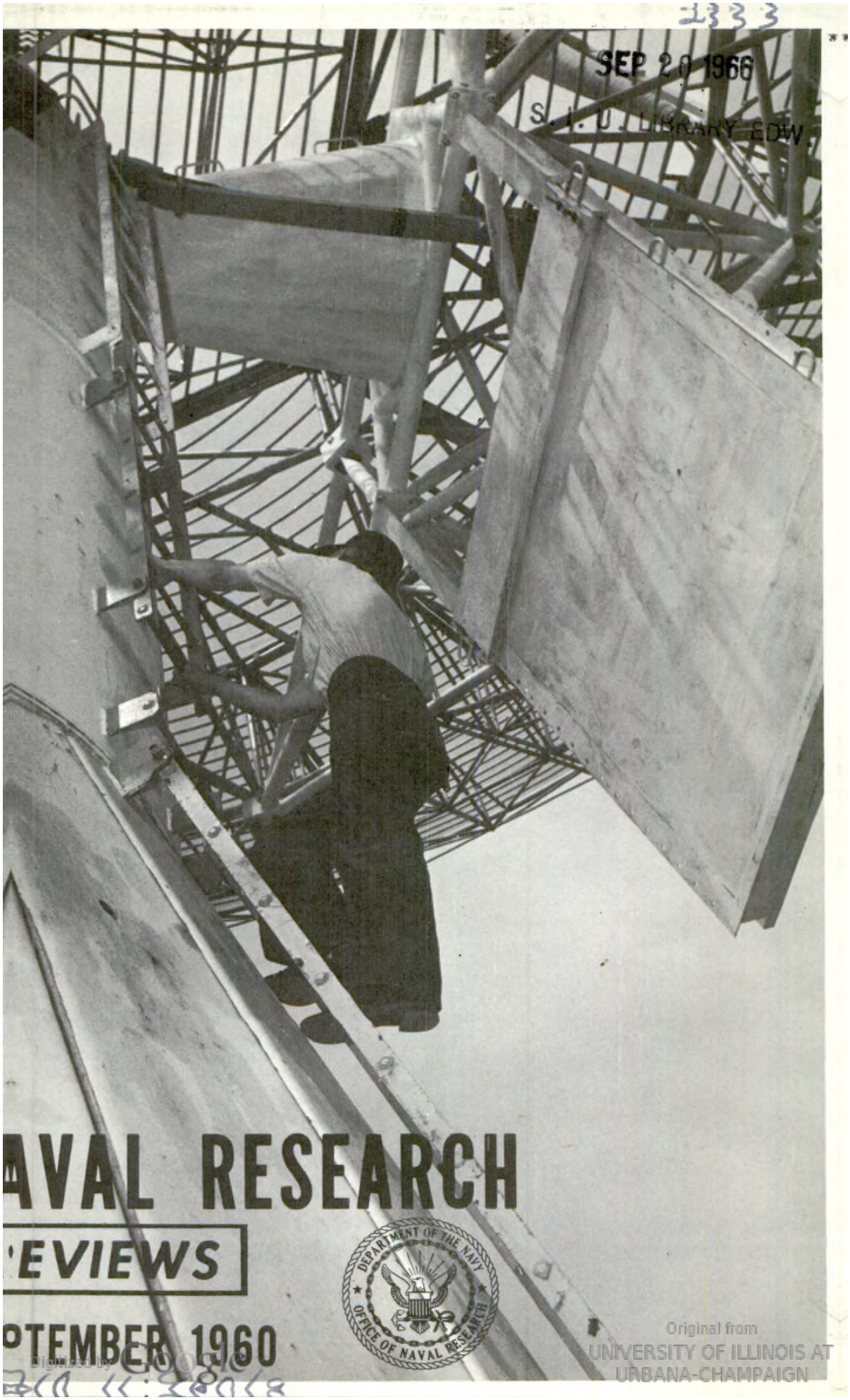

AVAL RESEARCH

'EVIEWS

OTEMBER 1960

Senior Scientists Council of Navy Laboratories

The Senior Scientists Council of Naval Laboratories fulfills in part a recommendation made in 1947 by the President's Scientific Research Board calling for closer coordination between scientists serving a department. Comprised of the Chief Scientists or Technical Directors of 7 West Coast and 18 East Coast Navy laboratories, the Council considers broad administrative and technical problems and is uniquely qualified to point out problems which may exist in particular portions of the Navy's over-all R & D program, as well as problems in laboratory management, and to recommend solutions for them.

