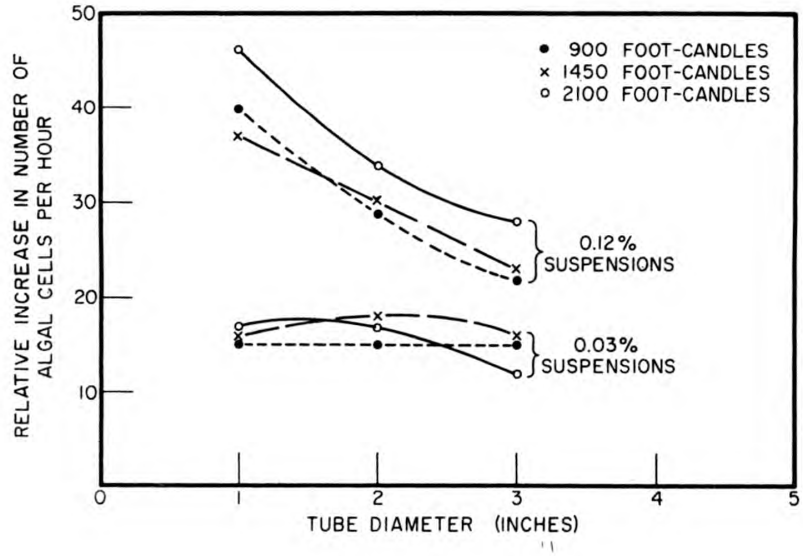
EXPERIMENTATION

The effects of both chemical and physical variables on the growth rate of algae have been investigated. Studies of chemical effects have concerned typical plant growth regulators (generally detrimental), varsol vapor, and exotic atmospheric contaminants, while studies of physical effects have involved such problems as light intensity, suspension density, and rate of stirring of the cultures.

The distance between lights in an algal gas exchanger is especially critical. It is conceivable that a few bright lights set far apart would provide the same growth as numerous lights of lower intensity set close together. The experiment described here was designed to determine, in a preliminary fashion at least, the optimum light intensities for various suspension densities.

Large test tubes (1-, 2-, and 3-inch diameters) were supported in a thermostatted bath and illuminated by a jacketed, 1500-watt incandescent lamp outside the bath, as shown by drawing on page 6. Algal suspensions were placed in each of the three tubes, and the optical density was measured hourly for 7 hours. From these data the time needed for the cells to double their original concentration was computed. The graph below shows the doubling time as a function of light intensity and tube diameter for two suspensions, 0.03 percent (0.3 cubic millimeters of packed cells per 1 milliliter suspension) and 0.12 percent.

Rate of algal growth as a function of light intensity, depth of suspension, and suspension density.



The graph shows that the 0.03-percent suspensions were so dilute that 2000 foot-candles intensity penetrated a 3-inch thickness as well as a 1-inch section; and while the shapes of the curves are not exactly the same, the discrepancies can be accounted for mostly from the limits of the experimental error. However, a different situation existed with the 0.12-percent suspensions. Here it can be seen that the growth rate in a 1-inch tube was rather constant for the three light intensities used, but as the diameter of the tube was increased and the light passed through thicker sections, the doubling time increased markedly with the tube diameter. Obviously 4700 foot-candles provide better growth in a 3-inch tube than 2000 foot-candles.

RAPID STIRRING AS A FACTOR IN GROWTH

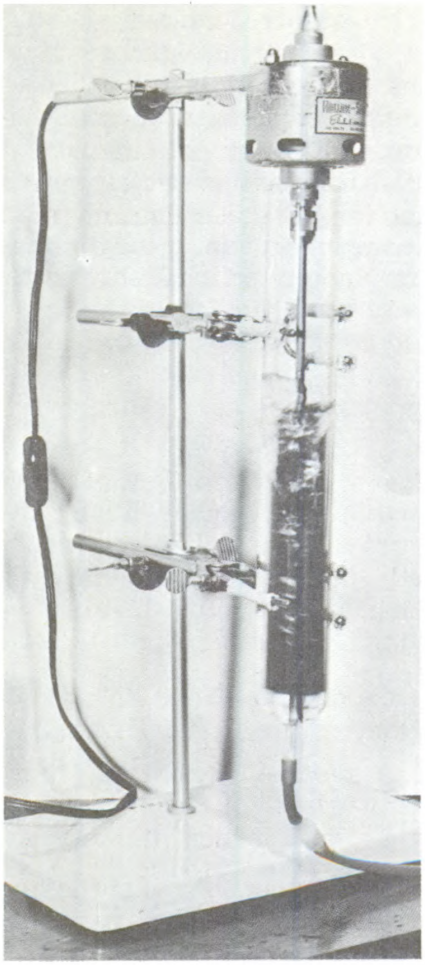
Algal cells grow best when exposed continuously to light of approximately 400 foot-candles, but they may grow as well under higher intensities so long as their exposure time is correspondingly reduced. In a mass culture the mutual shading of cells provides alternate light and darkness, the duration of each cycle being a function of the turbulence of the system. As indicated by the graph, the shading effect is noticeable in suspensions as dense as 0.12 percent.

By means of rapid stirring it should be possible to use higher light intensities and correspondingly higher suspension densities, thereby increasing the oxygen production per unit volume of suspension. This effect was studied in test tubes of 1-, 2-, and 3-inch diameters; the suspensions were stirred by a shaft with fins extending the depth of the algal suspension (see photograph at top of page 10), the rotation speed being about 1500 rpm. The clearance between the fins and the wall of the tube was approximately 1/8 inch in the 1- and 2-inch tubes, but about 5/8 inch in the 3-inch tube. This type of stirring produces a vortex effect which forces the suspension an inch or more up the side of the tube.

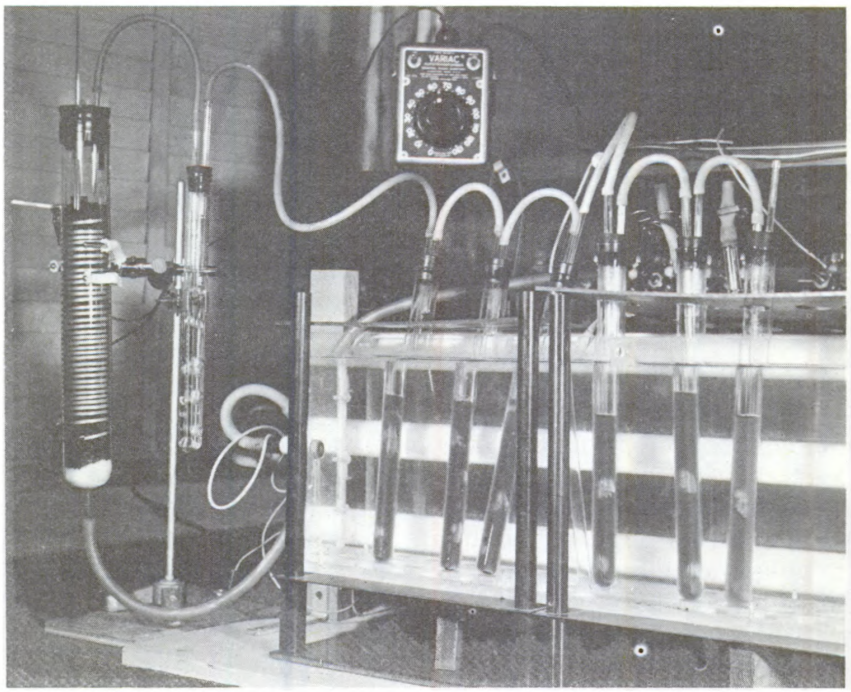
Generally the effect of stirring increases with the suspension density and the light intensity. The maximum effect was obtained with 2-inch tubes and 9000 foot-candles, the growth increasing 2- to 4-fold with stirring. Little effect could be detected in the 3-inch tubes, probably because there were a significant number of cells in the dark at all times despite the rapid stirring. Only one light intensity was used in tests with the 1-inch tube and the results are not conclusive.

