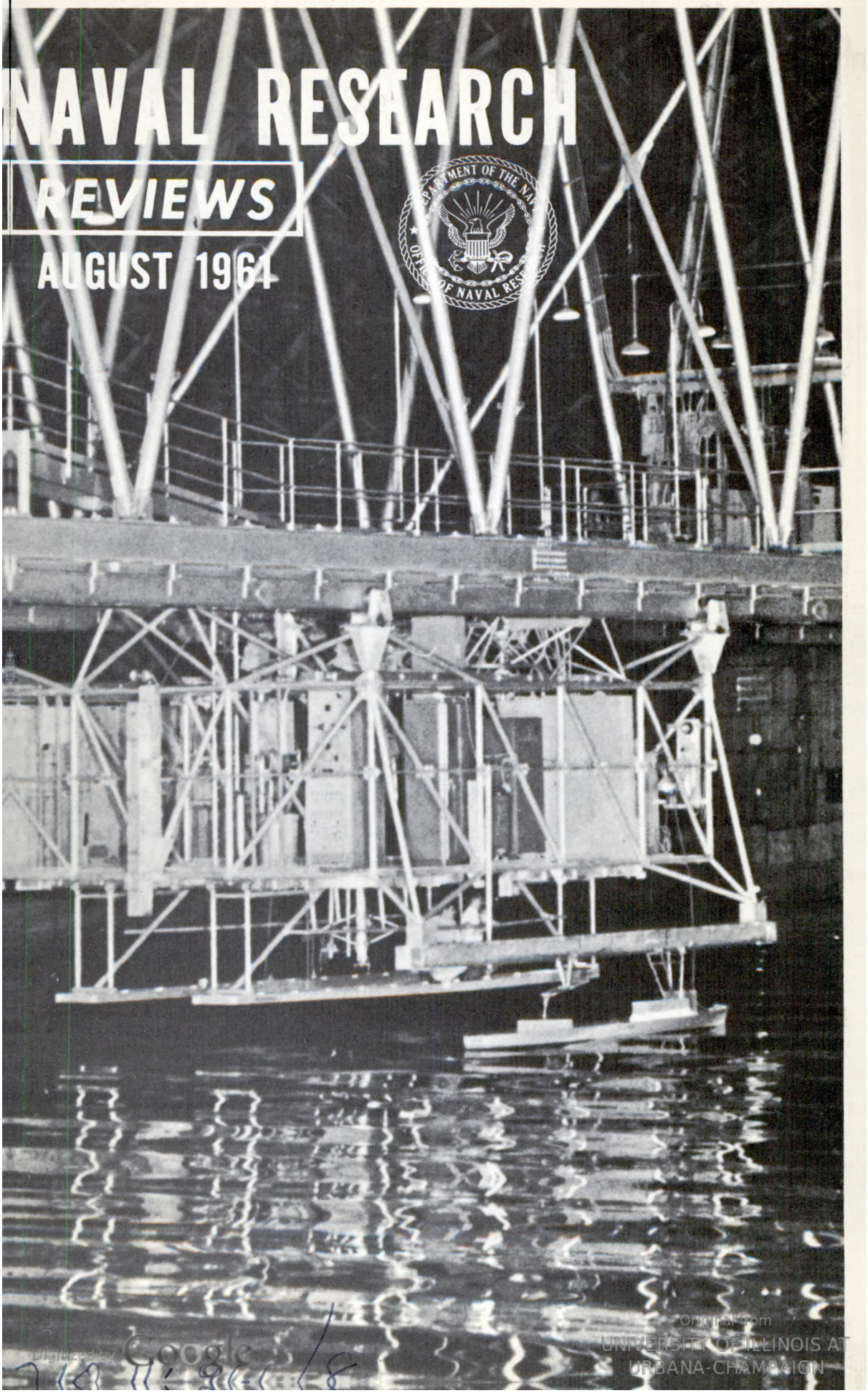
NAVAL RESEARCH REVIEWS

AUGUST 1964



New Chief Scientist at ONR

Dr. F. J. Weyl

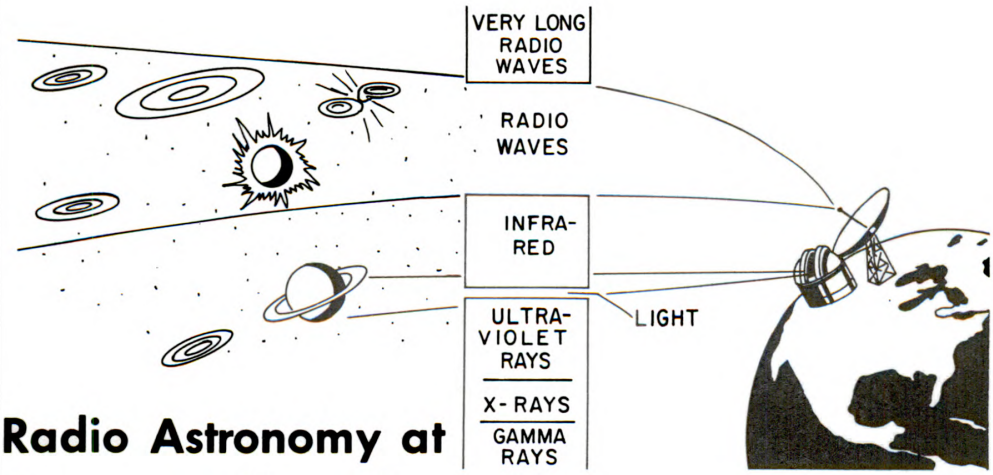
Dr. F. Joachim Weyl has been appointed Deputy Chief and Chief Scientist of the Office of Naval Research. He will replace Dr. Thomas J. Killian who has resigned to accept a position in private industry.

Dr. Weyl was born in 1915 in Zurich, Switzerland. (His father was Professor Hermann Weyl, the internationally known mathematician who resigned his professorship at the University of Gottingen in protest against the Nazi government.) Dr. Weyl attended Swarthmore College, graduating in 1935 with highest honors, and then went on to Princeton where he received his Ph.D. in 1939. Later, he taught at the University of Maryland and Indiana University. During World War II, he was employed by the Navy Department's Bureau of Ordnance in the Research Group on High Explosives. He also participated in the first atomic bomb tests at Bikini.

Dr. Weyl joined the Office of Naval Research in 1947 as a member of the Mathematics Branch, where he established a contract program in applied mathematics. He became head of that branch in 1949. In 1951 Dr. Weyl was assigned as a scientific liaison officer with the Office of Naval Research Branch Office, London. He returned to ONR, Washington, in 1952, and in 1953 was advanced to the position of Director of the Mathematical Sciences Division. While in this position, he was asked by the National Research Council to conduct a survey of research and training in applied mathematics in the United States. The report of this survey, completed in 1954, was published by the Society for Industrial and Applied Mathematics in 1956. In 1958, he was appointed Research Director, which placed him in charge of ONR's vast contract research program.

Dr. Weyl is a member of the Washington Academy of Sciences, the Washington Philosophical Society, the American Physical Society, the American Mathematical Society, the Mathematical Association of America, and is President of the Society for Industrial and Applied Mathematics. He resides with his wife, the former Martha Bowditch, and his two daughters Annemarie, 20, and Christine, 16, at 3025 Macomb Street, N. W., Washington, D. C.

The new RESEARCH DIRECTOR—relieving Dr. Weyl—is Dr. Shirleigh Silverman, who has headed the ONR Naval Research Group (the six "science" divisions) since June 1958.



Radio Astronomy at Owens Valley Observatory

G. J. Stanley
California Institute of Technology

Radio astronomy, one of the fastest growing branches of modern physics, encompasses the technical fields of radio and electronics and the observational field of astronomy. Today investigators using radio telescopes have opened up a newer and wider "window" in the spectrum and are working with astronomers using optical telescopes to disclose much new information about our universe that may answer questions concerning its origin, extent, and future. Some radio "stars," extra-terrestrial sources of radio energy whose nature was unknown until recently, are now revealing themselves to be extremely distant galaxies, some of which appear to be in collision; other "stars" have turned out to be vast clouds of debris (supernova remnants) from old explosions within our own galaxy. (Actually, the term "radio star" is misleading, for so far only one radio-energy source, other than our own sun, has been identified with a star.) Radio astronomy research has disclosed also that there may be a large halo or corona around our own galaxy, that the diameter of the sun's corona is at least ten times that of the sun itself, and that very distant parts of the universe are much different from, and more crowded than, the nearby more-visible regions.

In order to initiate an important program of radio astronomy, the California Institute of Technology established in 1958 a radio observatory in Owens Valley, California. This observatory, whose main mission at present is the precise location and size determination of radio stars, was constructed with the financial support and continuing aid of the Office Naval Research. Other fields of interest at Owens Valley include a study of the 21-cm (1420 Mc) hydrogen line emission from cold clouds of atomic hydrogen dispersed in interstellar space, studies of "brightness" variations over the surface of the sun, and observations of anomalous radiations from the planet Jupiter. In support of these programs, rather unique types of instrumentation have been developed and, to a limited extent, some development work in electronics is being carried on.

Since the discovery of radio stars in 1947, the accurate measurement of their positions and the correlation of these sources with optically visible objects remain among the most important and yet difficult problems in radio astronomy. The difficulty lies not only in the limited resolution of radio telescopes but in the nature of the radio stars themselves. The essence of the latter part of this problem is this: If radio stars were characterized by some feature of appearance on a photographic plate, such as shape or brightness, it might be possible to identify many radio stars with optically visible objects from relatively coarse radio-telescope position measurements. However, many radio stars are so faint optically as to be scarcely discernible on the most sensitive photographs, and frequently show no unique appearance. Under these circumstances, a radio-positional accuracy of better than 30 seconds of arc is needed to obtain a distinct correlation with objects seen on a photographic plate.

In order to achieve this precision, a novel variation of the much-used interferometry technique is being utilized at the Observatory. The interferometer consists of two 90-foot parabolic antennas (Figure 1) in which variable spacing can be obtained by moving the antenna units along 1600-foot tracks in either a north-south or east-west direction. The uniqueness of this system lies in the comparatively high resolving (''focusing'') power of the individual antennas (approximately 1°) and its mobility along the tracks.

The precise position of radio stars is determined by using the two antennas at fixed separations, first in an east-west direction to obtain the right ascension and then north-south to determine declination. Once located, the radio intensity variations across the radio source, as well as the angular size, can be obtained by plotting the intensity of radiation received versus the distance of separation of the two antennas used as an interferometer. It was found that this interferometer yields an absolute positional accuracy somewhat better than 10 seconds of arc; the fineness hinges upon the maintenance of the spacing between the two antennas to an accuracy of a few tenths of an inch. Furthermore, the relative position of an object in space can be determined with an accuracy of three seconds of arc. A typical record of a weak radio source is shown in Figure 2.