The West Coast group, organized in 1949 and known as the Inter-Laboratory Facilities Committee, made significant contributions to the participating activities by publishing "Unique Facilities" (of West Coast Laboratories), "Suggested Guide Lines and Operating Principles," and other reports.

Recognizing the potential benefit of such meetings to all Navy laboratories, the West Coast group invited representatives from Navy laboratories in the east to attend its April 1952 meeting at NEL. This led to the establishment of the East Coast Laboratories' group in June 1952. At the NEL session, it was further agreed that senior scientists of all Navy laboratories should continue to meet in informal roundtable discussion. Rapid and enthusiastic response to this suggestion resulted in the first meeting of the Senior Scientists' Council of Navy Laboratories at the Training Devices Center, October 2 and 3, 1952. Since that time the Council has met annually.

The need for a medium such as the Council was further emphasized in 1954 by the House Committee on Government Operations whose report on "Organization and Administration of Military R & D Programs" stated:

> "The Subcommittee recommends that the Department of the Navy give serious consideration to the advisability of organizing the top level scientists and technicians employed by the Navy at its bureaus and research and development field activities into an advisory committee which would participate with the Navy's highest level planning councils in considering problems concerning the research and development programs."

Thus sanctioned, the Senior Scientists Council is already a valuable agency for research and development coordination within the Navy Department. At present the membership includes such men as Dr. G. K. Hartmann, Naval Ordnance Laboratory; Dr. T. J. Killian, Office of Naval Research; Dr. E. Cooper, Radiological Defense Laboratory; Dr. R. S. Muckenfuss, Navy Medical Research Institute; and Dr. R. M. Page, Naval Research Laboratory.

Sputtering by Ion Bombardment

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When atomic particles such as ions, moving at high speed, strike a solid surface, they cause the surface to disintegrate. This process takes place wherever gas-discharge tubes—for example the familiar neon signs—are in operation. Whenever you switch on your fluorescent desk lamp, you have set this process in full operation, and by so doing have subtracted from the useful lifetime of the fluorescent lamp. The process at work here is known to physicists as sputtering. It has been the subject of fairly intensive research in recent years.

Sputtering as a phenomenon was first recognized by an English scientist in the middle of the last century. His interest, and that of many later researchers, was stimulated by the fact that sputtering is for the most part an undesired effect. In gas-discharge tubes it is responsible for the formation of deposits which poison oxide cathodes, cause difficulty with insulation, blacken tube walls, and limit the useful life of such tubes.

Sputtering has, however, many highly useful applications. For instance, it is employed in the preparation of thin metal films, particularly thin films of those materials which are difficult to vacuum evaporate. Sputtering has also been found to have certain advantages over the chemical etching of surfaces to reveal the atomic structure of metals because it leaves sample surfaces uncontaminated. This process is now used in the preparation of atomically clean semiconductor surfaces. The fact that sputtering differs basically from vacuum evaporation, resembling more an atomic-scale billiard game, makes it a highly interesting tool for the physicist in studying interatomic forces, radiation damage problems, atomic arrangements at a surface, etc.

Interest in sputtering has been further stimulated by the role this phenomenon might play in the erosion of a satellite's skin, or in the erosion of meteors in the early stages of their entry into the earth's atmosphere. Sputtering by proton bombardment ("solar wind") is thought to play a role in the sun's corona since protons emitted by the sun are active agents in the disintegration of solid matter from the same source. The moon's surface is subjected to a similar proton bombardment, although of a lesser intensity, because of the moon's distance from the sun. Over the billions of years of its life a loose dust layer has probably been converted through the process of sputtering into a porous but

relatively firm crust. Whenever a hot plasma comes into contact with a solid surface, sputtering conditions arise. In devices which duplicate the high temperature conditions necessary to trigger a nuclear fusion process, the cooling effects of sputtered atoms can become a real problem.