EFFECT OF VARSOL VAPOR ON GROWTH

A time-honored Navy custom has been to use Varsol as a means of cleaning certain portions of the ship. While this practice is discouraged now, the hydrocarbon content of the ship's atmosphere (from all sources) might be as high as 20 ppm. Inasmuch as this must be considered a possible deterrent to the growth of algae, a preliminary experiment was conducted to determine the effect of Varsol vapor on the growth of the culture. Although the tests were by no means exhaustive, they went far enough to indicate that even a high Varsol concentration had no observable adverse effect on the culture.



Arrangement of test tube and rotating shaft with fins used to stir algal suspensions. Stirring action permitted application of higher light intensities and use of higher suspension densities. The purpose was to increase the oxygen output per unit volume of suspension.



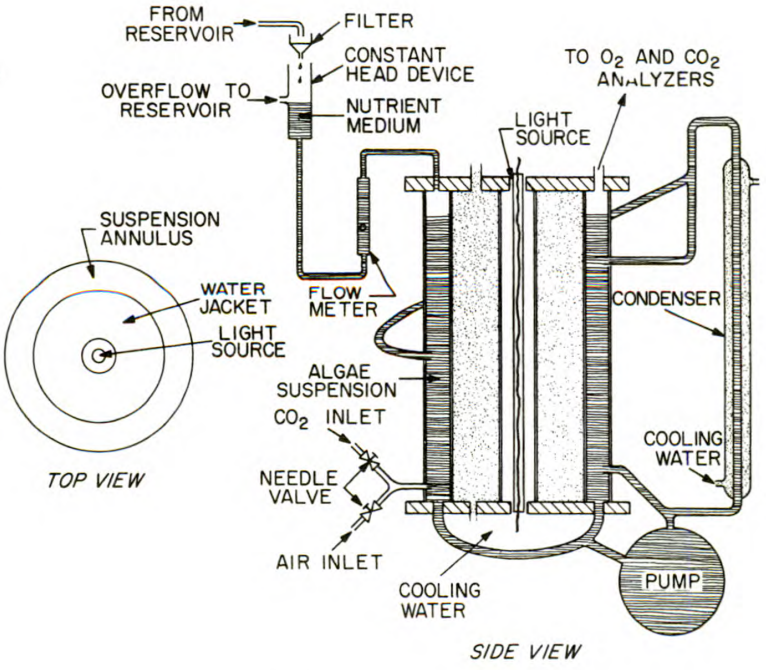
Apparatus used to determine absorption of hydrocarbon vapors by algae.

VAPOR REMOVAL BY ALGAE

The results of the Varsol experiment suggested that algal suspensions may remove exotic vapors from an atmosphere such as is found in submarines. To determine whether this was so or not, an apparatus was built to mix these vapors with a CO_2-air mixture which was then bubbled through a series of six tubes containing algal suspensions. The purpose was to detect any successive change in growth in the six tubes, which would be an indication of a "gas-scrubbing" action.

This apparatus is shown in the lower photograph on page 10. A large glass tube contained charcoal removed from a canister filter aboard a submarine; the charcoal had an obnoxious odor characteristic of a combination of fresh paint and stale cigarette smoke. The charcoal was maintained at 45°C overnight by a heating strip wrapped around the tube, and the gas after being passed through the charcoal was passed successively through a humidifier and then through the six culture tubes. After 18 hours culture all of the suspensions appeared healthy and the growth was indistinguishable from three control tubes cultured at the same time.

In order to determine whether the hydrocarbons were simply passing through the cultures without change or were being partially absorbed, a hydrocarbon detector was used to trace the concentration of the gas at various points in the train. Ample contaminant was provided for this test by raising the temperature of the charcoal to 60°C. The CO_2-air mixture was passed through at a rate of 100 ml per minute. At successive sampling points, between the charcoal chamber and the outlet of the first algal culture tube, the detector registered the hydrocarbon content at 66 ppm, 45 ppm, 34 ppm, and 3 ppm. The big drop between the last two figures indicates that the algal suspension acted as a rather efficient scrubber of these particular contaminants.



Schematic diagram of pilot plant containing one 1500 watt lamp.

PILOT PLANT STUDIES

The purpose of a pilot plant operation is to culture algae on a mass scale and to provide for the measurement of carbon dioxide absorption from a gas stream and the consequent oxygen production by the algae. There are many possible designs of such pilot plants; some of the variables are the types of lights to be used (e.g., incandescent or fluorescent), the light intensity, the depth of the suspension being serviced by each light, and the rate of circulation.

A schematic representation of the unit now in operation appears on page 11. This unit has proved useful in studying the efficiency of algal cells as producers of oxygen. Also this unit has been used to assay quickly the effects of chemicals added to the culture medium, because the increase or decrease of oxygen production is apparent usually within a half hour or less (whereas if one were to determine the effect of the additive by a change in the volume of cells with time, at least four hours or more would be required for any degree of accuracy). To give some idea of the magnitude of the gas volumes used, a typical gas stream would pass through the system at a rate of about 400 ml per minute; at this rate, if its initial CO_2 concentration is 1.9 percent, the concentration in the effluent gas would be approximately 0.5 percent or less. The analyzer reads 2 percent full-scale deflection, therefore the change in the CO_2 content of the gas stream is easily detected.

The culture chamber consists of three concentric lucite tubes with an outside diameter of six inches. The suspension is illuminated by a 1500 watt incandescent lamp (3/8-in. diameter by 10-in. long) suspended in the center of the innermost tube. Heat generated by the lamp is largely dissipated by passing water through the 1.5-in. inner annulus surrounding the light source. The outer annulus contains approximately 1600 milliliters of suspension and is 3/4-in. thick. An additional 175 ml suspension is required to fill the pump and connecting tubing.

The suspension is thermostatted by means of a condenser placed outside the culture chamber. This condenser serves as a heat exchanger; when the temperature reaches 38.5°C, a temperature controller activates a solenoid valve allowing cooling water to flow through the condenser.

A major conclusion of the pilot plant studies conducted so far is that the depth of the suspension being serviced by each light is highly important, the efficiency of the unit being greater the smaller the depth. The chart below provides a comparison between the results of two units with different light paths but with essentially the same stirring techniques and with the same light intensities:

Light path	0.75"	2.0"
M1 0_2/hr/liter suspension	3.5	60

A practical limit to the minimum light path is set by the volume of suspension surrounding each light; the total oxygen produced is the product of the number of cells involved times the output of each cell.

And while the efficiency per cell increases as the volume of cell suspension around the light is decreased, the total output will depend on the two factors.

THE OUTLOOK

At present, the consensus is that between 50 and 75 liters of algal suspension would provide sufficient oxygen for one man. As indicated in the preceding paragraph, one must make a choice between efficiency in the total size of the unit or efficiency of the performance of a volume of suspension, the two being nearly mutually exclusive.

On one score, at least, the results of these tests have exceeded the expectations, and that is in the area of reproducibility. There has been a gratifying duplication of results in the various pilot plant runs, much more so than in duplicate test-tube type experiments.

The electrical power requirement for an algal system large enough for submarine use is higher than had been anticipated. Some of the factors contributing to this high value are unavoidable, while others may be minimized through further experimentation. In order to reduce the volume of the suspension as much as possible it is almost imperative that light sources of high intensity be used and their efficiency is 10 percent or less; the efficiency of conversion of photo energy to chemical energy (by the production of plant material) is 25 percent at the very best; therefore the overall utilization of electrical energy is of the order of several percent. It is conceivable that the physical sciences will be able to provide a more efficient light source eventually, and it is possible that further knowledge of the process of photosynthesis will permit greater growth efficiencies.

Air Photo Collection Begins with Discarded Prints

During World War II, a large number of aerial photographs of islands in the Pacific Ocean were taken for military use. When the war ended, and they were no longer needed, many were left on shelves, unused, and others were thrown out. Eventually, many more of the photographs probably would have been discarded had it not been for an avid collector, E. H. Bryan, Jr., now manager of the Pacific Scientific Information Center in Honolulu. Mr. Bryan happened to notice some of the photographs in an incinerator at a Pacific island military headquarters that was being deactivated. By the time he had finished cleaning out the incinerator he had several thousand photographs in his possession.