RESEARCH PROGRAMS AT OWENS VALLEY

The first research program was a partial survey of the sources in the Third Cambridge Catalog of Radio Stars (usually referred to as the 3C survey). The most important result obtained from this survey was the marked difference found between the observed radio spectra of galactic and extragalactic radio sources. The known 10 super-nova remnants in the galactic plane (the Milky Way) were again examined and another 12 identifications of radio sources with such objects were added. The positioning program currently in progress consists of a detailed study of approximately 200 known extragalactic radio sources in a selected list. The radio-telescope observational part of the program is now almost completed. Most of the remaining work involves attempting to identify these radio sources with optically visible objects on the currently available photographic plates of the Palomar Sky Survey. Of the radio sources so far examined, 53 percent have been identified with

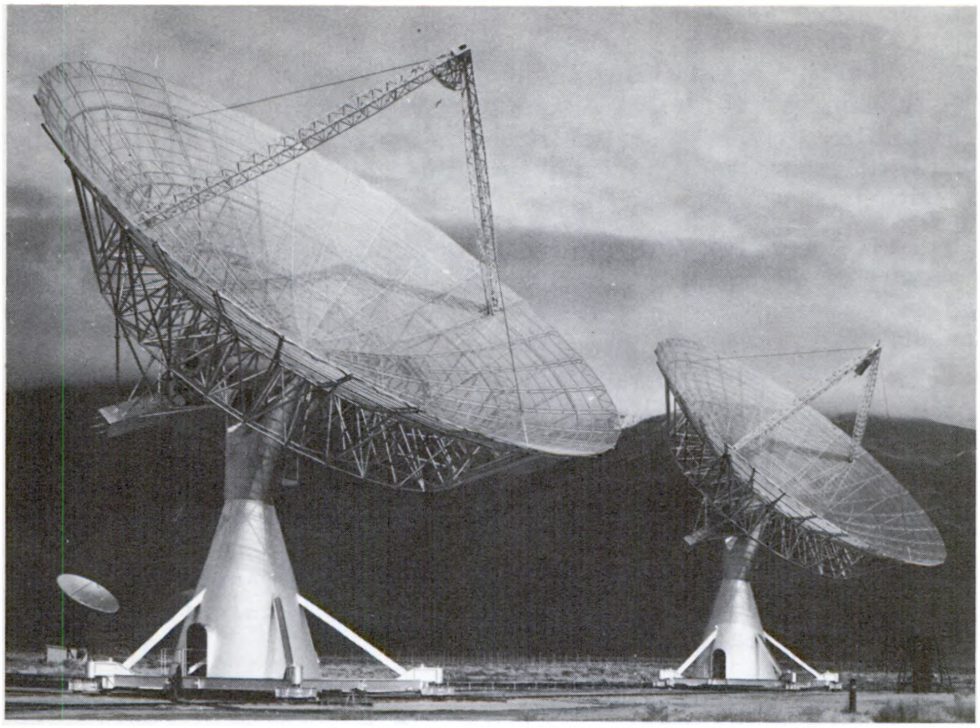


Figure 1 - The east-west arm of CalTech's Owens Valley Radio Observatory interferometer system showing the two 90-foot parabolic antennas. In the left background is a 32-foot precision antenna. (CalTech photo)

optically visible objects. Of these, 45 percent were found to be near clusters of external galaxies. It is certain that the percentage of corroborative identifications will go even higher when the position data are correlated with the angular size measurements. Some of the strongest emitters among these radio sources have already been photographed with the Hale telescope at Mt. Palomar Observatory.

Among these objects was the radio source 3C-295 in the constellation Boötes. The nature of this source, unknown for 10 years, was recently solved when more precise position information was obtained. Using these new data, Dr. Minkowski of the Mt. Palomar Observatory, re-photographed the area with the Hale telescope and after two hours of exposure obtained a picture that showed a tiny blurred speck surrounded by numerous ill-defined and fainter dots. All of the objects are thought to be extremely distant galaxies. The most important finding, however, came after the optical spectrum was obtained by exposing a slow photographic plate for four and one-half and nine hours on two different nights.

Such spectra can reveal not only the elemental makeup of an object, but can also disclose its velocity through space by making use of the well-known Doppler effect used commonly in radar observations. For example, if an object in space is receding from our vantage point, the Doppler effect shows up in a lengthening of its energy waves, thus shifting its spectrum toward the longer wavelengths. This is called the red-shift phenomenon. The largest red shift ever seen—from the ultraviolet

to the green wavelength—was recorded for the galaxy 3C-295. This means that the observed galaxy is receding at the phenomenal rate of almost half the speed of light, which, according to the velocity-distance relationship, represents a distance of six billion light years. Through this single finding, then, the observable universe has been extended three times its formerly visible radius and, therefore, 27 times its previously known volume!

At the other extreme, the radio object 3C-48, after being precisely located and then photographed through the Hale telescope, was located within our own galaxy and was found to be a special type of star having unusual spectral properties. This discovery probably carries even more fascinating implications for radio astronomers, for it is the first stellar object to be identified as a radio-wave emitter, other than our own sun.

The task of photographing the remaining objects in the list is so tedious that the optical spectra of the radio objects identified at Owens Valley will take almost five years with any reasonable allocation of telescope time. It may be that when such a program is at last completed we will be able to find some systematic pattern in the physical nature of the extragalactic radio sources.

The Owens Valley interferometer is also capable of producing detailed radio isophotes (lines of equal radio-wave intensity, giving a kind of two-dimensional "topographic" map) of objects as small as 2 minutes of arc in diameter. Another large, and as yet incomplete, part of our research effort is devoted to the measurement of isophotes of the 200 sources in our position-finding list. Our efforts so far have produced the largest list of radio stars for which detailed structure has been observed. The results are highly suggestive, for very few of the objects show a smooth, symmetrical isophot distribution. In fact, a very high percentage of the radio objects show evidence of what are apparently two physically linked systems. This evidence, in combination with accurate spectral indices, could well give us a method for the future classification of radio stars. A careful evaluation of all this evidence would appear to be essential before any conclusions can be drawn about the distribution of radio sources in space.

Several other major programs at the Observatory are directly connected with the study of the 1420-Mc (21-cm) hydrogen line emission—extraterrestrial radio energy generated in a manner differing from that assumed for radio sources at other wavelengths and restricted to a very narrow frequency range. The most important of these studies concerns the observation of absorption due to the presence of cold clouds of atomic hydrogen between us and a "hot" radio source. On radio spectra, this absorption appears as lines (absorption lines), a deep line indicating almost complete absorption of the energy from the "hot" radio source. In these studies the interferometer system in use at Owens Valley has many advantages over the normally used switched-frequency, single-antenna systems, which switch rapidly from high to low frequencies, and are therefore dealing with a large unbalanced signal. To measure a minimum signal at the point of maximum absorption (thus obtaining the amount of absorption) is extremely difficult because of the unbalanced nature of the signal in the latter system. On the other hand, the nature of the signal in the unswitched

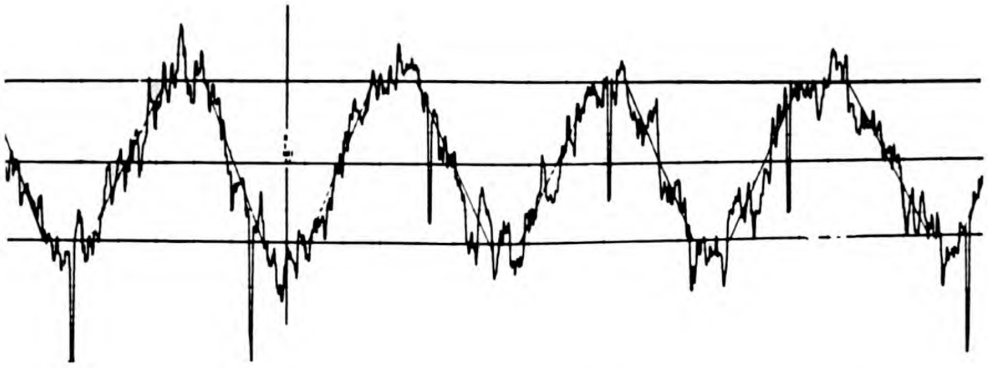


Figure 2 - Sample interferometer record of the weak radio source 3C-208.

interferometer is such that it is in a condition approaching "balance" at the deepest part of the absorption line; thus measurement of the remaining signal is very easy.

There are, however, even more important physical differences between the two systems of observation. The interferometer gives entirely different apparent optical depths (absorption capacity of the cloud) from those deduced from observations with a single "dish" antenna. Indeed, in some cases the interferometer gives a smaller value for the optical depth than the single-dish measurements. This may be interpreted as being due to the presence of a relatively large absorbing cloud in front of the emitting source. This cloud would absorb the contiuum radiation coming from the general background and produce a dip in the line radiation even in the absence of a point source of radiation. The interferometer resolves the cloud; consequently the absorption of the signal from the continuum background will not be seen. This interpretation is based upon our discovery of small dips in the 21-cm emission profiles unassociated with any radio source. The Owens Valley interferometer is a powerful new tool that will enable us to make better estimates of the density and temperature of the absorbing clouds as well as helping us to make more accurate plots of their radio isophotes.

The other major program at 21 cm is the observation of the absorption lines of radio-emission nebulae. When complete, it is hoped that we will have examined as many as 50 nebulae and, from the measured velocity of their absorption lines, determined their approximate position in the galactic plane. We hope that the combination of these two programs will provide us with vital information about the distribution and density of neutral hydrogen in our own and other galaxies.

Besides these major programs, the Observatory has embarked on a number of less ambitious projects. One of these is extended studies of the abnormal radiation from the planet Jupiter. Measurements were made initially with the antennas set up at a fixed separation on the east-west baseline. From this it was discovered that the radiation was of the

plane-polarized type* and had a diameter several times greater than that seen through an optical telescope. More recently, measurements were made along the north-south baseline and, since there was no reduction in the amplitude of the interference pattern at a spacing of 1600 feet between the antennas, it was deduced that the planet must have an elliptical halo emitting radio waves. A large amount of observational work remains to be done on this planet, and the complete program will take several years. We hope with its completion to be able to explain some of the abnormalities in this planet's radio emission.

SINGLE-PARABOLA RESEARCH

The earliest measurements made with single parabolas at the Observatory were two check-surveys of known radio sources. An extremely important result from these was the comparatively small scatter in the spectral indices of the known extragalactic sources and the large scatter in the indices of galactic sources. An attempt is being made to link this latter observation with evolutionary effects in supernova remnants.

Another of the initial single-parabola research projects was the determination that the two extended sources (halos) surrounding NGC 5128 were connected with the nebula. This makes the geometry of the radio nebula appear very similar to that of the well-known radio source Cygnus A. Both have radio diameters fifty times greater than their optical diameters. An attempt was also made to detect radio emission from planetary nebulae. There was only one positive measurement, NGC 6543, and it remains as the only planetary nebula yet identified as a radio source.

The first measurement of the diameter of the solar corona at 26 Mc was made at Owens Valley with a fixed-antenna array. The corona was found to be approximately 8° of arc, or about 16 times the optical diameter of the sun. The antenna array and equipment used in this experiment were also used in a study of the correlation between scintillations and refraction at the same frequency.

EQUIPMENT DEVELOPMENT

In addition to the observational work, a number of equipment-development programs are underway. Within the limitations imposed at the Observatory, improvements have already been made in phase-locking and following equipment, and on the phase stability of local oscillators. Also, a series of diode switches was worked out to operate in a frequency range of 900 to 3000 Mc for use in the initial single-antenna program. To combat the problem of radio interference from "noise" associated with the operation of amplifiers and receivers, we have developed a parametric-type, low-noise amplifier for 1500 Mc with a 25-Mc band width. Also, along these same lines, a low-noise crystal receiver has been developed. The performance of this receiver equals the best yet reported with a maser (using equivalent time constants in both types of amplifiers).

---

*Implying that there is a magnetic field around Jupiter. If so, this is the first time that this has been observed for a planet.

Finally, the present impossibly long data-reduction time precludes many problems that we would like to attempt. For this reason, the techniques of machine reduction will occupy much of our near-future development time. Toward this end, a program of computing techniques has recently been initiated and an analog computer developed for use with the interferometer. A faster and better delineation of the radio sources should result from this program.

With radio astronomy, we have not only widened our "window" in the spectrum but have also, by use of the longer wavelengths available in most of the radio spectrum, been able to see through clouds of interstellar matter that are opaque to the shorter light waves. If the startling discoveries—such as giant whirling masses which are suspected of simulating huge dynamos or synchrotrons that generate radio energy by accelerating matter in a magnetic field—that have so far been revealed are any indication, the future of this new science promises to be exciting indeed.