The researcher investigating the sputtering phenomenon either uses ion beams or places a target metal in a chamber which contains an ionized gas at reduced pressure, thereby simulating the conditions to which orbiting satellites or earth-bound meteors are exposed. When gas ions, such as H^+, He^+, Ne^+, A^+, etc., are accelerated to the desired velocities by an electrical field, they bombard the surfaces of target metals, and sputter off surface atoms. By bombarding many different metals with various gas ions, researchers have sought to establish a sputtering law which would make it possible to predict the behavior of any gas-metal sputtering combination.

The study of sputtering has not been without its special problems. In early work, for example, one major barrier to a systematic, scientific study of metals sputtering was the fact that the mean free path of gas ions bombarding metal targets was too short. The "mean free path" is the average distance that gas ions travel between collisions with other gas atoms. To obtain reliable data on the sputtering rates of various gas-metal combinations, the exact bombarding energy with which gas ions strike metal target surfaces and the angle at which these ions strike the surface must be known. It is impossible to know these things when bombarding ions experience numerous collisions with gas atoms in the tube. Furthermore, atoms sputtered from the surface of a target metal strike gas atoms in the experimental chamber and are reflected or "diffuse" back to the target. Obviously, under these circumstances, it is impossible to determine the true sputtering rates of the target metals under investigation.

To lengthen the mean free path of bombarding ions and of the sputtered atoms, the obvious answer is to reduce the gas pressure in the tube or chamber. This increases the vacuum, so that there are fewer gas atoms with which bombarding ions or sputtered atoms can collide in their flight. In early work with cold cathode discharges, it was not possible to reduce the pressure to the desired low value because normal cold cathode glow discharges will not operate at pressures below 0.1 mm of mercury. To overcome this problem, additional electrons were provided from a mercury pool-type cathode or a thermionic cathode. With the gas pressure reduced to a level of 10^{-3} mm of mercury or less, the unobstructed flight path of ions moving toward a target is greater than the dimensions of the experimental chamber or tube, and atoms sputtered from the target surface travel freely from metal to collector or chamber walls. Sputtering at this reduced pressure then becomes independent of tube geometry and gas pressure.

Another major difficulty confronting the sputtering researcher is the tenacious nature of the oxide film or layer which coats many metals in air. Some metallic oxides are extremely resistant to sputtering, others less so. Even when metal samples have been thoroughly deoxidized before being placed in the sputtering chamber or tube, oxide and other films are reformed continuously on the metal surface during the sputtering process, for instance, from background impurities in the tube. With the pressure of impurities in the experimental apparatus at a level as low as 10^{-6} mm of mercury, a complete layer one atom thick would be formed on the surface of a metal in one second if every impurity atom adhered to the surface. Obviously, where ion bombardment must compete with the formation of such interfering oxide or impurity films, a basic requisite for reliable sputtering measurements is that the density of the bombarding ion current must be high enough to overcome the formation of contaminating surface layers. In our work. we have achieved bombarding ion current densities of 10 ma per cm^2, which is roughly equivalent to 60 impacts per surface atom per second. Such high current densities make it possible to sputter off measurable amounts of surface metal in a reasonable time even when ions strike at relatively low velocities.

Bombarding particles must have a certain minimum velocity before sputtering will occur. Charged atoms, i.e., ions, are used rather than neutral atoms because charged particles can be accelerated without difficulty to the required velocities by means of electric fields. It is reasonable to assume that sputtering by neutral particles would not differ from that by ions. Sputtered particles have been found to be single atoms which leave a clean metal surface in an uncharged, unexcited state, a fact which has led to some difficulty in their detection and measurement. Where sufficiently large amounts of material are sputtered, measurements can be made by determining either the weight loss of the target or the weight gain of a collector. Where the sputtered amounts are extremely small, ingenious techniques for detection and measurement have been developed, such as radioactive tracer methods, surface ionization indicators, and spectroscopic methods.