Then began a serious search for more of the unwanted pictures. In this effort, Mr. Bryan was aided by the Geography Branch of the Office of Naval Research, which arranged, through the Office of Naval Intelligence, for him to receive a much larger set. Furthermore, ONR gave Mr. Bryan a grant to put the pictures in order.

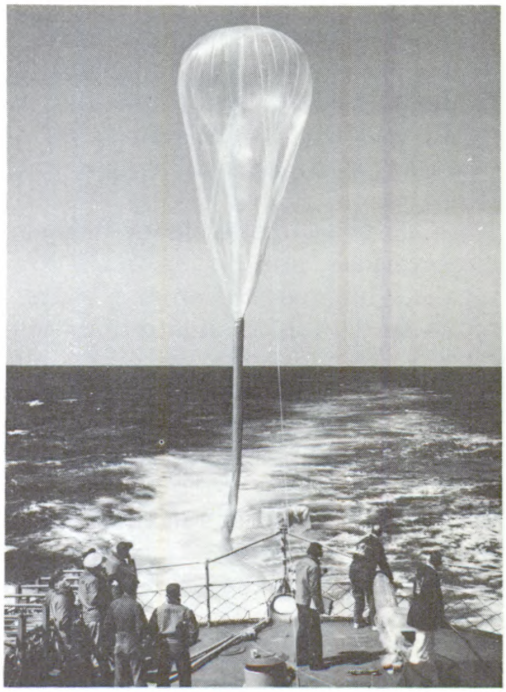
Now the collection numbers about 65,000 photographs, all catalogued and neatly filed--the most exhaustive collection in existence for the Pacific area. The photographs now repose in the Bishop Museum, Honolulu, where they serve as an excellent reference for geographic, anthropologic, and other scientific studies of the Pacific islands.

Project Wetfoot:

Launching of High Altitude Plastic Balloons from Small Vessels

LCDR William S. M. Arnold, USN
Physics Branch
Office of Naval Research

A balloon is deployed and inflated on the ocean surface astern of the USS KRAUS in the Atlantic.



Throughout the history of ballooning, both scientific and military, the greatest impediments to successful operations have been surface winds, unfavorable trajectories aloft, and poor recovery conditions. Through the balloon program of the Office of Naval Research, efforts have been made to improve this situation by using sheltered sites in the mid-continental areas of the United States, such as the "Strato Bowl" of South Dakota and the iron-mine pits of Minnesota. However, these measures have become more and more useless because of several developments:

- Balloons have become larger and, therefore, have "outgrown" the available shelter areas.

- Scientific investigators are requiring more of their balloon-borne experiments to be conducted in areas of the world where shelters, either natural or man-made, do not exist.

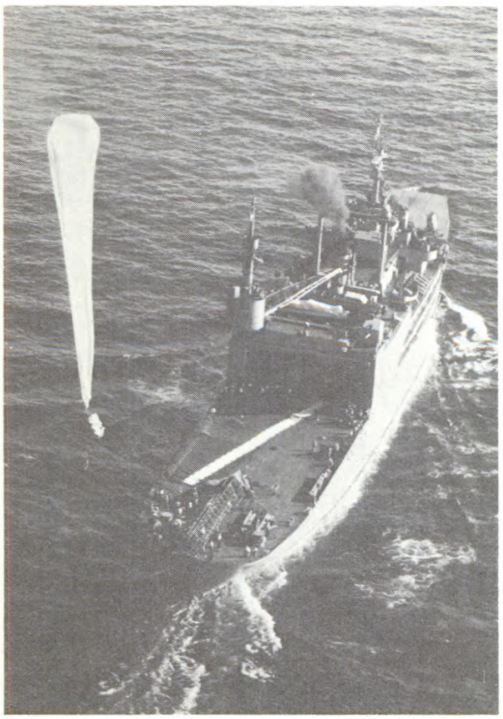
- Flights of such long duration are now required that if they originate in mid-continental United States, they stand a fair chance of terminating over either ocean or over the Gulf of Mexico.

The waiting period that has existed before surface conditions were favorable for a launch has now been lengthened, owing to the larger sizes of Skyhook balloons and to the increased lengths of the load trains. Present launching techniques involve either the vertical (static) or the

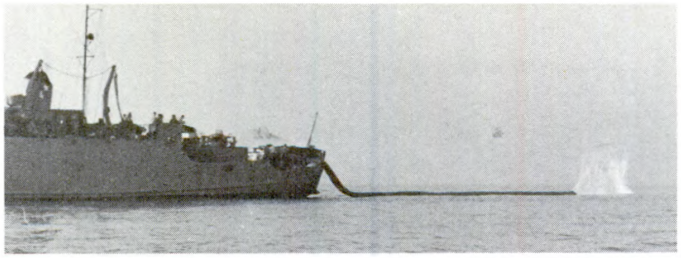
mobile (dynamic) methods, which expose the large surface area of a balloon to the wind region from the surface to an altitude of about 600 feet before payload release can be effected. Although at the surface the air may be "calm," particularly in regions in and near high pressure centers, the overlying air is commonly in motion. This wind increases sharply in velocity from about 200 feet on up, especially at night, and at 600 feet may blow at a speed exceeding 20 knots. Needless to say, these supergradient winds are capable of creating havoc when balloons are launched by either the static or dynamic methods—destroying the balloons, overturning launch vehicles, damaging scientific equipment, and injuring personnel. Of course, other conditions affecting a successful flight, such as trajectory, cloud cover, and recovery-area weather, compound the problem.

Because of these difficulties, ONR has adopted an alternative system for launching balloons which employs ships as mobile launching sites. This scheme is not new. As far back as 1949, plastic balloons of all sizes were launched from a variety of ships, ranging from ice breakers to aircraft carriers, and from locations as far north as Davis Strait and as far south as the Galapagos Islands. The principle, which is a simple one, is this: Assuming that a true wind exists, the ship steams downwind at the true-wind speed, creating a zero relative-wind speed with respect to the balloon in launching configuration. Over open water, low-altitude wind shears are confined mainly to layers below the level of the deck, and these have little effect on the balloon.

This scheme enjoys all the advantageous features that mobility provides: bad weather areas can be avoided, the launch position can be chosen with respect to favorable recovery areas and to regions which are significant from the point of view of the experiment itself. Another



A Skyhook balloon is launched from the deck of the seaplane tender USS NORTON SOUND. Only aircraft carriers and certain seaplane tenders have sufficient space to lay out large balloons on deck in preparation for launching.



Launch test aboard the USS LAMAR, showing sequence of deployment and inflation of balloon.

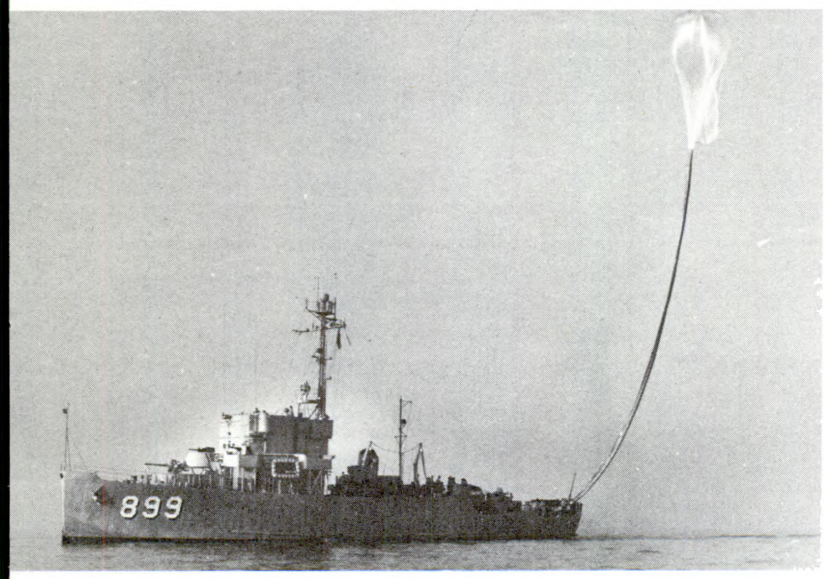
advantage is the availability of on-board shop facilities, instrument shelters, and living accommodations. A small ship can also carry sufficient helium (in bottles) for more than 3,000 pounds of lift (50,000 cubic feet).