Symposium Volume in Print

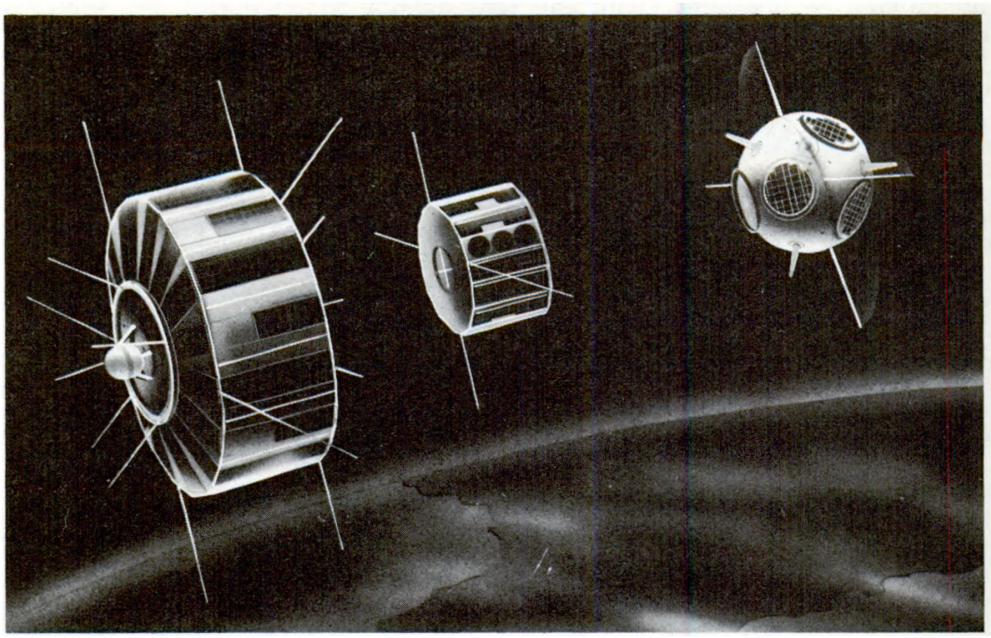
The Proceedings of the First International Symposium on Gas-Lubricated Bearings is now available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for $4.25 per clothbound copy.

The Symposium, sponsored by the Office of Naval Research and conducted by the Franklin Institute, was held in Washington, D. C. from October 26 to 28, 1959. The meeting served to present an introductory overall examination and critical review of research and development pertinent to gas-lubricated bearing design technology.

The printed volume of the Symposium will provide realistic guidelines for continuing research; serve to attract the additional efforts of competent scientists in related areas of research; and assist in publicizing the vital contributions which these bearings have already made, and promise to extend, in highly diversified fields of application. The 617-page volume records the 20 technical papers presented at the meeting in their entirety, as well as a final panel discussion. In addition, an appendix contains some 290 bibliographic entries.

The U. S. Navy's new ultra-sensitive radiation-measuring device, DUNC (Deep Underwater Nuclear Counting), can detect one atom of radium in a billion billion molecules of water.

Navy Space Triplets Launched



Artist's concept of the Navy's recently launched triple-decker payload orbiting the earth. They are, from left to right, TRANSIT IV-A, INJUN, and Solar Radiation III. The latter two satellites did not separate as planned, but scientific information is being received from them. (Drawing courtesy of APL)

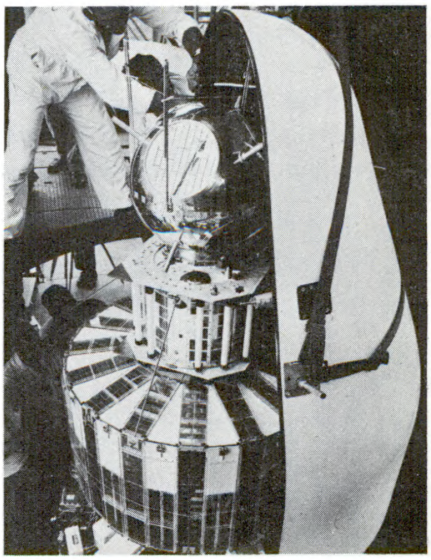
Three satellites were launched with one rocket on June 28 at Cape Canaveral, Florida. They were the Navy's TRANSIT IV-A navigation satellite and two Navy research satellites, Solar Radiation-III and INJUN, which rode pickaback. The launch vehicle was a THOR-ABLE-STAR rocket. Two previous TRANSIT satellites have each carried a single pickaback satellite with them into orbit, but this latest launch marks not only the first time that a triple-decker-payload launch has been attempted, but also the first use of a nuclear power source in a satellite. The three satellites, joined by a spring mechanism, were designed to separate on achievement of orbit altitude and to circle the earth independently.

TRANSIT IV-A is the fourth in a series of satellites in the Navy's program to develop an all-weather, world-wide navigational system based on signals from orbiting satellites. It differs from earlier TRANSIT models in shape and size, and embodies the latest improvements. The TRANSIT also has an improved memory system (including an absolute time system) which will periodically receive orbital data from a ground data-injection station. The satellite will transmit these orbital data continuously until the information is replaced by new data transmitted from the ground station. A properly equipped ship at sea would be able to compute its own position from the orbital data provided

by the satellite and its velocity as revealed by the apparent change in pitch of its signal. (This change in pitch, known as the Doppler effect, is used commonly in radar and radio telescope work.)

TRANSIT IV-A weighs 175 pounds and has four transmitters. Two are powered by solar cells and two by a small, light-weight thermo-electric generator fueled by a small piece of plutonium-238, a non-fissionable radio-isotope element. This generator, developed for the Atomic Energy Commission by the Martin Company, has fuel theoretically sufficient to provide power for many years. The TRANSIT system is being developed by the Applied Physics Laboratory of The Johns Hopkins University for the Bureau of Naval Weapons. The Naval Ordnance Test Station at China Lake, California; the U. S. Naval Weapons Laboratory at Dahlgren, Maryland; the U. S. Naval Ordnance Laboratory of White Oak, Maryland; the Navy's Bureau of Ships in Washington, D. C.; and the Pacific Missile Range at Point Mugu, California, are also participating in the TRANSIT development program.

Solar Radiation-III is another in a series of U. S. Naval Research Laboratory's satellites designed to measure the intensity of X-ray emissions from the sun. Solar storms produce changes in the earth's ionosphere, which in turn cause considerable disturbance to long-range radio communications on earth. On August 6, 1960, during a solar storm (flare) that produced a fadeout of radio communications, NRL's first Solar Radiation satellite found that this disturbance was accompanied by a large rapid increase in solar X-ray intensity. Since no accompanying change in the intensity of the sun's ultraviolet rays was detected, it was concluded that the increase in X-ray intensity had caused the radio fadeout. These findings are the best evidence to date of the cause for the fadeout. Although it is admitted that there might have been a change in intensity of the ultraviolet radiation from this flare that was too small to be detected at the time, such a change would have had negligible effects on the ionosphere.

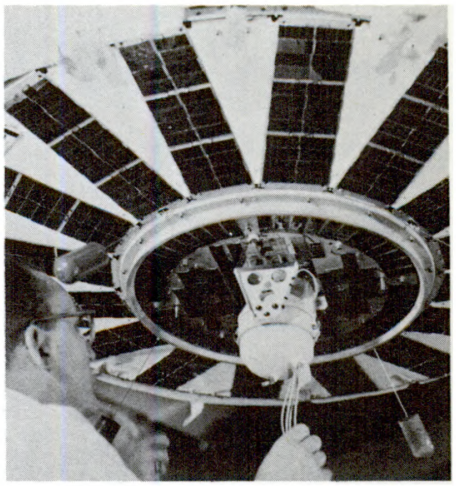


Triple-decker satellites being placed inside the rocket nose cone. (U. S. Air Force photo)

603658 O - 61 - 2

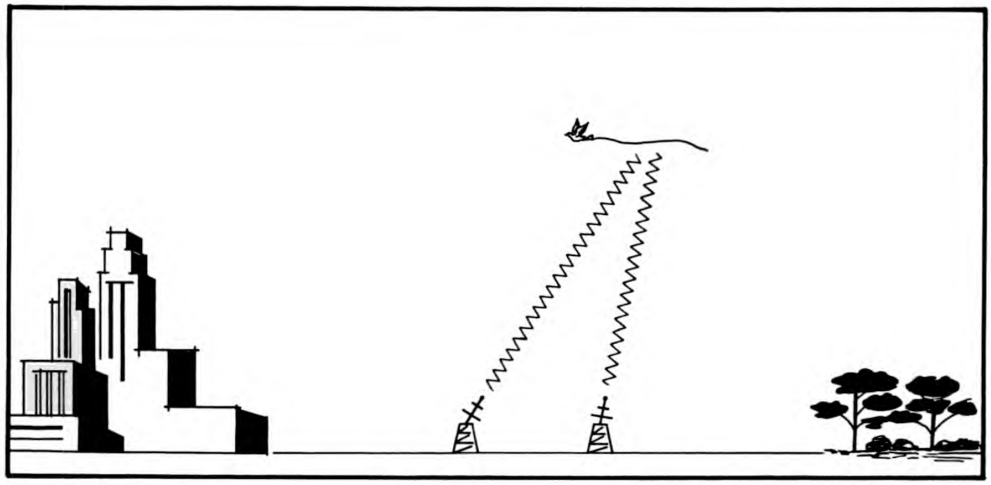
The Solar Radiation-III satellite, however, is expected to observe smaller solar events and background fluctuations in the emission of solar X-rays. Correlation of the data furnished by this latest satellite with ionospheric changes and radio fadeouts, along with the data provided by Solar Radiation-I, is expected to shed light on the relationship between sunspot activity, solar X-ray emission, and radio-wave propagation on earth.

INJUN, the third satellite in the triplet launching, was designed by Dr. James Van Allen of the State University of Iowa as part of a program of research that he directs under the auspices of the Office of Naval Research. This research deals with measuring the intensity of cosmic radiation, particularly in the inner and outer Van Allen belts, and with investigating auroral phenomena (the northern and southern lights). Dr. Van Allen, who discovered the belts of intense radiation surrounding the earth that bear his name, has developed a theory that aurural displays are caused when charged particles, trapped in the outer radiation belt, are dumped into the upper atmosphere in the Arctic regions. Indications are that the outer belt has a horn that extends deep into the atmosphere, forming a "leak" through which trapped particles enter the atmosphere, particularly during magnetic storms. Data from the satellite will provide more information for use in studies of the influence of auroral phenomena on problems of radio propagation in the polar regions, and the connection between solar flares and the occurrence of both auroral displays and radio blackouts. INJUN will also aid the TRANSIT program by directly measuring the influence of particle radiation on the lifetime of solar cells and other electronic components.



The grapefruit-shaped nuclear power supply of TRANSIT IV-A is tested by Applied Physics Laboratory scientists. (APL photo)

The combined weight of the three satellites used in the triple launching is about 265 pounds. They are now circling the earth once every 103.8 minutes completing an orbital path approximately 619 (apogee) to 548 (perigee) miles above the earth. The orbit has an inclination of 66.8 degrees from the equator. It is predicted that the satellites will remain in orbit for 110 years.



Animal Tracking Gone Modern

How does a homing pigeon navigate unerringly even through unfamiliar territory to its home loft? For many years scientists have offered various theories that attemped to explain the mechanisms involved in the homing instinct, but the mystery remains because there was no way to prove whether or not these theories were correct. Now, however, we may be on the threshold of resolving this question, with the aid of a new research tool which has been developed under the Navy's Biological Orientation Program.