In our work, we have succeeded in collecting many data for various gas-metal combinations in both the range of low (less than 50 electron volts) and medium (between 50 and 500 electron volts) energies. Researchers elsewhere have begun to gather data on sputtering in the energy region above 1000 electron volts. When the number of atoms sputtered per incident ion is plotted as a function of bombarding kinetic energy, the result is a curve which is characteristic only of the particular gas ion-target metal combination. All such "yield" curves have certain characteristics in common: atom/ion yields are low at very low ion energy; above a certain minimum (the "threshold energy") yields rise in a linear fashion; and, as ion energy increases, yields rise less than linearly, moving on to a broad maximum and decreasing when the ions bury themselves deep inside the metal, spending their energy in processes other than sputtering. Each such curve is as distinct for any given gas ion-metal combination as an individual's fingerprint. Results show a very interesting relationship between a metal's

position in the periodic system and its sputtering rate. Copper, silver, and gold with completely filled d-shells exhibit the highest sputtering yields, whereas titanium, zirconium, and hafnium with unfilled d-shells give the lowest yields.

One of the interesting results of recent sputtering research has been the discovery that the angle at which bombarding ions strike a target surface has an important bearing on sputtering efficiency. Sputtering is much more pronounced when bombarding ions strike a target surface at an oblique angle than when they strike the metal surface squarely. Figure 1 shows what happens to a metal sphere when it is bombarded from one side in an ion beam. It is a composite shadow micrograph of the sphere before and after sputtering. The gray area represents the material which has been sputtered away; it shows that much more material is sputtered from regions of the sphere where ions strike the surface obliquely.

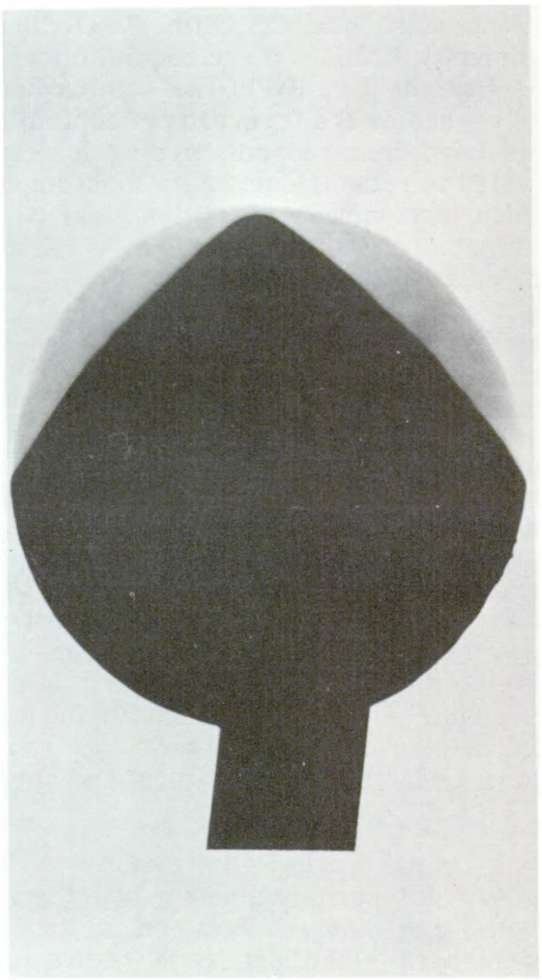

Figure 1—Shadowgraph of iron sphere sputtered in an ion beam

Sputtering is a rather complex process, dependent on many parameters such as the kinetic energy of the bombarding ion, its mass and angle of incidence, the mass of the target atom, interatomic forces between target atoms, crystal structure and orientation, and finally the energy which binds atoms to a surface. The whole process resembles a billiard game with atoms where the interatomic forces determine how closely the atoms behave like hard spheres.