Common to all shipboard launches to date has been the requirement of sufficient deck area to properly lay out the balloon material prior to inflation, as well as to place the payload, launching rig, and helium supplies in the most favorable positions. With balloons of one million cubic-foot capacities and greater, only aircraft carriers and certain seaplane tenders, such as the NORTON SOUND (see photograph, page 15), have sufficient "real estate" for a topside layout. As a matter of fact, the NORTON SOUND has been engaged previously in Skyhook operations, and both the Essex-type carriers VALLEY FORGE and ANTIETAM have been used successfully in the launching of large balloons—during Project Skyhook's 1960 operations and for Stratolab V, respectively.

The purpose of Project Wetfoot is to demonstrate that smaller vessels can be used to accomplish essentially the same mission that previously has been assigned to larger ships. Instead of the balloon envelope being laid out along the deck, however, it is deployed on the surface of the water astern of the vessel. The balloon material (in this case, polyethylene) does not become wet as a result of lying in the water, and it does float, because of the entrapped air bubbles. Thus, the balloon can be made to glide along the water surface as it is towed downwind by the vessel. In addition, it has been determined that chemical reactions between polyethylene and either salt water or water contaminated by oil or other organic substances are negligible; by comparison, on routine flights, those reactions which occur as a result of ultraviolet exposure by the sun are considerably stronger.

The balloon is deployed over the fantail into the water, normally with the ship steaming downwind. In this phase of the launching procedure, the relative wind does not have to be zero. This is significant, because drag forces tend to become excessive at ship speeds in excess of 12 knots, in spite of polyethylene's comparatively low frictional resistance. For this reason, under true-wind conditions, with a wind speed greater than 12 knots, the deployment and initial stages of inflation are performed at lower ship speeds. When the helium bubble at the end of the balloon becomes large enough to rise from the water's surface and to pick up the balloon train, the area of contact between the balloon and the sea decreases, causing the drag forces to decrease, and permitting the ship to accelerate to the ultimate true-wind speed. Thus, balloons can be launched in this way at true-wind speeds as great as the ship's maximum speed as long as sea conditions are not such that they make topside work hazardous. After the balloon is clear of the water and erect, the procedures applicable to a routine vertical (static) launch apply. Water accumulations on the balloon sufficient to affect an accurate weigh-off are shed in a matter of a few minutes or in the period of time required for the payload to be attached and for a final check to be made of the equipment.

Three series of tests under contract with General Mills have been completed to date in increasing order of rigorous launching conditions.



The first, in November 1960, was performed from a raft on White Bear Lake, Minnesota, in relatively calm weather. This was followed, in September 1961, by a test of two balloons from the USS LAMAR (PCE-899) on Lake Michigan (see photographs on these pages). Although wind and lake conditions were still rather calm, an 880,000 cubic foot balloon of comparatively fragile construction (1 mil, tapeless) was inflated and actually flown to maximum ceiling altitude with a scientific payload attached. The light and variable surface winds encountered provided a severe test of the ship's capability of maintaining steerageway in a zero-wind condition. Finally, in April 1962, a series of three deployment

and inflation tests (no flights) were performed aboard the USS KRAUS (DD-849) on the high seas off the eastern seaboard (see photograph, page 14). Winds of up to 15 knots were encountered, with swells running across the seas.

The test phase of Project Wetfoot is expected to be concluded this summer with launchings of balloons carrying actual payloads from an ocean area.

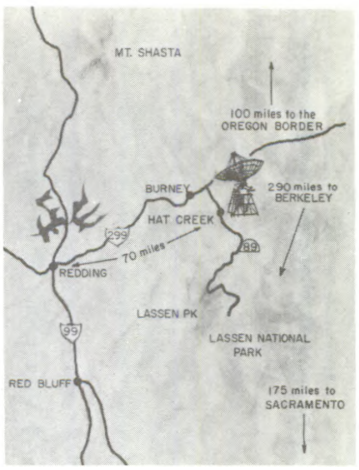
The Wetfoot launching system does not overcome the tracking and recovery problems that exist after a launch. But where flights are made to altitudes in excess of 100,000 feet, it is not unreasonable to assume that a balloon can be kept in sight for several hours from the launch ship. This period of time can be extended, of course, if the ship "chases" the balloon. And with LF/MHF direction-finding equipment, tracking can be maintained for great distances from the launch ship and from shore stations thousands of miles away.

Recovery becomes more difficult in remote ocean areas. This problem can be solved, of course, by the use of expendable payloads that are relatively inexpensive (in terms of value of data obtained), utilizing telemetering equipment to obtain the data. A second solution is the utilization of a system adapted from the "Fulton Skyhook Aerotriever," now being developed under ONR sponsorship. This system permits the recovery of payloads in midair, the payload descending on a parachute after separation from the balloon, then being retrieved in the air by an airplane. This adaptation was successfully demonstrated last spring, when light loads dropped from one aircraft were recovered in the air by another aircraft. However, the system has limitations: one is load weight, and another is the range (and endurance) capability of the retrieval aircraft to effect rendezvous with the descending balloon and to return to its base. A third possible solution to the recovery problem is the positioning of the launch vessel so that the balloon, after launching, will move toward land and come down over land. However, the application of this procedure would in some cases be contingent upon obtaining approval to penetrate foreign territory and airspace.

The Wetfoot system should prove valuable for upper atmospheric research, especially over remote ocean areas. It would be useful, for example, in conjunction with research projects of the type now in progress in the Indian Ocean (conducted as part of the international Indian Ocean Expedition), permitting balloon-borne probes to be sent as high as 120,000 feet into the atmosphere. Of course, international boundaries and airspace restrictions must always be recognized when planning balloon operations—whether the flights are to originate on land or sea—so as to minimize chances of inadvertent overflights; however, employment of the Wetfoot system, which is given mobility by the launching method it entails, enables flight officials to adjust more easily to these conditions.

The National Science Foundation has awarded a grant of $2 million to the Woods Hole Oceanographic Institution for the construction of a laboratory for research in marine sciences.

New Telescopes Begin Survey of Milky Way



In a California wilderness valley 20 miles north of the Nation's only active volcano, Mt. Lassen, two new radio telescopes have begun receiving signals from the Milky Way. One of these instruments ranks among the largest steerable radio telescopes in the world, measuring 85 feet in diameter, 110 feet in height, and weighing 200 tons. The other one is small by comparison, being 33 feet in diameter, but it is extremely accurate. The two telescopes and associated buildings and equipment, called the Hat Creek Radio Astronomy Laboratory, were erected at a cost of $1.2 million. Most of this sum was provided by the Office of Naval Research, which has conducted a broad program in radio astronomy since 1947. The Laboratory will be operated by the University of California.

How are the stars formed? What "shape" is the universe? Is there life on other planets? These are some of the questions astronomers hope eventually to find answers to, in part at least, with such instruments. Already, the smaller telescope has mapped a portion of the northern Milky Way, revealing new details about the multitude of clustered stars that make up this part of the galaxy. The 85-foot telescope has been put to work also, recording radio signals from deep within the galaxy's center.

The two instruments are made up of thin aluminum reflectors mounted in aluminum and steel frames and supported on steel towers. By means of remote-controlled electric motor drives and large gears, the telescopes can be pointed at any spot in the sky and can "track" a radio source as the earth rotates. Because the surface error in the 85-foot reflector has been reduced to less than 1-millimeter, the instrument is regarded as the most accurate large telescope yet built in the United States.