The new apparatus, developed by the American Electronic Laboratories of Philadelphia for the Biology Branch of the Office of Naval Research, features a powerful miniaturized radio beacon transmitter that can be strapped on the back of a bird. This apparatus was recently used successfully to track a pigeon during a 20-mile flight to his home loft in Philadelphia. To track the pigeon, two receiving stations were set up at known distances from the point of release. When the bird was released, the two stations began to record directional data at exact prespecified time intervals. From this information, the location of the bird could be pinpointed at any time during the flight. Later on, the exact flight path was plotted by triangulation methods from the recorded data.

The tiny transmitter's transistorized oscillator and amplifier have an output of one-thousandth of a watt (one milliwatt). Power is supplied by three mercury-button cells that can operate the unit continuously for at least 20 hours. The whole unit including the power supply weighs less than one ounce. Attached to the transmitter package is a half-wave dipole antenna that trails about 40 inches behind and below the bird. The first eight inches of the antenna are stiffened by a fiberglass rod to prevent the antenna from interfering with the bird's tail feathers needed for flight control. The receivers, especially designed to be used with the transmitter package, are highly sensitive and can pick up signals from any direction over an average range of 20 miles (when the transmitter is at a height of 40 feet or more). Since the transmission is line-of-sight, the range is also somewhat

dependent upon local terrain features. Each receiving station includes a direction-finding, high-gain Yagi antenna attached to a rotating pedestal. The pedestal's job is to elevate the antenna to 10 feet and rotate it in azimuth through a full 360 degrees.

Eventually this transmitter package may be incorporated into a much more sophisticated system of sensory devices which will monitor both environmental changes and the bird's reactions to such changes. Scientist will then correlate the physiological data, such as blood pressure and respiration rate, with the environmental data to discover the specific factors involved in homing and migration. Such information is expected to help us discover the bird's secret of navigation. And that disclosure might, in turn, lead to new concepts for the development of advanced miniaturized navigation and detection systems.

THEORIES ON THE MECHANISMS OF THE HOMING INSTINCT

This new tracking system may provide a much-needed research instrument to help clarify the various hypotheses advanced by scientists concerning the homing instinct. Some scientists believe that the homing instinct is responsive to physical forces, while other workers say that it depends upon visual aids, such as the sun or moon, or familiar land marks. These theories have been considered both separately and in combination.

According to one theory, certain organisms are sensitive to the earth's magnetic field, which varies both at different geographic points and at different altitudes. This theory postulates that these organisms are able not only to pick out magnetic lines of force that correspond with geographic locations but also to detect changes in the electromagnetic flux. To test this theory, a miniature magnetometer could be used in conjunction with the transmitter to show whether or not the bird was reacting physiologically to changes in magnetism.

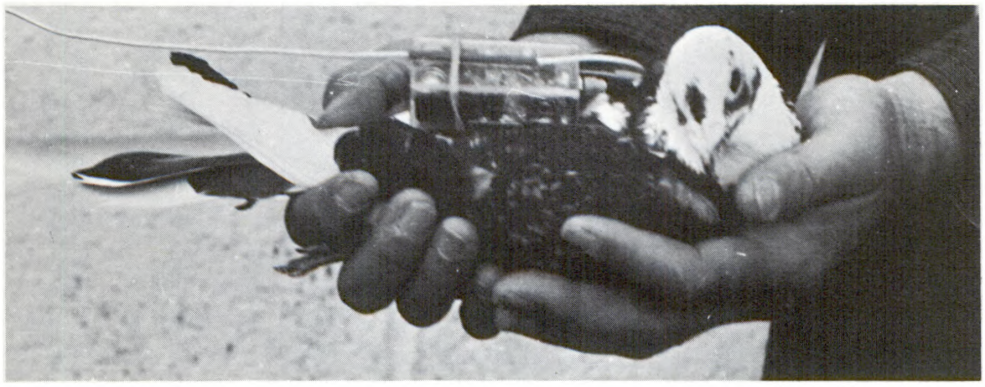
A phenomenon attributed to the earth's rotation, known as the Coriolis effect, is also offered as a partial explanation of homing ability. An illustration of this effect might occur during the summer months when many birds in the Northern Hemisphere migrate northward. During flight, the birds would be facing northward and would fly steadily in that direction. However, the actual path followed would not be straight but would curve because of the deflecting effect of the rotation of the earth. This theory assumes that the bird has no built-in physiological mechanism to nullify this effect, but that it instinctively uses the effect in determining its own latitude circle.

A third theory supposes that creatures are able to navigate by means of observed landmarks, while a fourth states that animals instinctively chart their courses by observing the positions of the sun and moon.

Scientists plan to apply the information and experience gained from this first test flight in tracking larger birds—particularly the gooney birds that interfere with flight operations at many oceanic airfields, notably Midway Island. It is hoped that a more intensive study of the environmental factors that influence the gooney birds' behavior will lead to a solution to the problem by enticing them to live elsewhere.

AQUATIC TRACKING SYSTEM

Porpoises, whales, sharks, and marine turtles may one day reveal their navigation secrets, for the American Electronics Laboratory is also developing for the Biology Branch of the Office of Naval Research an aquatic tracking system employing the same receiver and antenna components as in the pigeon system. Although present devices will transmit only while the antenna is above the water, the system will be capable of collecting and storing data while the animal is submerged. The stored information would then be transmitted when the animal rose to the surface. Animals selected for study will be those that habitually swim close enough to the surface to permit the instrument package to transmit. In tracking a porpoise, for example, the signal from the transmitter will be received intermittently during the periods when the porpoise is close to or at the surface. The antenna will be a flexible whip extending backward at a 45-degree angle from the top of the instru-



Homing pigeon just before takeoff with the new animal-tracking transmitter aboard.

ment package. The unit, powered by a battery with a continuous lifetime of one month, will be designed to withstand water pressures up to 200 psi and the waterloading forces generated by the 35-knot potential swimming speed of the porpoise.

ONR'S BIOLOGICAL ORIENTATION PROGRAM

Biological orientation is a relatively new field in the biological sciences. It may best be described as a research program aimed at studying living organisms as biological models with information-selection, integration, and translation characteristics which are of current interest to the U. S. Navy and other organizations. Specifically, this fundamental research program is aimed at obtaining basic data which may be useful to mathematicians, physicists, and engineers in the development of new concepts and the construction of mechanical and electronic analogues of biological systems. It is noteworthy that many animals—ranging from bees through bats, birds, and marine and freshwater fishes—possess systems which not only enable them to detect, discriminate, and identify targets located at great distances from the

animal but to navigate with unerring accuracy towards the target as well in ways which are not presently understood. These abilities, coupled with the fact that the total biological systems governing such activities frequently weigh less than a few ounces (bio-microminiaturization of a very high order of sophistication), suggest compelling reasons for the Navy's sponsorship of biological orientation research.

Researchers in several fields of biology, including cytology, physiology, biophysics, and ecology, are actively engaged in the ONR program. Studies in almost every division of the animal kingdom have resulted in the identification of the organs and systems used in detection and guidance. Research is presently being conducted into the structure and operation of the cellular, tissue, organ, and system components and their inter-relationships. Emerging from such research is the fact that certain fishes can retrace their path to a home stream or find food by "smelling" very small chemical variations in the water.

Recent studies of the comparative physiology of the sensory mechanisms of insectivorous bats revealed the presence of enormous auditory centers in the brain. Although bats have a remarkable acuity in avoiding obstacles and catching insects in rapid flight, their ability to prevent "jamming" of their echo-location (sonar) system is even more remarkable. For insectivorous bats are able to hear and react to echoes at least 35 decibels below the level of the ambient noise in the same frequency band as the signals. How they distinguish between the signal and the noise is still a mystery. So far, scientists have found that pulsed signals, which they produced to jam the bat signals, were less effective at jamming than continuous noise. In addition, certain insects are known to be able to detect the bat signals and can thus avoid being caught.

Of particular value to the Navy are studies of certain aquatic organisms that make use of underwater sound waves. The porpoise, because of its high intelligence and its use of "sonar," is a very useful animal for research in this field. It is expected that further information will be obtained on the mechanisms of both the time-sense and the direction-sense in animals, which may explain their remarkable navigational abilities. Such information may prove to be a basis for the development of mechanical or electronic analogues in guidance systems.—S. R. Galler and C. E. Fix

---

AFRRI Directors Named

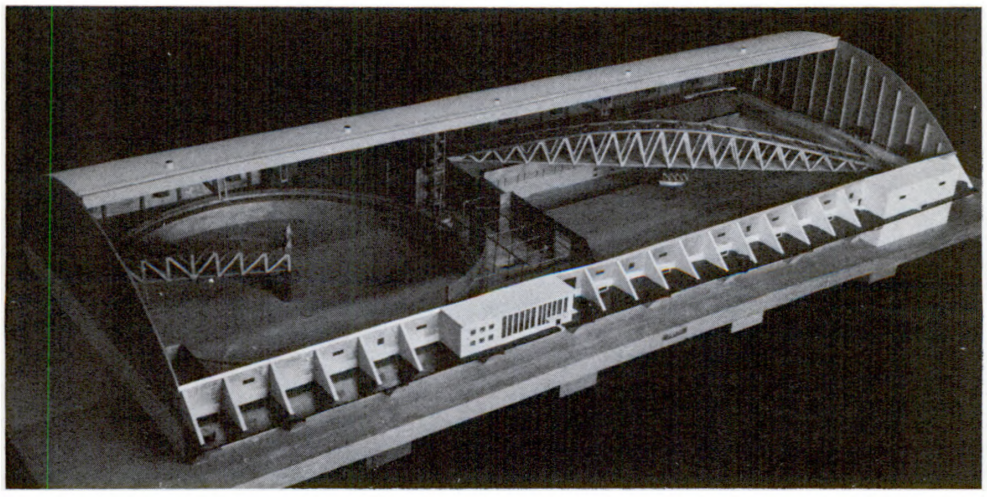
The Board of Governors of the Armed Forces Radiobiology Research Institute (AFRRI) has nominated the following officers for the Directorate of the AFRRI: COL James T. Brennen, MC, USA, Director; CAPT Francis W. Chambers, Jr., MSC, USN, Deputy Director; and LT COL Carl Hansen, MC, USAF, Deputy Director.

DTMB Gets Two New Basins

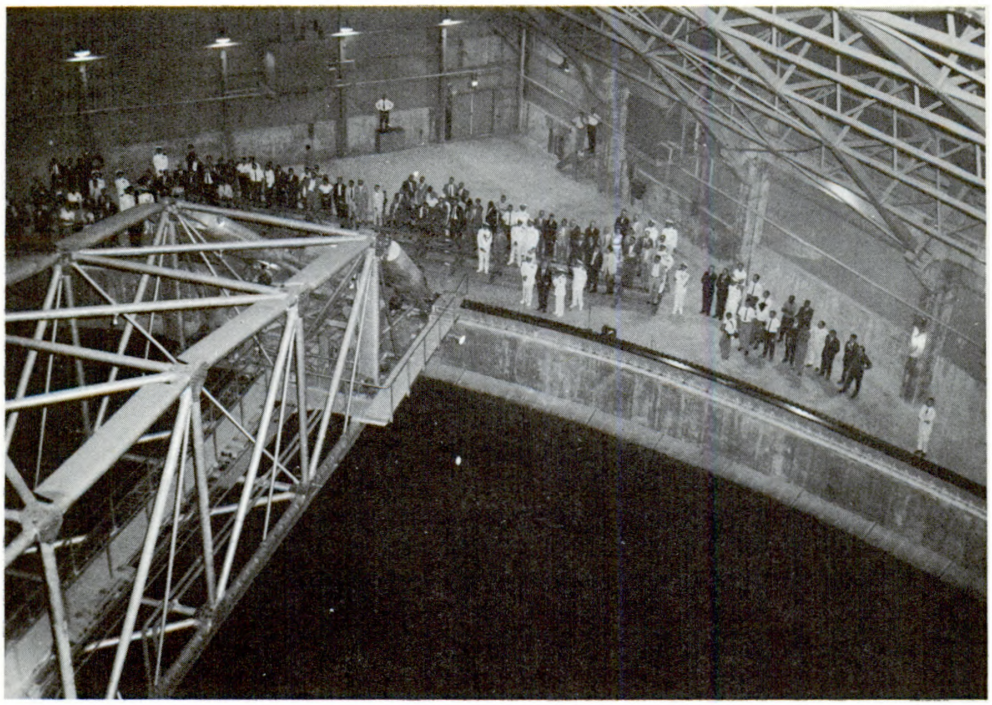
On 20 June, CAPT H. E. Saunders, U.S.N. (Ret.), former Commanding Officer and Director of the David Taylor Model Basin, pressed a button to open the main door of a vast new building that houses the Maneuvering and Seakeeping Basin and the Rotating Arm Basin at Carderock, Md. These two adjuncts to the great three-fifths of a mile long towing basin greatly enhance the ship-performance predicting capabilities of the David W. Taylor Model Basin, already the largest laboratory of its kind in the world.