To untangle the influence of the many different parameters is a complicated task. One way to simplify this task is to use single crystals instead of polycrystalline materials. Single crystals have the same regular and identical atom arrangement throughout the whole target while a polycrystalline target consists of myriads of tiny, randomly oriented crystallites. When a single crystal is sputtered a surprising, unexpected discovery is made: the sputtered atoms are always ejected in certain preferred directions. Thus the deposit of material sputtered from a small single crystal onto a glass slide is not uniform but shows

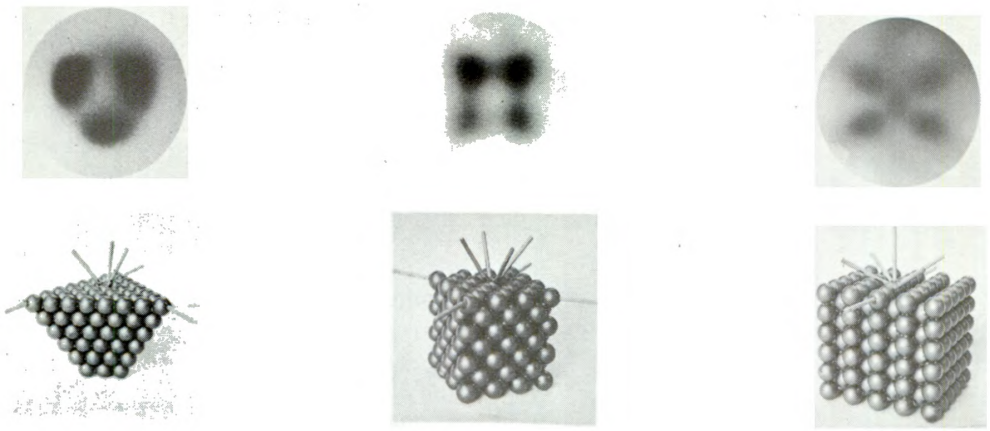

Figure 2–Deposit patterns obtained when silver single crystals are sputtered

a pattern of patches. The study of these patterns in relation to the crystal structure and orientation of the target reveals that atoms are always preferentially ejected in the directions of closest neighboring atoms in the lattice. Figure 2 shows the patterns obtained from three differently oriented silver single crystals. (The corresponding models of the crystals are shown in the lower part of the pictures.) The detailed study of these patterns furnishes a wealth of interesting information on the complicated rules of the atomic billiard game as well as on the specific arrangement of atoms at the target surface and the "focusing collisions" which play an important role in modern radiation damage concepts.

Tremendous strides have been made in the last decade toward a better understanding of this phenomenon, which has emerged from an obscure oddity to one of great interest in such different fields as plasma physics, gas discharge tubes, thin films, semiconductor and surface physics, astrophysics, satellite surface interaction, radiation damage, and thermonuclear research problems. But, much additional research will be necessary before the process is fully understood.

Dr. Dyer Receives ASA's Biennial Award

Dr. Ira Dyer, chief investigator of two ONR contracts with Bolt, Beranek, and Newman, Inc., is the 1960 recipient of the Acoustical Society of America's Biennial Award in recognition of "outstanding contributions to the science of acoustics." The award honors the achievements of the younger members of the Society (those under 35 years of age). Dr. Dyer, an outstanding representative of this group, has many notable accomplishments to his record. His authoritative work on noise and noise control has won wide recognition in the fields of mechanical and aeronautical engineering and space technology. His studies in sound scattering, as presented in his Ph.D. thesis, led to a pioneering contribution on the scattering of sound by a cylindrical vortex. Dr. Dyer, a scientist with rare versatility, has done considerable field work with the Navy.--ONR, Boston.

Precision Frequency Control And Millisecond Timing

H. F. Hastings
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The Navy has always been deeply concerned in the development of precise techniques and devices for accurate generation and determination of frequency and time. The Naval Observatory has been determining time for the United States since the early 1830's. In 1904, the Navy transmitted the first radio time signal. The U. S. Naval Radio Station, Arlington, Va., in 1913 began the first regular time broadcasts, which were received in distant parts of the world including Europe, as well as in areas close to the United States. In the latter 1920's, the Naval Research Laboratory conducted studies of the international transmission of precision frequency signals at 20 Mc.