Construction of the Laboratory was begun two years ago on a 60-acre site located in the "quietest" (in terms of radio interference) accessible valley in northern California. Surrounding the site is the massive Hat Creek lava flow, while about 50 miles to the north is 14,162-foot Mt. Shasta and 20 miles to the south, 10,453-foot Mt. Lassen. Against this background the two telescopes appear as dwarfs. They stand 400 feet apart on an east-west line, each with its own laboratory

Atop portable elevator a technican makes adjustments on the antenna "horn" at focus of the new 85-foot telescope. Radio waves are reflected into the coaxial horn, then sent to receivers in a laboratory building nearby.

building containing control instruments and sensitive radio receivers. The receivers are connected to recording devices where the incoming radio signals are traced off on paper. Living quarters, situated one-half mile away, consist of homes for three resident staff members and a modern dormitory for students and faculty members from the Berkeley campus.

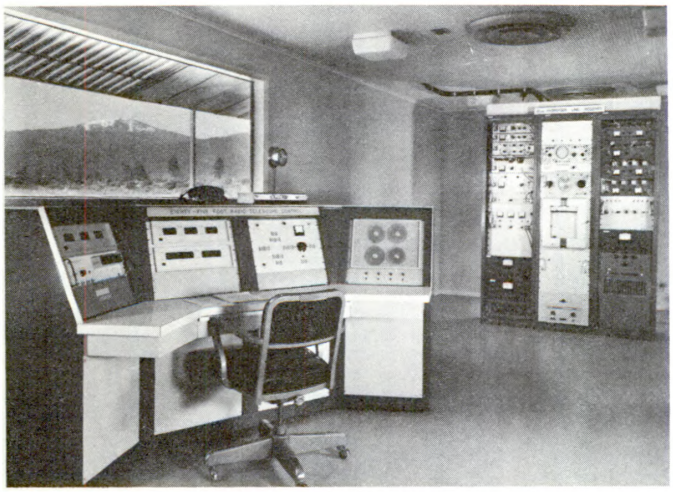
The initial research programs of the Laboratory will be confined largely to the study of the Milky Way. "In the broadest sense," says Dr. Harold Weaver, Laboratory Director, "we will be interested in the distribution of gaseous material in the galaxy, and the motions of this material. From the study of these aspects of the gas, we hope to learn more about the structure and dynamics of the galaxy, and about the way it changes with time. We hope also to learn more about the way in which stars are formed from the gases and particles in the arms of the galaxy."

The map of the northern Milky Way, already produced by the smaller Hat Creek telescope, shows the pattern of thermal radiation arising from hydrogen gas. From this map, determinations will be made of the distribution of ionized hydrogen—known to be associated with hot, bright stars—making it possible to trace the pattern of the stars in the spiral arms of the galaxy. The next project for the smaller telescope will be another mapping of the galaxy to determine the distribution of neutral hydrogen gas—which emits radiation on a well-defined wavelength. The ultimate goal is to learn whether the spiral arms of the galaxy occupy the same positions if they are defined by stars, by neutral hydrogen, or by magnetic fields.

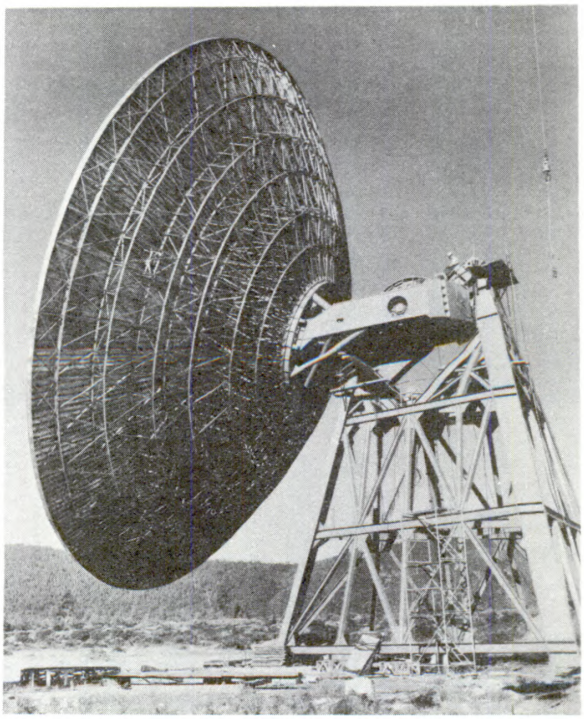
The intensive study of the center of the galaxy, being conducted with the 85-foot telescope, will provide information about the little-understood

concentration of gaseous material there. This nucleus, which was first observed with radio telescopes, is thought to hold the key to important questions about the circulation of matter through the entire galaxy. Measurements made with this instrument will also provide more information on the way in which stars are formed. As hydrogen condenses to form a new star, it gradually heats up, eventually to the point at which nuclear reactions take place, converting hydrogen into helium. Thermal radiation generated by this heating process can be observed by the Hat Creek telescope.

The Hat Creek Laboratory is one of four major radio telescope installations which have been built for universities with funds provided in



Control panels for 85-foot telescope.



Workmen put finishing touches on new 85-foot telescope. Shown here is back of reflector, displaying truss structure and mounting ring. The polar-axis drive, capable of pointing the telescope at any spot in the sky, can also be seen.

large part by the Office of Naval Research. ONR is also supporting, in part, the operation of the telescopes.

A second 85-foot instrument is operated by the University of Michigan [Naval Research Reviews, July 1959], which has as its special mission the study of the sun and the planets. The recent addition of a ruby maser to this instrument resulted in the first clearcut detection of radio waves from the planet Saturn.

Another installation is located in Owens Valley, California, and is operated by the California Institute of Technology, [Naval Research Reviews, April 1959]. It consists of two 90-foot dishes which operate on tracks perpendicular to each other. Serving as a radio interferometer, the twin antennae can focus sharply on radio sources in galaxies hundreds of millions of light years away. Scientists at this establishment are attempting to identify hundreds of radio sources in space by relating them to nearby visible stars. Working in conjunction with the 200-inch Palomar telescope, the CalTech instrument last year located the most distant galaxy yet discovered--about 6 billion light years away.

Just completed near Danville, Illinois, is the fourth ONR-sponsored radio telescope [Naval Research Reviews, July 1960], which at present is one of the largest non-steerable telescopes in the world. Operated by the University of Illinois, this unique instrument has a parabolic cylinder that was literally scooped out of a convenient valley. The antenna, 400 feet wide and 600 feet long, is now undergoing tests prior to being put into full-scale operation. It will receive radio signals as they cross the meridian, giving accurate positions and spectral information of sources far outside our galaxy. It is expected to be the most sensitive radio telescope in the world.

Through its own research establishment—the Naval Research Laboratory—ONR supports several other large radio telescopes. A 50-foot reflector, located on the Laboratory grounds in Washington, D. C. [Naval Research Reviews, March 1958] has been in use for many years, an 84-foot instrument is in operation at Maryland Point, Maryland [Naval Research Reviews, January 1958], and a 150-foot telescope is nearing completion at NRL's Chesapeake Bay Annex, Maryland [Naval Research Reviews, February 1962]. However, the largest steerable radio telescope of them all--worldwide--is now being erected at Sugar Grove, West Virginia. This Navy antenna, whose technical characteristics were determined by NRL and whose astronomical research program will be directed by that Laboratory, will be 600 feet in diameter, more than 7 acres in extent, and taller than the Washington Monument.

But the objects in space to be investigated are multitudinous. Although the now large Hat Creek reflector will be small tomorrow, at least when compared with the Sugar Grove giant, it is expected to become even more useful as time passes.

Two aircraft soon to be developed by the Department of Defense will have variable sweep wings, giving them the slow-speed landing and take-off characteristics of straight-wing aircraft, and the high speeds possible with swept wings.

Research Notes

KYMA Begins Ocean Research for NYU

New York University's new research ship KYMA (Greek, meaning "waves") begins its first research task for the University this summer with an investigation of ocean features over the Hudson Canyon. The study, which will extend into autumn, will concern bottom pressure fluctuations due to wave action over the canyon, radiation balance, including incident and reflected short-wave radiation, turbulence, and surface-wind patterns at selected levels within a 1- to 10-meter range above the sea surface.