The Maneuvering and Seakeeping Basin is a model-size ocean, 360 feet long, 240 feet wide, and 20 feet deep. One end wall, and one side wall of the basin support pneumatic wavemakers which can create regular, irregular, and short-crested seas. A confused sea state can be established which closely approximates the cross-sea of a true ocean in a full gale. By running a model ship through the man-made waves, designers can predict, almost exactly, how their proposed ships will respond in pitch, roll, and yaw.

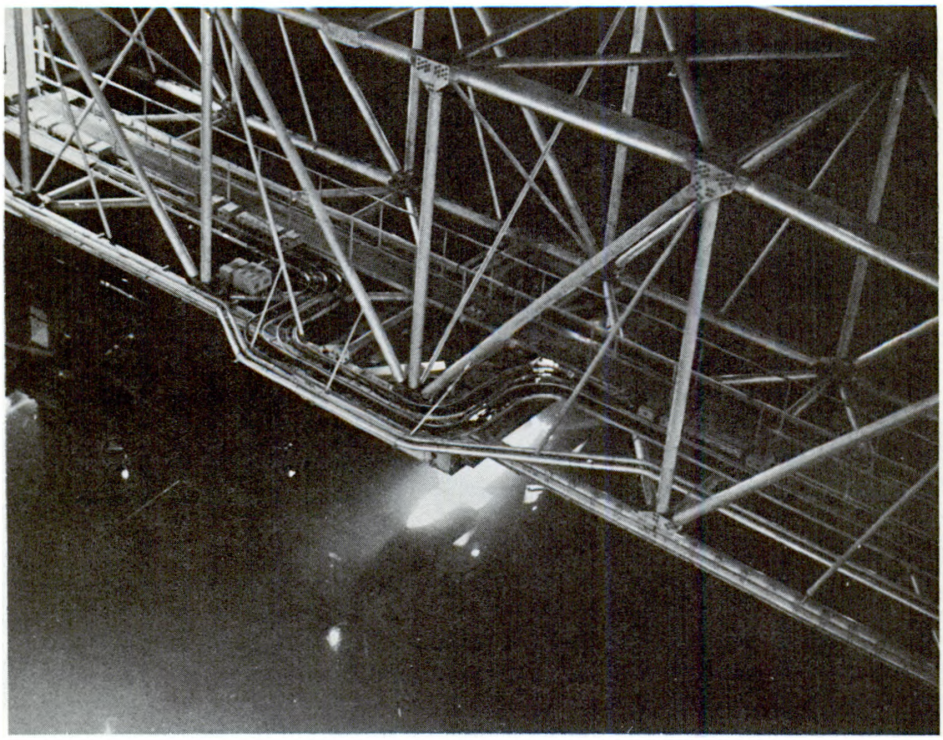
Each wave generator is a cylindrical air dome with an air-water interface inside the dome. The tank can "breathe," somewhat like an iron lung. Intermittent pressure on the water, alternating between pressure and suction, creates the wave. There are eight such units at the west end of the basin, and thirteen along the north side; they can be operated separately or in unison as a bank. The waves can be "programmed," that is, a train of low, long rollers can be followed by one or more short, high ones. When the waves are generated from two directions, there is a simulation of the violence and natural irregularity a ship would be expected to encounter on the high seas. The wave length, in the basin, varies from 3 feet to 40 feet, with corresponding height of 2.5 inches to 24 inches. At full scale, in the ocean, the largest waves would be as high as 100 feet and 2500 feet from crest to crest.



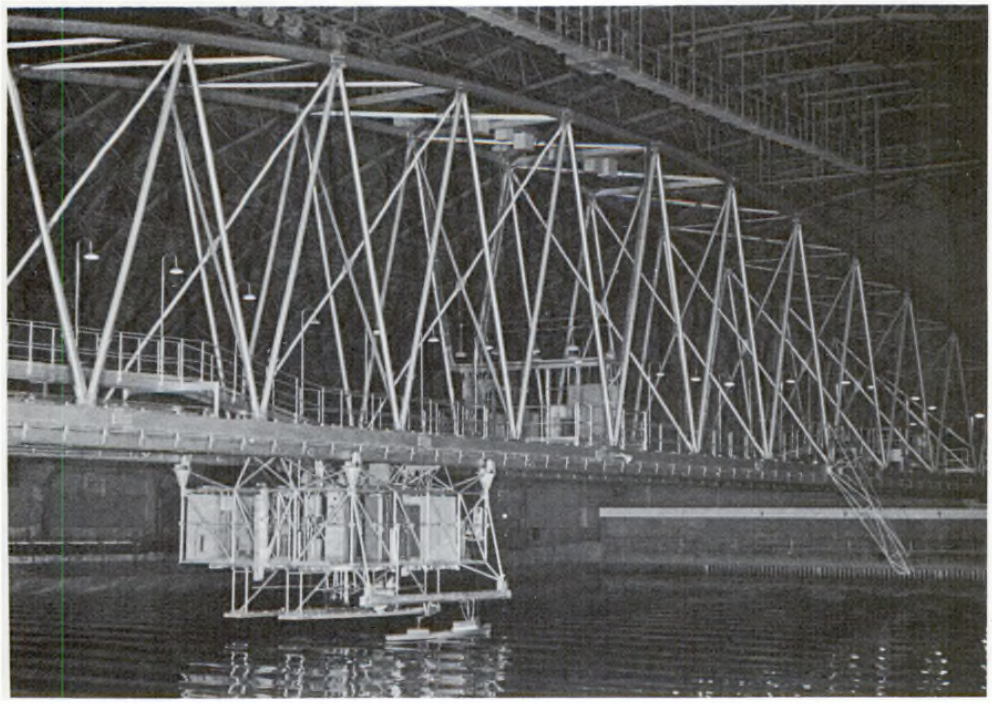
Cut-away scale model of the David Taylor Model Basin's new five-acre building housing the two newest basins. The Rotating Arm Basin is on the left and the Maneuvering and Seakeeping Basin on the right.



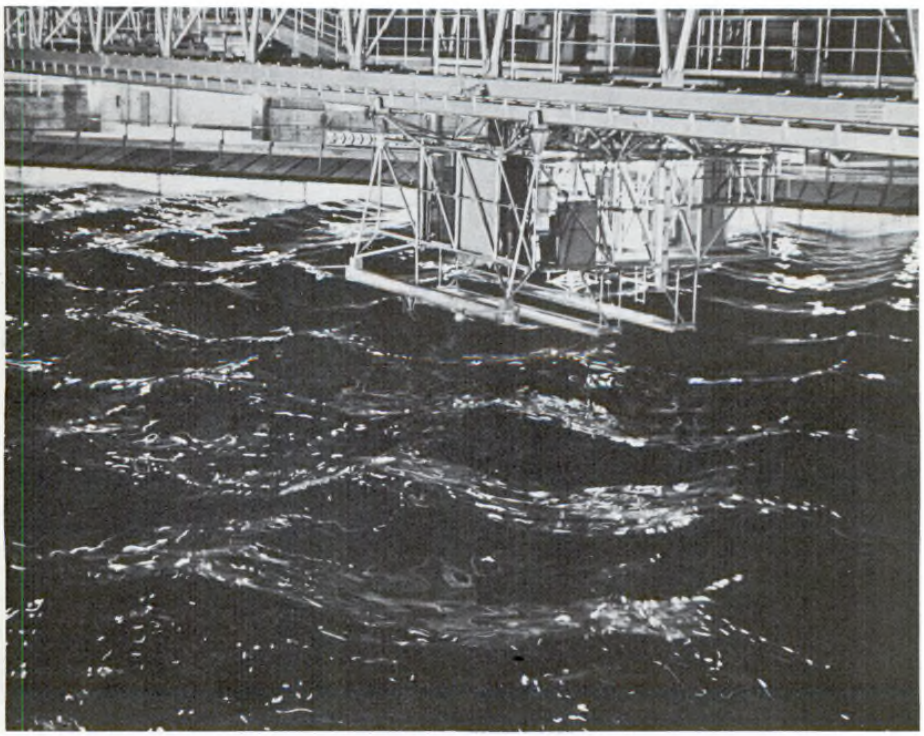
Interior view of DTMB's new Rotating Arm Basin during the recent dedication ceremony.



A submarine model, attached to the arm spanning the circular Rotating Arm Basin, will undergo tests in the new facility.



Wave-making machines at DTMB's new Maneuvering and Seakeeping Basin can create several kinds of wave patterns and sea states. Above: a 16-foot scale model is run at an angle to the regular waves of a calm "sea." Below: rough seas can also be made that closely resemble the cross-sea, confused pattern of a true ocean during a full gale.



The opposite (south and east) sides of the basin are equipped with fixed-bar type concrete wave absorbers. These dampen the waves so effectively that reflected waves are virtually eliminated and a turbulent "sea" settles to flat calm in a few minutes after the generators are turned off.

Ship models—exact-scale hulls, 10 to 30 feet long, of actual or proposed surface vessels—are self-propelled, radio-controlled, or towed. Submarine models are self-propelled or towed. If towed, the models are pulled through the water at scaled speed by a towing carriage that is suspended from a long bridge. As can be seen in the photo of the scale model of the building, the bridge can be rotated through angles up to 45 degrees from the longitudinal centerline of the basin. This rotating feature permits ship models to be towed at any angle from zero to ninety degrees in head or following seas. The models are usually linked to the carriage in such a way that they are free to roll, pitch, heave, yaw, and sway while sensitive instruments on the carriage measure these actions. The tests in the Seakeeping Basin will be concerned with loss of sea speed due to waves, improvement of seakeeping characteristics of surface vessels, and the prediction of ship motions in rough water.

Of current interest, for which the Seakeeping Basin is particularly appropriate, is the testing of hydrofoil craft and ground effects machines, those amphibious vehicles that scoot across land and water on a cushion of air. It is known that both types will operate on reasonably flat water, but how they will behave in a heavy sea is still problematical.

THE ROTATING ARM

The Rotating Arm Basin is exactly what its name indicates: A circular tank with a centrally pivoted arm that swings around like the hand of a clock. Models can thus be towed on an infinite circular course, in contrast to the finite straight course of DTMB's main basins.