The ship, which arrived in New York in May after a 2,300-mile voyage from New Orleans, was made available to NYU by the Office of Naval Research for use by the University's Department of Oceanography and Meteorology. ONR also instrumented the ship for the school.

KYMA is about 65 feet long, has a beam of slightly more than 17 feet, and is powered by a 270-horsepower diesel engine. Her top speed is 12 knots and her cruising range, 500 miles. Before leaving New Orleans, KYMA was extensively modified by the Industrial Manager of the Eighth Naval District. One of the outstanding changes made was the conversion of a former cargo space into an oceanographic-instrumentation laboratory. The many shelves built along the bulkheads and the spacious work benches that were provided would be envied by many sea-going oceanographers.

Instrumentation and equipment added to KYMA include the following: a bathythermograph winch and boom, LORAN, radar, an echo sounder (Raytheon) with two recorders, two ship-to-shore radios, and a 20-kilowatt ac auxiliary diesel generator. At present the ship does not have an oceanographic winch, A-Frame, and platform. It is expected that these will be added during the early part of next year.

KYMA is now anchored at the New York State Maritime Academy, Fort Schuyler, New York. Permanent docking facilities will be constructed on the Harlem River with funds provided by the National Science Foundation and matched by the University.

Solar Elastic Waves Detected

With support from the Office of Naval Research, Dr. Robert B. Leighton of the California Institute of Technology has achieved the first direct detection of the large-scale elastic waves which have for some time been thought to exist in the atmosphere of the sun. This was done through the 60-foot solar telescope on Mount Wilson, using Leighton's doppler camera. The camera takes two pictures of the solar surface simultaneously, one using the light from one edge of a spectral line of, say, hydrogen, and the other using the light from the other edge of the same spectral line. The negative of one of the pictures is superposed on the positive of the other, and as a result of the doppler effect the motion of the gases in the solar atmosphere is translated into shades of gray.

Using this technique, Dr. Leighton has discovered the existence of huge solar patches consisting of waves which rise and fall at speeds of 1000 miles per hour. These elastic waves appear in a random spatial pattern, but the pattern has a strong tendency to repeat itself with a 5-minute period. The large patches are similar in appearance to the well-known granules in the solar surface, but have diameters of about 10,000 miles as compared with the 600-mile diameters of the granules, and last for as long as a day as compared with the lifetime of a few minutes of a granule.

Dr. Leighton believes that the roots of the large patches go much deeper into the sun, perhaps several thousand miles, to some solar instability at that depth. The elastic waves may provide the mechanism whereby energy is transferred from the interior of the sun to the chromosphere and the corona. Each of the patches—about 5,000 have been observed—is an independent atmospheric circulation system, as are the several million granules.

Dr. Leighton is improving his technique, and hopes that work now in progress will provide much new information about the general nature as well as the detailed properties of the motions in the solar atmosphere.

Awards

• Dr. Norman Jasper, technical director of the Navy's Mine Defense Laboratory, Panama City, Florida, has received the Department of Defense Distinguished Civilian Service Award. Dr. Jasper was chosen for the award for achievements in providing a solution to a problem in ship silencing. The work was performed at the David Taylor Model Basin, where Dr. Jasper served as supervisory physicist and consultant to the Commanding Officer and Director. The Distinguished Civilian Service Award is the highest honor conferred on civilian employees by the Department of Defense.

• Dr. Donald R. Griffin, of the Biological Laboratory of Harvard University, has been awarded the Daniel Giraud Elliot Medal by the National Academy of Sciences. The award was presented in recognition of Dr. Griffin's outstanding book, "Listening in the Dark: The Acoustic Orientation of Bats and Men." The greater part of the research discussed in the book was conducted by Dr. Griffin under a contract with the Biology Branch of the Office of Naval Research.

• A medal and $5,000 have been presented by the Navy to Dr. Herbert Friedman, superintendent of the Naval Research Laboratory's Atmosphere and Astrophysics Division. Dr. Friedman was singled out for this award—the first Navy Award for Distinguished Achievement in Science—for his many discoveries and accomplishments in upper-air research. These include the first proof of the origin of X-rays in the sun, development of the new science of rocket astronomy, and the compilation of the first ultraviolet map of celestial bodies. In 1959, Dr. Friedman was awarded the Department of Defense Distinguished Civilian Service Award for the development of radiation detection devices.

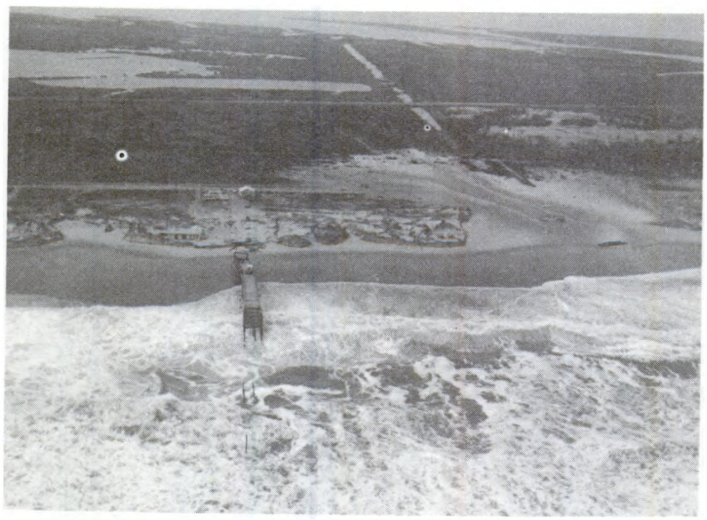
Hibernation and Temperature Acclimation

Ground squirrel in deep sleep at 5° C.

The Physiology Branch of the Office of Naval Research is co-sponsoring two symposia later this summer.

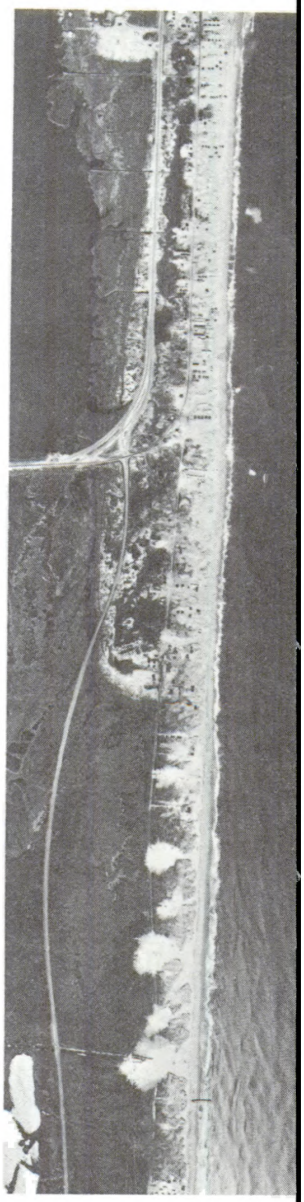
The Second International Symposium on Natural Mammalian Hibernation will be held in Helsinki, Finland, August 27-31, under the chairmanship of Dr. Paavo Suomalainen of Helsinki University. Approximately 60 invited attendees will be present, including representatives from Sweden, Russia, France, Germany, Austria, and Norway. This symposium will elucidate research progress which has been made by American and foreign scientists in hibernation, a biological phenomenon which produces drastic adaptive changes in normal physiological mechianisms. Hibernation is of increasing interest in the scientific community today due to its relevance to hypothermia and the latter's application to open heart surgery and other medical problems, as well as its application to cold survival.

The Temperature Acclimation Symposium will be held in Leiden, the Netherlands, Holland, September 5-7. Included in the program are such aspects of the overall problem as age, sex, and race factors; recent metabolic, neurological and hormonal developments in adaptation; and a comparison of natural and artificial acclimatization. A critical analysis of the current status of the physiology of exposure to heat and cold will be of great value to the Navy.