The circular concrete basin is 260 feet in diameter, 21 feet deep, and holds approximately 8,000,000 gallons of water. The rotating arm is an aluminum, bridge-like structure some 129 feet long. The center end is attached to a tapered roller bearing that turns on a pintle fixed to the pivot "island." At the peripheral end is a two-wheel, motor driven carriage that rides on a single rail atop the basin wall. The direct-coupled electric motors can accelerate the arm to a speed of 30 knots (at the normal model position 120 ft from center) in 1/2 revolution, or a speed of 50 knots in 2 revolutions. By moving the towing carriage in or out, along the arm, the model can be towed in a narrow or wide circle; model positioning apparatus, controlled remotely from a station at the center island, can position submerged models in yaw, roll, and pitch.

The success of various new vehicle concepts required in modern warfare is largely dependent upon a detailed knowledge of the stability

and control characteristics in all degrees of freedom. The Rotating Arm Basin will provide the basic hydrodynamic coefficients required to solve the complex problems associated with these vehicles. Model tests will be conducted which are concerned with the directional stability, maneuverability and control of high speed submarines, torpedoes, and surface ships. Model tests will also be conducted to provide design information for high speed hydrofoil craft and GEM vehicles.

The main buildings at Carderock, embracing the 2775-foot towing basins and the hydromechanics and structural mechanics laboratories, shops, and administrative offices, were opened in 1939. Since then, many other facilities have been added, the most notable of which are a swimming-pool-size circulating water channel, three variable-pressure water tunnels, a pressure tank for testing submarine models, a large concrete pond where structural models are tested for resistance to underwater explosions, and a complete aerodynamics laboratory that includes subsonic, transonic, and supersonic wind tunnels. Just recently, as was noted in the July issue of this magazine, the LARC computer—one of the largest and fastest electronic calculators in the world—was placed in operation. It will allow ship designers to determine ship lines on the computer rather than by full-scale layout in a builder's loft.

The Navy's model research facilities are unique in that Congress provided that they should be made available to the maritime industry. In the past DTMB has not been able to meet all the requests from private industry, but with the operation of the two new basins, it is expected that much more time will be made available to commercial shipbuilders and naval architects.

Hazards of Cold Immersion

In a talk recently given at the Naval Medical Research Institute, Dr. W. R. Keatinge, currently doing cardiovascular research in this country and soon to return to England to continue research at Oxford University, reported observations made by the British Royal Navy and Medical Research Council in relation to hazards of cold immersion. It was found that physical exertion accelerated the rate at which deep body temperature falls in cold water regardless of whether the victim works moderately or as hard as possible, whether he wears clothes, or whether the water is agitated. Alcohol ingestion rather surprisingly failed to increase the rate at which experimental subjects' temperatures fell in cold water; on the other hand, it greatly reduced their discomfort. He suggested that men should not attempt to keep warm by swimming when waiting for rescue from cold water and, if possible, should float still with the aid of a life jacket. External protection is clearly highly important during immersions at near-freezing temperatures; even conventional nonwaterproof clothing gives a striking amount of protection under these circumstances. - U. S. Navy Medical News Letter.

Psychologic Factors in Space Travel*†

Henry A. Imus
Assistant Director of Research
U. S. Naval School of Aviation Medicine
Pensacola, Florida

All the reliability that scientists and engineers can build into space vehicles will be meaningless if the men who make the flights fail to perform successfully because of psychologic factors. The key to successful completion of a manned space flight lies in the motivation and competence of the astronauts selected for the journey. The history of exploration has shown repeatedly that strongly motivated men will accomplish difficult missions against almost overwhelming odds. Many examples could be mentioned of adventures in the Arctic, Antarctic, Atlantic, and Pacific Oceans and of balloon flights into the stratosphere. Further, laboratory experiments and other types of psychological testing have borne out the theory that superior men produce superior deeds.

MOTIVATION AND MORALE

Motivation and morale undoubtedly are high on the list of factors which produce superior performance. In one study a number of aviation cadets at Pensacola, Florida, were asked to volunteer for extra hazardous duty. Those who volunteered invariably showed superior qualities of attitude and performance in naval aviation training. Furthermore, of all the cadets who were dropped from aviation training at their own request, those who did not volunteer for the extra hazardous duty outnumbered the volunteers four to one.

That test pilots possess strong motivation, as well as aptitude, physiologic fitness, and psychologic adaptability, has been demonstrated by their stability, good judgment under pressure, and competency to deal with the hazardous emergencies which are common occurrences in their daily routine of work. These factors were given special consideration in the selection of the Project Mercury Astronauts by the National Aeronautics and Space Administration. Each man volunteered twice: once for consideration and, after a complete briefing and testing, again for selection. Since selection, they have become familiar with every phase of the projected mission and every aspect of the equipment, in addition to maintaining their usual flight proficiency in high-performance aircraft. Not one of them has asked to be released, although they may do so without fear of any adverse entry in their personnel records.

*Opinions or conclusions contained in this report are those of the author. They are not to be construed as necessarily reflecting the views or the endorsement of the Navy Department.

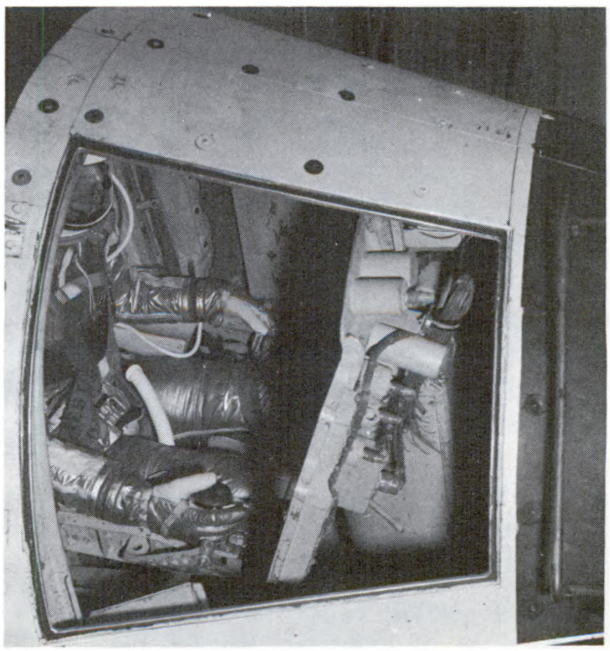
†Adapted from an article in the U. S. Navy Medical News Letter.

PERSONALITY

In the actual missile and orbital flights, the Astronauts' tasks may involve only reading instruments, recording observations, and certain decision-making functions. Yet preparations for the flight require the men to have high intelligence, be able to interpret complex instruments, and have excellent appreciation of mathematic and spatial relations. Their drive and creativity should be strong, and they should be free from conflict and anxiety. They should not be overly dependent upon others, but should be able to accept such dependence when required for the success of the mission. They should be able to tolerate both close association with others and extreme isolation. Their motivation for space flight should reflect primary interest in the mission rather than in the satisfaction of exaggerated needs for personal accomplishment. Any indication of self-destructive wishes or over-compensation for felt inadequacy would be undesirable. They should be prepared to take well-considered and deliberate action when necessary and be able to refrain from impulsive action when inactivity is appropriate. They must tolerate stress situations without requiring motor activity to dissipate anxiety.

BOREDOM AND FATIGUE

The principal effects of boredom and fatigue are carelessness and inefficiency. In an intensive study of performance during confinement in a space-cabin simulator at the U. S. Air Force School of Aviation Medicine at Brooks AFB, Texas, volunteers monitored aircraft indicators for 30 consecutive hours. The task required that they take corrective action whenever the indicators departed from the zero position. During all this time there was no change in the physiologic functions of the volunteers. Nevertheless, their performance was high for only 15 hours, then declined to 20 or 30 percent of the original level, and finally



Mercury astronaut awaits hatch securing before being lowered into the Gulf of Mexico for egress and sea-survival training.

showed an end spurt of only 50 percent. As a result of these and other studies, it has been recommended that planned schedules of continuous diverse activity be arranged for the Astronauts in order that their capacity to react promptly to emergency situations might be maintained.

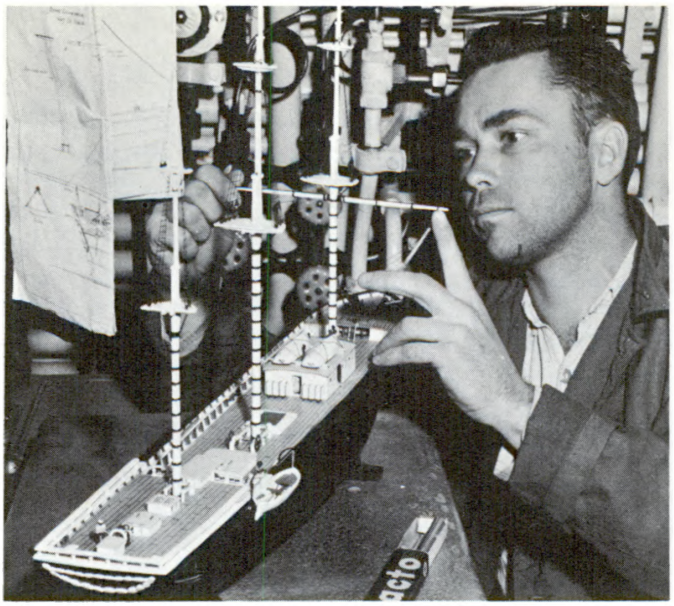
That morale can be maintained and that boredom and fatigue can be eliminated was demonstrated quite effectively during the transpolar cruise of the submarine Nautilus. The well-known reliability of the power plant, the capability of the sonar gear to detect obstacles, the advanced equipment for navigation while submerged, and the closed-circuit television which permitted visual observation of the ice formations and surface reconnaisance without breaking the seal contributed greatly to the confidence of the men in their safety while on the mission. An ideal environment was maintained, with temperatures ranging from 72° to 76° F, humidity from 40 to 50 percent, oxygen at 20 percent, and carbon dioxide at less than 1.5 percent. Emergency air-breathing systems were available for immediate use in the event of equipment failure. Fresh water was plentiful for drinking, bathing, and washing clothes. The food was unlimited and excellent in quality. Hi-fi music was played almost continuously, and reading and movies provided leisure entertainment. Planned schedules of games and tournaments appropriate for such close quarters were conducted, with special incentive awards of liberty in England as prizes for the winners. Friendly arguments, physical horseplay, and joking among the men relieved the tension.

ISOLATION AND SENSORY DEPRIVATION

During the extended flights in space, man will be physically, psychologically, and emotionally separated from his long-accustomed environment. Such separation may seriously affect his behavior and performance. For example, pilots flying at very high altitudes have experienced for short periods a feeling of being isolated, detached, and physically separated from earth. This has been termed the "break-off" phenomenon.

Sensory deprivation has been produced experimentally by several methods. One investigator submerged his subjects in a constant-temperature water bath, while another placed either frosted glasses or earplugs on recumbent subjects for a period of three days. A third used isolation chambers. In all cases the subjects experienced illusions and hallucinations, lack of ability to think clearly, and increased suggestibility and irritability. Among those subjects who had not been deprived of the sense of sight, position and relationships of objects with the visual field would change, resulting in disorientation.

It is possible that the effects of isolation and sensory deprivation might be offset, in part, by habituation and conditioning prior to embarkation on a space flight. The most important aspect of isolation is the reduction of incoming information. It is believed that many of the effects of isolation could be counteracted by providing members of the space crew with ties to familiar customs and surroundings, thus duplicating the diversity of experience on earth. The limitations of the



Seaman making a ship model on off-duty time aboard the nuclear submarine USS SEAWOLF during a 60-day underwater cruise.

artificial environment, such as restriction of movement, knowledge that escape is impossible, and deprivation of communications, may result in increased suggestibility and illusions. The personality, background, and motivation of each individual would influence his responses to such situations as well as greatly affect his interpersonal relations with fellow crew members.