Pier that was site of ONR-LSU studies is pictured above and below, after and before storm. It can be seen at bottom of aerial photo (right) as thin dark line; note the many paths made by storm waves which washed through or over dunes.

Coast & Geodetic Survey photo; March 13, 1962; altitude, 12,000 feet.



BEFORE

AFTER

Views of beach and dune ridge from study-project pier before and after storm, showing extent to which ridge was cut back. Original stakes ("BEFORE"), washed out by storm, were replaced for "AFTER" photo.

Atlantic Storm Area Revisited

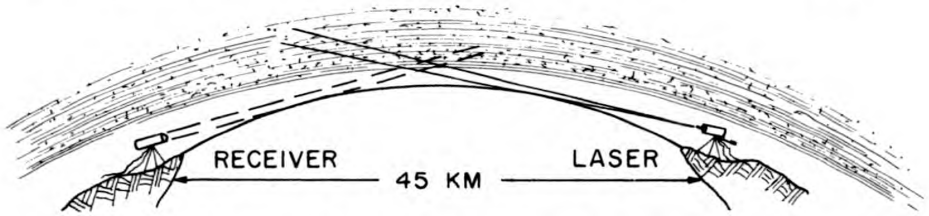
An account in Naval Research Reviews (April 1962) describes briefly the devastation wreaked on an ONR-supported beach-studies project near Cape Hatteras by the violent storm last March which battered the Atlantic coast from the Carolinas to New York. The project director, Mr. Robert Dolan of Louisiana State University, has now made a preliminary survey of changes effected by the storm along a 26-mile stretch of the outer banks near Cape Hatteras, utilizing aerial photographs taken by the Air Force. A summary of his findings is given below:

At the project site, the barrier dune ridge was cut back between 100 and 135 feet, a wedge of material being removed that averaged a little more than 8 feet in thickness. Considering that the dunes had remained in place for a period of 25 years prior to this storm (they were built up by artificial processes), this change may prove to be permanent.

Along the 26-mile stretch of coastline southward from the project area to Rodanthe, the following major effects were noted: Sea water washed over sand dunes at 62 points; the ocean breached the dune wall at 85 locations, and the ocean actually cut all the way through the island in 8 areas. One of the dune breaches, 1 mile north of Rodanthe, is more than 3-1/2 miles in length, and sand was carried up to 1000 feet inland. An idea of the tremendous amount of material moved by the storm is revealed by the average distance inland the dunes were cut back—between 85 and 95 feet along the 26-mile stretch of coastline.

The ONR-LSU investigation of beach processes will be resumed after repairs have been made and equipment reinstalled.

Long Range Light Transmission with a Laser



As everyone knows, a light held a few feet above open water on a clear night can be seen only a mile or two away by a person also near the water—say in a small boat—owing to the curvature of the earth. But a group of NRL physicists, carrying out a series of optical experiments on Chesapeake Bay, recently succeeded in detecting a beam of light over a distance of 45 kilometers—about 28 miles. At the time, furthermore, a slight haze limited natural visibility to less than 10 kilometers. Both the light source (on Tilghman Island), and receiver (at Patuxent NAS) were only 6 feet above the water.

The device that enabled the light to be propagated over so long a range was a ruby laser, a device that collimates a light source into an extremely narrow, pencil-like beam with a spread of only 45 min. of arc. The beam was trained at the distant receiver at an elevation of 1 degree. The detector, which had a receiving field of 2 degrees and was also elevated 1 degree, received the light not directly, but reflected from the atmosphere. Although the light is drastically attenuated in this way, such is the intensity of the laser's concentrated beam, and the sensitivity of the pick up, that the transmission on a clear night could presumably be extended to several hundred kilometers.

For the Chesapeake experiments, the original light source, or exciting lamp, had an energy of 450 joules at 1500 volts. The laser (light amplification by stimulated emission of radiation) absorbed a portion of the lamp light and emitted 0.2 joule at a wavelength of 6943 Angstrom units—corresponding to dark red in the color spectrum. The atmospheric reflection from this faint red light was picked up at the receiving end by a reflecting mirror, or small optical telescope, which focused the light into a photomultiplier tube. It was estimated that the received signal strength was about 1/100,000th of the original, after the 45 km transmission.

These experiments, carried out with a laser of comparatively low energy, were exploratory, done in connection with a general study of the optics of the atmosphere. More sophisticated devices could extend the range much further, and could presumably permit transmissions in daylight as well as in darkness. The latter presumption depends upon the development of sensitive filters that will bypass all of the solar radiation except the narrow band at the laser's emission.

Of the 370 United States oceanographers--listed in the International Directory of Oceanography--who do not work directly for the Government (about 90 others do), nearly all are entirely or in part supported by research grants and contracts stemming from public funds.

On The Naval Research Reserve

CDR D. E. Oglevee, USNR, Reserve Plans Section, Bureau of Naval Personnel, addresses seminar.

ONR Seminar

The Fourteenth Annual Naval Reserve Research Seminar—sponsored by the Office of Naval Research and conducted by Naval Reserve Research Company 5-8—convened for two weeks in Washington, D. C., on June 4. This seminar was the largest yet conducted in the series, with 139 officers from the Naval and Army Reserves participating. The objective of the seminar was to provide a broad view of current research and development activities in the Navy, to discuss research trends and future programs, and to interest the seminar officers in research problems facing the Navy. The program was under the general direction of CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve) and CDR R. N. Jennings, USNR, Training Officer. Technical direction of the program was provided by Dr. S. Silverman, Research Director, ONR. CDR J. W. Winchester, USNR, of NRRC 5-8, served as chairman.

Unlike the previous several seminars, the fourteenth seminar was held in general sessions in order to carry out the seminar objective. During the first week, naval development programs and long term naval requirements were considered. During the second week, research activities in scientific fields of interest to the Navy were stressed. The seminar included three field trips to research facilities—one day each at the Naval Research Laboratory and the Naval Ordnance Laboratory and a half day at the NASA's Goddard Space Flight Center.

CAPT John M. Ballinger, USN, Deputy and Assistant Chief, ONR, welcomed the officers on behalf of RADM L. D. Coates, USN, Chief of Naval Research. The Hon. James H. Wakelin, Jr., Assistant Secretary of the Navy (Research and Development), discussed the "Role of the Navy in Research and Development." The group had the pleasure of being addressed by several flag officers during its first week of sessions. VADM William F. Raborn, USN, Deputy Chief of Naval Operations (Development), spoke on "Research and Development Concepts in OPNAV." RADM T. F. Connolly, USN, Director, Strike Warfare Division; RADM J. N. Shaffer, USN, Director, Anti Submarine Warfare Division; RADM J. P. Monroe, USN, Director, Development Facilities, Astronautics and Ranges Division; RADM I. J. Galantin, USN, Director, Special Projects; and RADM T. H. Moorer, USN, Director, Long Range Objectives Group, each discussed the activities of his Naval Operations office as related to research and development and long-range requirements. Mr. S. E. Clements, Executive Assistant to the Director of Defense (Research and Engineering), spoke on "Research and Development Management in DOD." Also during this week, RADM H. S. Monroe, USN, Assistant Chief of Naval Operations (Naval Reserve), addressed a luncheon meeting of the seminar. The last day of the

Officers discuss Reserve activities at ONR Seminar. Left to right, CDR W. J. Winchester, USNR; CAPT J. J. Michael, USNR; CAPT G. A. O'Connel, USN; CAPT J. W. Jockusch, Jr., USNR; and CAPT F. A. Wiggin, USNR.

development portion of the seminar covered "The Navy and the Space Age;" its sessions were chaired by CAPT R. J. Trauger, USN, of ONR.