ANXIETY

Uncertainty about the reliability of the space cabin and equipment, lack of knowledge about the course and progress of the flight, and anticipation of the hazard of re-entry are psychologic obstacles which may lead to anxiety on the part of the space crew. If adequate flight information is not provided by the control equipment of the space cabin or by the ground station in communications with it, or if corrective actions taken by the pilot in response to his instruments or to the ground station do not seem to have the desired effect upon the course of events, the pilot is subjected to considerable stress. Under severe stress, the individual's efficiency may decline rapidly. This could result in a vicious circle of increased anxiety accompanied by a still further decrease in efficiency. One individual might tend to give away to resentment and projection of blame upon others. Another would fall into a state of depression, inertia, and apathy. Some might experience hallucinations or delusions as a result of unusual patterns of sensory input, such as disorientation and vertigo from zero-G and tumbling. In all cases, continuing frustration would lead to a complete lack of appropriate response, irritability or apathy, and irrationality. Here, again, the personality and background of the individual would determine the kind of behavior.

CONCLUSIONS

As a result of scientific data and first-hand observations from balloon and simulated space-cabin flights, it is possible to predict the qualities of human performance necessary for successful manned vehicle missile and orbital flights. The control of motivation, morale, boredom, and fatigue, the reduction of feelings of isolation, and the minimization of anxiety are all important factors and should be given the utmost consideration. But the selection of men who have demonstrated consistent and reliable performance in a variety of hazardous missions over a period of years still provides the best guarantee of a successful mission into outer space.

New Association of Universities

Last year, the Big Ten universities, plus the University of Chicago, formed an eleven-institution association for cooperative funding of large research projects and for other matters of common interest. The formation of this group, called the "Committee on Institutional Corporation" (C.I.C.), followed a trend started by the nine-member "Associated Universities, Inc." on the East Coast.

Now still another grouping, the "Mid-America State Universities' Association," has been established. The charter members are:

Colorado State University	University of Kansas
University of Colorado	University of Missouri
Iowa State University	University of Nebraska
State University of Iowa	Oklahoma State University
Kansas State University	University of Oklahoma

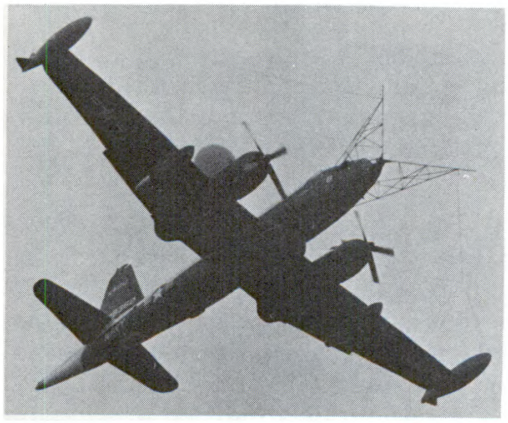
The Executive Committee of the Association consists of members as high as university president level.

Objectives for this new Association are similar to other associations of universities, and if realized, will have far-reaching effects on Government research support. For example, Mid-America Association representative, President Elmer Ellis of the University of Missouri, stated:

> "I have long been of the opinion that individual universities in this region can improve their quality by developing their present programs of teaching and research rather than by establishing competing programs that unnecessarily duplicate those of other institutions. It is by concentrating available funds on fewer programs that a university can raise its standards and be of greater service to society." - Argonne Reports, May, 1961; ONR - Chicago.

Research Notes

Skyhook-Aerotriever System



A Navy P2V Neptune equipped with special pickup fork gets ready to "rescue" survivor.

The first full-scale demonstration of a new Navy system capable of effecting the rapid rescue of personnel from sea or remote land areas by means of a long-range, fixed-wing aircraft was held on June 14 at the Naval Air Station, Patuxent River, Maryland. Installed on a P2V Neptune, the new Skyhook-Aerotriever system picked up an enlisted man from a life raft at sea and then a Navy doctor from the ground.

Under development since 1954 by the Robert Fulton Company, Newton, Connecticut, for the Office of Naval Research, the system is in the final-evaluation stage prior to Navy acceptance. The volunteer

LT E. P. Jacobs, MC, USN, awaits simulated rescue after donning the gear of the Skyhook-Aerotriever system.

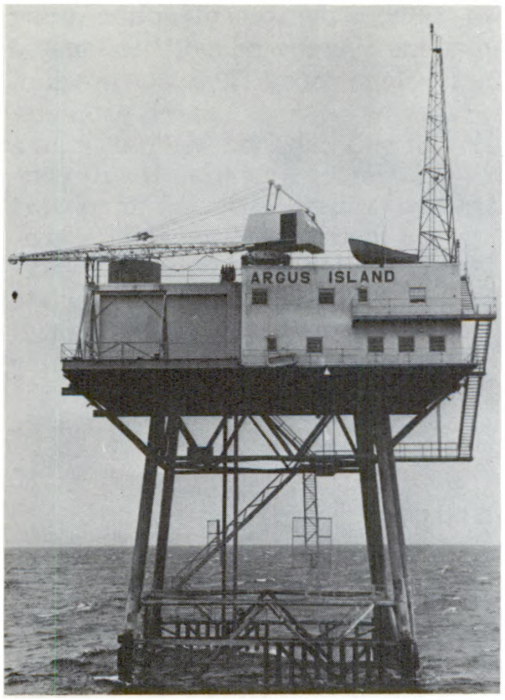
participants in the recent demonstration were Chief Mineman James H. McGee attached to UDT-21, Little Creek, Virginia, and Lieutenant Edmund Perry Jacobs (MC), USN, head of the Aeromedical Branch, Service Test Division, of the Naval Air Test Center at Patuxent. Previously a large number of inert loads up to 400 pounds had been retrieved and seven pickups of men had been made (see NavResRev, October 1960). The evaluation of the Skyhook-Aerotriever is being conducted by the Naval Air Development Unit based at the Naval Air Station, South Weymouth, Massachusetts, under the technical direction of ONR and in cooperation with the Bureau of Naval Weapons. The first time two men were retrieved in succession by a fixed-wing aircraft in continuous flight, however, was during the June 14 test.

In the rescue operation a specially designed packet is dropped to the man. The packet contains a harness which is donned in the same manner as a pair of overalls, a 500-foot braided nylon line attached to the harness, and a balloon envelope at the end of the line. A helium bottle also in the packet is used by the man to inflate the balloon. When ready for pickup, the man releases the balloon which lifts the line to a height of 500 feet. The man awaits pickup in a seated position. The aircraft, equipped with a "yoke" or wide fork, approaches the line hanging just below the balloon at a speed of about 150 miles an hour. An automatic device in the crotch of the yoke secures the line to the aircraft, and the balloon breaks away. The man is lifted vertically into the air, slowly at first and then more rapidly as he progresses, in a parabolic trajectory during acceleration to the speed of the aircraft. The crew operating the rescue equipment on board the aircraft hooks a section of the line and secures it to a powered winch inside. The man is then reeled in through the hatch.

The accelerative stress on the man is approximately one-third of that experienced in a parachute jump. The entire operation from the time the man is lifted from the surface until he is safely inside the plane takes about seven minutes. Neither Chief McGee nor Dr. Jacobs had been previously picked up. Chief McGee is both an experienced underwater demolition team swimmer and parachute jumper, while Dr. Jacobs is a flight surgeon experienced in "G" environments and survival equipment as well as a jet pilot.

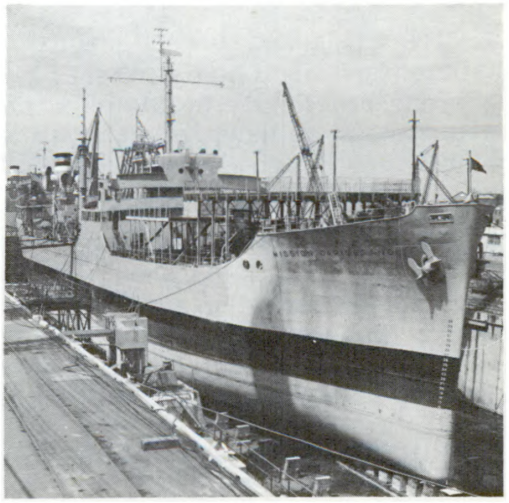
New Ship and Tower for Research

A modified Navy tanker and a new Texas-type tower have joined the Navy's Project Artemis. This project is an exploratory development effort, sponsored by the Office of Naval Research, to determine the feasibility of using a large transducer (in this case, a device for converting electrical energy into sound) and high-gain receivers, together with advanced data-processing equipment, for submarine detection. This particular concept was proposed by Dr. Frederick V. Hunt, a Harvard professor, in 1951. In recognition of his work, the project was named after Artemis—Greek goddess of the hunt. About 30 U. S. university, industrial, and government scientific groups are involved in various aspects of the program.



New Navy research tower installed 30 miles southwest of Bermuda.

The former T-2 class Navy tanker is the USNS MISSION CAPISTRANO which has recently undergone extensive modifications to fit her for her new role. Aft of her bridge she now contains a large well for stowing and lowering and raising the giant transducer (five stories high) and associated equipment in and out of the water. On her decks is an almost solid maze of hoisting apparatus—large winches and capstans, windlasses, cables, tag lines, and even a 30-ton cargo boom. Below decks, the space formerly occupied by seven large tanks is now used to stow the power supply and auxiliary equipment for the transducer. On the main deck, quarters and other facilities have been installed for 16 scientists and technicians. The electrical energy she will supply to power the sound source would furnish lights for a town of 50,000 persons. The officers and crew to man the ship will be furnished by the Military Sea Transportation Service.



A former Navy T-2 class tanker, the USNS MISSION CAPISTRANO, has been modified to carry Project-Artemis equipment.

The Texas-type tower, built in 1960 under the direction of the Bureau of Yards and Docks and named the "Argus Island," is located in 190 feet of water above an extinct volcano about 30 miles south of Bermuda. Designed as a platform for various ocean-research projects, it consists of a two-story, 85 by 85-foot building, and will serve as a hydrophone relay point in connection with Project Artemis. It will contain equipment such as electric generators, a distilling plant to convert sea-water into fresh water, and laboratory instruments as well as provide living quarters, food facilities, and laboratories for scientific personnel. The tower will also be equipped with lights and other appropriate devices. Located as it is at the limit of visibility of Gibbs Hill Light, it is also expected to act as a valuable local aid to navigation, enabling mariners to obtain a pinpoint "fix" many miles further at sea than is possible at present.

Midwestern Oceanography Symposium

The first symposium on "Oceanography in the Midwest," sponsored by the Office of Naval Research, the National Science Foundation, and the Committee on Institutional Cooperation, was held at the University of Wisconsin on May 15 and 16, 1961. The purpose of the meeting was to further an exchange of ideas and to determine, in so far as possible, how the midwestern universities might help to expand the Nation's oceanographic research programs, including the training of oceanographers. Some of the opinions and conclusions which emerged from the Symposium are summarized here; they are based on material supplied by F. G. Stehli of Western Reserve University and S. F. Salwak of the Committee on Institutional Cooperation.

Three major areas of contribution were suggested for midwestern universities. One was to establish a Great Lakes Research Station to study such phases of oceanography as could be appropriately undertaken with the Great Lakes used as a natural laboratory. Another was that midwestern universities should concern themselves primarily with theoretical investigations which could be conducted as well in the Midwest as anywhere else. The third was to establish a cooperative midwestern oceanographic institute at some appropriate point along the coast.

There seemed to be general agreement that any oceanographic institute that might be established by the midwestern universities should be sponsored jointly by all interested institutions, administered by a permanent staff independent of any single institution, and operated 12 months per year. It was also felt that additional summer facilities would doubtless be needed.

On the question of training oceanographers, the concensus was that prospective candidates should first complete a sound, undergraduate basic-science program with a major in one field before undertaking intensive oceanographic training which should be limited to the graduate level. At present the training needs cannot be met by existing oceanographic institutions, which now are saturated at the advanced teaching level as well as at the staff research level. Several new facilities, which are believed to be more desirable than great enlargement of existing

ones, are in the process of development, but several more will be required for the contemplated expansion of oceanographic research and oceanographer training programs. Physics, chemistry, biology, and geophysics ought to be applied to problems of the oceans, and, according to representatives from oceanographic institutions and fund-granting agencies, their work in all of these disciplines is being actively pushed.

Most of this year's funds for supporting the Nation's oceanographic program will come from the Office of Naval Research, the National Science Foundation, and the National Institutes of Health, with minor assistance from numerous other sources. During the Fiscal Year 1962, ONR plans to spend approximately 62 million dollars in the support of oceanographic work. The expected passage of the Magnuson Bill will enable the National Science Foundation to allocate about 450 million dollars for oceanographic work, to be spent at the rate of about 45 million dollars a year. No figures are available on the dollar value of support that might originate from other sources.

All agreed that the symposium resulted in a better understanding of the Nation's needs and the problems to be solved in meeting them. The ultimate outcome should be a significant contribution to the field of oceanography by scientists and institutions in the Midwest.

New Hydrobiology Laboratory

ONR-sponsored hydrobiological research on the orientation and migration of aquatic organisms, under the direction of Professor Arthur D. Hasler, will soon be housed in a new and modern laboratory of the University of Wisconsin. This structure, which is financed through a grant of $480,000 from the National Science Foundation, will be built on the southern shore of Lake Mendota. The basement of the three-storied structure will contain a boat slip with entrance to the lake, fish-holding tanks, boat storage, and workshop space. The first floor provides space for equipment storage, showers, and lockers. The second floor will have four offices with adjoining laboratories, one large laboratory, a library and reading room, and a conference room. The third floor will contain four offices with adjoining laboratories plus two large laboratories. The basement and first floor will each cover 2700 sq. ft.; the second and third floors, which overhang the lake, will each have 5200 sq. ft. of floor space. A pier adjoining the laboratory will permit easy access to Lake Mendota. Construction of the laboratory is scheduled for completion before the fifteenth meeting of the International Congress of Limnology, which is to be held at the University of Wisconsin in August 1962. - L.S.K., ONR - Chicago.

Drawing of new hydrobiology laboratory to be built on the southern shore of Lake Mendota at the University of Wisconsin.

On the Naval Research Reserve

Great Lakes Seminar

Ten naval districts and 28 states were represented by the 61 Naval Reserve officers who attended the Research Reserve Seminar held at Great Lakes, Illinois. The two-week seminar, completed 24 June, was under the direction of CAPT C. J. Schroeder, USN, Commanding Officer of the Office of Naval Research Chicago Branch Office. CDR L. P. Hoskins, USNR, Reserve Assistant, served as Seminar Coordinator assisted by LT H. D. Sims, USNR, of the Chicago Branch Office.

More than 50 speakers contributed to the theme, "Research in the Modern Navy." The speakers, chosen for their experience in basic research, represented local universities, the Bureau of Naval Weapons, the Office of the Chief of Naval Operations, and various departments of the Office of Naval Research.

Two field trips were also a part of the program. One, a trip to the campus of the University of Illinois, offered a first-hand look at ONR-sponsored projects presently in progress. Professors and university staff members, by explaining the projects, made the tour more meaningful. The betatron, computers, radio telescope, radio direction finder, and various bioscience projects provided an impressive display of current research. The other was a trip to Cook Electric Laboratories in Morton Grove, Illinois. There the participants gained a representative view of the contribution of private industry to research for the needs of the Navy. In addition, an interesting session gave insight into research management within industry.

CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve, was the after-dinner speaker for the seminar banquet held at the Officers Club at Great Lakes on 20 June. He discussed the importance and future of the Naval Reserve. The general concensus on the value of this seminar was summarized by one Reservist: "This has been the best seminar and one of the most informative ACDUTRA periods."

CAPT H. E. Ruble, USN, Deputy and Asst. Chief of ONR, addresses Great Lakes Seminar.

Group Training Seminars

Two successful group-training, week-end seminars were conducted in June by Research Reserve Companies. One of these was arranged by NRRC 8-4, Houston, Texas, and the other by NRRC 11-1, Los Angeles, California.

NRRC 8-4 ARRANGES TOUR OF SCHOOL

Sixteen reserve officers participated in group-training duty at the U. S. Naval School of Aviation Medicine, Pensacola, Florida. Eleven were members of Naval Reserve Research Company 8-4, three were from the U. S. Army Reserve Research and Development Company 4001, and three were from the U. S. Air Force 446th Troop Carrier Wing. CAPT Walter E. Liljestrand, USNR, a member of NRRC 8-4, was in charge of the group as senior officer.

The program, which consisted of talks, demonstrations, and tours, was arranged by Dr. Henry A. Imus, Assistant Director of Research at the School of Aviation Medicine. Some of the research work being carried out at the School and Medical Center was demonstrated. Factors in the selection and education of aviation trainees were explained with particular emphasis on the continuing reevaluation of training and testing methods based on statistical correlations with fleet-aviator performance. A missile space-probe passenger, a monkey named "Baker," was shown and instrumentation problems and results of the flight were discussed. The hazards of space flight due to cosmic radiation were discussed in another talk, along with the continuing research into cosmic radiation. More down-to-earth was a study of heart disease by the periodic physical examination of a group of 1000 aviators. The facilities seen on a tour included the human centrifuge, the slow rotation room, disorientation device, and low-pressure chambers. At each facility the research in progress was described in detail. The program was remarkably comprehensive and informative in view of the relatively short time available.

Air transportation to Pensacola on the evening of 15 June, and the return to Houston on the afternoon of 17 June, was provided by the 446th Troop Carrier Wing, USAF, stationed at Ellington Air Force Base, Houston, Texas.

NRRC 11-1 HOSTS TOUR OF AIR FORCE BASE

Twenty-seven officers from six southern California Naval Reserve Research Companies toured the U. S. Air Force's rocket-test facility at Edwards Air Force Base in the Mojave Desert on 17-18 June. Two days of briefings and a tour of the rocket-test facilities were provided the reserve officers at this site of Air Force, Navy, National Aeronautics and Space Administration, and civilian-contractor tests and experimentation.

Host company for the tour was NRRC 11-1 with CDR Thomas J. Ayres, USNR, Commanding. The visit was arranged through the Pasadena Office of the Office of Naval Research by LCDR N. L. Fish, USN, Program Officer for the Research Reserve for the area. The first day of the tour (Saturday) was spent in classified briefings at the rocket

test facility. The second day involved actual inspection of various non-classified facilities: from an Atlas missile mock-up flight pad to a distant view of the Saturn rocket motor and its test stand.

New Companies Activated

Two new Research Reserve Companies have been activated in the Ninth Naval District and one in the Fourth Naval District. There are now a total of 115 Research Reserve Companies located throughout the United States.

NRRC 9-21

Denver, Colorado, is the location of new Naval Reserve Research Company 9-21. This company was activated on 1 February 1961 with CDR W. E. Thornton, USNR, serving as the Commanding Officer and LCDR G. Francis as Executive Officer. CDR R. H. Crawford, USNR, Commanding Officer of the U. S. Navy and Marine Corps Reserve Training Center, Denver, Colorado, represented the Commandant in the activation ceremony. The company has an initial membership of fifteen officers and will drill semimonthly at the Denver Research Institute.

NRRC 9-9

Another new company in the Naval District was activated at Kansas City, Missouri, on 1 July 1961. This company, with a membership of sixteen officers, will drill semimonthly at the U. S. Naval and Marine Corps Reserve Training Center. CDR Alonso C. Hare, USNR, is serving as Commanding Officer.

NRRC 4-13

Also on 1 July 1961, NRRC 4-13 was activated at Philadelphia, Pennsylvania. CAPT Robert Mayer, USNR, and CDR Joseph F. Cox, USNR, are serving as Commanding Officer and Executive Officer, respectively. Twenty-seven officers are members of the new unit, which will meet at the Naval Science Building of the University of Pennsylvania.

NRRC 13-6 Receives SecNav Recognition

Under the direction of CAPT T. J. Wadsworth, USNR, Commanding Officer of Naval Reserve Research Company 13-6, Idaho Falls, Idaho, the members of the company recently devised a unique and effective means of publicizing the recent address of the Hon. John B. Connally, Secretary of the Navy. In cooperation with the Skyline Television Network a 30-minute program was presented which contained direct quotes from the Secretary's speech. CAPT Wadsworth subsequently received a letter of commendation from the Hon. John B. Connally.

U.S. GOVERNMENT PRINTING OFFICE: 1961 O - 603658

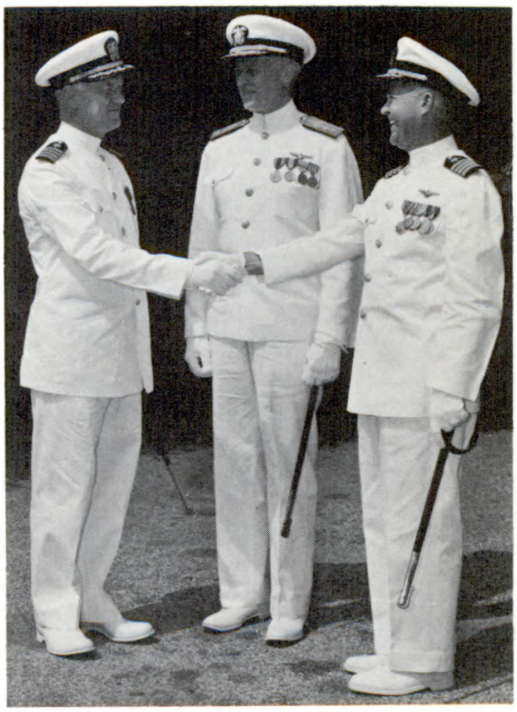
CHANGE OF COMMAND AT TDC

On 30 June, CAPT Elton L. Knapp, USN, relieved CAPT Edw.C. Callahan, USN, as Commanding Officer and Director of the U. S. Naval Training Device Center. Army and Navy officers attached to the center participated in the impressive full-dress traditional change of command and retirement ceremonies. Prior to his assignment to the Training Device Center, CAPT Knapp was Director of the Power Plant Division, Bureau of Naval Weapons, Washington, D. C. CAPT Callahan served as Commanding Officer and Director at the Center from 20 June 1957 and has retired from the active list of the Navy after 33 years of service.

RADM L. D. Coates, USN, Chief of Naval Research, made the principal address. He also presented CAPT Callahan with letters of commendation from the Office of Naval Research and from the Commander Antisubmarine Defense Force, U. S. Pacific Fleet.

Both letters cited CAPT Callahan for the outstanding manner in which he directed the training device program for providing the Fleet and Field Forces with the tools for more effective training.

CAPT Knapp comes to the Training Device Center with a broad background of Naval experience. A graduate of the U. S. Naval Academy, class of 1938, CAPT Knapp was designated Naval Aviator in March 1941. He was Fleet Duty Officer at Kaneohe Bay when Pearl Harbor was bombed 7 December 1941, and he participated in the early campaigns in the Pacific with Patrol Squadron 14. In 1945 CAPT Knapp earned an M.A. degree in Aeronautical Engineering at CalTECH. His subsequent career has been preponderantly in air assignments—at various air stations and with the Bureau of Aeronautics.



CAPT E. C. Callahan, USN, (left) former C.O. and Director of the U.S. Naval Training Device Center, congratulates his relief, CAPT E. L. Knapp, USN. RADM L. D. Coates, USN, Chief of Naval Research, stands between them.

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.

A ship model breasting the waves in the Navy's 12,000,000—gallon model ocean. (See pp. 15 to 19)