During the second week of the seminar the state of the art in several basic scientific fields was reviewed. Dr. R. D. Reid, Director, Biological

Summer Seminars

The Research Reserve is sponsoring three seminars in the First Quarter of Fiscal Year 1963:

Seminar	Convening Date
Nuclear Sciences at Idaho Falls, Idaho	July 23
Naval Research Laboratory at Washington, D. C.	August 20
Biological Defense at Fort Detrick, Frederick, Maryland	September 10

Making its initial debut in the Research Reserve Program on September 10 is the Biological Defense Seminar to take place at Fort Detrick, Frederick, Maryland. It will be presented by the members of NRRC 5-3 of Frederick. The members of this company have arranged an exceptionally fine program on the capabilities, limitations, and problems of biological warfare and defense, both from scientific and military viewpoints. Qualifications in the biological sciences are desired, and a Secret security clearance is required.

Sciences Division, ONR, acted as chairman for the biological sciences presentations, and Dr. R. Trumbull, Director, Psychological Sciences Division, ONR, chaired the sessions on the psychological sciences. The discussions on the "Geophysical Relations to Nuclear Weapons" was chaired by J. W. Winchester, Physical Sciences Administrator, Earth Sciences Division, ONR. Dr. A. E. Maxwell, Head, Geophysics Branch, ONR, was chairman for the sessions on the "Frontiers of Oceanic Research." The group was most fortunate in that the speakers in these sessions were leading authorities in their fields. This led to some very interesting and useful question periods following the presentations. Interest in the discussions was further enhanced by the freshness of subject matter, some of it concerning experiments which were still in process.

The last day of the seminar brought the officers up to date on the Naval and Army Reserve programs. For this purpose, the seminar held its only separate meetings. Reserve progress and objectives were reviewed and, as a matter of personal interest, presentations were made on Reserve promotions and officer plans. CAPT Jockusch gave the final briefing, on the Research Reserve program. After closing remarks by the seminar chairman, the "Seminar Degree," a certificate attesting to attendance at the fourteenth seminar, was presented to each officer by CAPT Jockusch and CDR Winchester. The excellence and overall value of the seminar were demonstrated by the many comments made during the sessions and was further reflected by the written critiques received from each officer who attended the sessions.

Oak Ridge Seminar

The Thirteenth Annual Research Reserve Nuclear Sciences Seminar at Oak Ridge, Tennessee, was conducted during the period June 4-16. The program was organized and presented by the local Research Reserve Company, NRRC 6-3. In attendance were 91 Reserve officers—71 from the Navy and 20 from the Army's Research and Development Reserve Program. The seminar was sponsored by the Office of Naval

Dr. L. K. Akers of Oak Ridge National Laboratory, explains to reservists the application of low-level counting techniques to dating of ocean-bottom sediments. Left to right, CAPT L. T. Palmer; LTCOL M. J. Burns, USAR; CDR J. D. Baer; and LCDR D. M. Molnar.

Research in conjunction with the Atomic Energy Commission (AEC), the Oak Ridge National Laboratory (ORNL), and the Oak Ridge Institute of Nuclear Studies (ORINS). LCDR Claude L. Yarbro, USNR, a member of NRRC 6-3, served as chairman.

Dr. R. T. Overman, Director, Special Training Division, ORINS, opened the seminar and welcomed the conferees to Oak Ridge. Presentations were made on the opening day by CAPT W. T. Sawyer, USN, Director, Naval Applications Group, Office of Naval Research, and Mr. S. R. Sapirie, Manager, Oak Ridge Operations, AEC. The technical program consisted of lectures and discussion of topics and recent developments in the nuclear sciences including reactor design and engineering, health physics, peaceful uses of atomic energy, accelerators, radioisotope instrumentation, transuranium elements, radioactive waste disposal, biological effects of radiation, and radioecology.

Among the highlights of the seminar were the tour of the Oak Ridge National Laboratory, where the seminar group was shown the Isotope Area, the Oak Ridge Research Reactor, the Bulk Shielding Reactor, the X-10 Graphite Reactor, and the Oak Ridge Isochronous Cyclotron. Also received with enthusiasm were the talks by Mr. P. P. Holz, ORNL, and a member of NRRC 6-3, who made a presentation on reactor maintenance highlighted by an illustrated discussion of the repair of the core vessel of the HRE-2 reactor at ORNL; the talk by Mr. Murray Rosenthal, ORNL, who discussed problems associated with the design and engineering aspects of the pebble bed reactor concept; and the talk by Dr. T. S. Osborne, of the University of Tennessee—Atomic Energy Commission Agricultural Research Laboratory, who spoke on research problems and developments in the area of utilization of radiation in plant breeding.

On Monday, June 11, military speakers' day, informative presentations were made by CDR Gordon C. Facer, USN, Weapons Division, Defense Atomic Support Agency, "Nuclear Weapons;" CDR W. P. Crutchfield, USN, Head, Power Section, Atomic Energy Division, Office of the Chief of Naval Operations, "Navy's Nuclear Power Program;" CAPT Joseph F. Castro, USA, Division of Reactor Development, AEC, "Army Nuclear Rocket Program," and CAPT C. W. Morgan, USAF, "Project Pluto."

On Friday of the first week, CAPT J. W. Jockusch, Jr., USNR, Assistant to the Chief of Naval Research for Research Reserve, brought the Reservists up to date on the Reserve program.

New Company Established

A new addition to the Research Reserve Program is the recently activated company at Indianapolis, Indiana—Naval Reserve Research Company 9-25. With an initial membership of ten officers, this company was formally established on May 12, at a ceremony presided over by CAPT Barton E. Day, USN, Commanding Officer, Naval Avionics Facility, Indianapolis. LT Albert S. Humphrey, USNR, is serving as commanding officer.

Also present at the Naval Avionics Facility that day were officers of other Research Reserve companies who visited the activity for one

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day on group training duty. Participants in the tour of the Facility, in addition to members of the newly founded company, were reservists from Chicago, Illinois; Lafayette, Indiana; St. Louis, Missouri; and Forest Park, Illinois.

Engineering Development Center Toured

Nine members of Naval Reserve Research Company 6-3, Oak Ridge, Tennessee, visited Arnold Engineering Development Center, Tullahoma, Tennessee, on May 25 as part of a group training tour.

The Center operates under the Air Force Systems Command and has a four-part mission: (1) basic concept validation; in other words, to prove or disprove the designer; (2) development testing; (3) "debugging;" and (4) design and development of future testing facilities. Initially the Center tested air-breathing, air-lifted systems whose performance was in the low supersonic regions at best. Today, it is capable of handling aerospace systems at hypersonic speeds in the rarefied, rigorous environment of future flight. Its test facilities fall into three groups, as follows:

- The von Karman Gas Dynamics Facility performs aerodynamic testing of scale models of aircraft, missiles, and space weapons under simulated altitudes ranging from sea level to more than 200,000 feet and at speeds ranging from 1,000 to over 18,000 miles per hour.

- The Rocket Test Facility tests aircraft, missile, and spacecraft propulsion systems under simulated altitudes ranging from sea level to over 140,000 feet, with speeds ranging from subsonic to Mach 3 at temperatures between -120° and +800°F.

- The Propulsion Wind Tunnel tests aircraft and missile propulsion systems, mounted as in flight, to investigate the combined aerodynamic-propulsion characteristics. Altitudes of more than 100,000 feet and speeds up to about 3,800 miles per hour can be simulated.

RADM Coates to Speak in Buenos Aires

At the invitation of the Argentine Navy, RADM L. D. Coates, Chief of Naval Research, planned to visit Buenos Aires this month to discuss research and development programs of the U. S. Navy with Argentine officials.

During his stay in this capital city--from July 16 to 19--the Admiral was scheduled to make several speeches--one to a gathering of Argentine Navy officers and civilian technicians; another to senior officers; and a third to a meeting of the members of the Naval Institute of Conferences at the Centro Naval (Naval Club). One of the fields of research to be stressed in the talks was oceanography. Another subject to be discussed was international cooperation in research and development, such as between the United States and Argentina.

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.

Prototype amphibious Airoll vehicles, of about 1/2-ton payload, being developed for the Marine Corps. See story beginning on page 1 for a discussion of this vehicle and the experimental work involved in perfecting it, carried out under sponsorship of the Office of Naval Research.

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