The demand continues for ever greater precision and accuracy of time and frequency. Today, microsecond* time pulses are used in radar, in precision navigation systems, for velocity measurement and guidance of fast-moving aircraft and missiles, and in the rating of ship and shore frequency standards. Microsecond synchronization of clocks for periods of 24 hours or more at a number of range stations is desirable, for instance, for accurate determination of the velocity of a missile along its trajectory. This means that the standard frequency oscillators used to control the clocks at the various remote points must not vary by more than one cycle in one hundred billion cycles (1 part in 10^{11}) per day.

Similarly, accurate synchronization of precision frequency standards ashore and aboard ship is essential for the successful operation of suppressed, carrier-type, single-sideband communication systems. To assure the necessary minimum allowable accuracy of one cycle in 10 million ($1p/10^7$) of transmitter emission and receiver tuning, the standard oscillator used for reference or control in each installation must not deviate from that of any other ship or shore station by more than $1p/10^8$ over a period of 60 days. This requirement assumes that each station will have an opportunity to check and correct its reference oscillator at least once every 60 days against reference standards available on a nationwide or worldwide basis, and that the individual standard reference oscillators do not drift at an average rate of much more than $1.5p/10^{10}$ per day.

For nearly 40 years, the Naval Research Laboratory (NRL) has been developing new means and techniques for measuring and producing electrical waves of accurate and constant frequency. Through its close cooperation with the Bureau of Ships and many outside contractors in

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* A microsecond is a millionth of a second, or 1 part in 10^6; a millisecond is a thousandth of a second.

this field, the state of the crystal oscillator art has been so advanced that naval applications requiring highly precise frequency determination and control (such as suppressed carrier communication and various types of radio navigation) have become feasible. Extraterrestrial communication and space navigation, among other requirements, will necessitate continuing refinement of existing techniques. In addition, new precision frequency sources, such as those of the atomic type, are being developed for these applications as well as for the improvement of existing systems.

LONG-DISTANCE FREQUENCY SYNCHRONIZATION

In free space and in the earth's atmosphere, radio signals traverse a distance of approximately 186 statute miles in one-thousandth of a second. In one microsecond, the distance is only 0.186 statute mile, or a little less than 1000 feet. If either or both of the radio system's terminals is moving, or if the path of the radio wave varies in length from moment to moment for other reasons, it becomes difficult to compare or synchronize frequency standards by radio means, particularly when the terminals are located at widely separated points on the surface of the earth. The difficulty is caused by the doppler shift of the signal frequency. Since the path taken by the waves is certain to vary, really accurate frequency comparison will require long-term observation of the received signal over days, months, or years, even when both points are fixed in location. In general, 24 hours can be considered as a usable although small sampling period.

Radio time signals can be derived from a synchronous-motor clock driven directly by a precision frequency standard and corrected to agree with astronomical observations. These time signals, or time ticks (Figure 1), can be received at a remote point and applied to a time comparator consisting of a similar frequency-standard driven clock equipped with a calibrated delay-measuring circuit and oscilloscope indication. Such a system provides a practical means for long-distance comparison of frequency and time over long periods. The clocks at the time transmitter and at the receiver, in effect, continuously count the cycles generated by the frequency standards. In other words, the clocks are essentially time integrators; the longer the time period over which they count, the more accurate are the results.

One millisecond change in a 24-hour period represents approximately $1p/10^8$. Where it is possible to observe accurately a difference of 0.1 millisecond (100 microseconds) in 24 hours, frequency can be checked to $1p/10^9$ per day. The resolution can be increased by developing the capability of observing smaller time changes accurately or by making measurements over a longer period—for instance, 10 to 100 days. The average accuracy of frequency determination increases directly as the increase in ability to resolve smaller increments of time difference.

WORLDWIDE COVERAGE

Time pulses transmitted in the 2-Mc to 30-Mc band are easily observed up to the limit of high-frequency coverage. The doppler shift

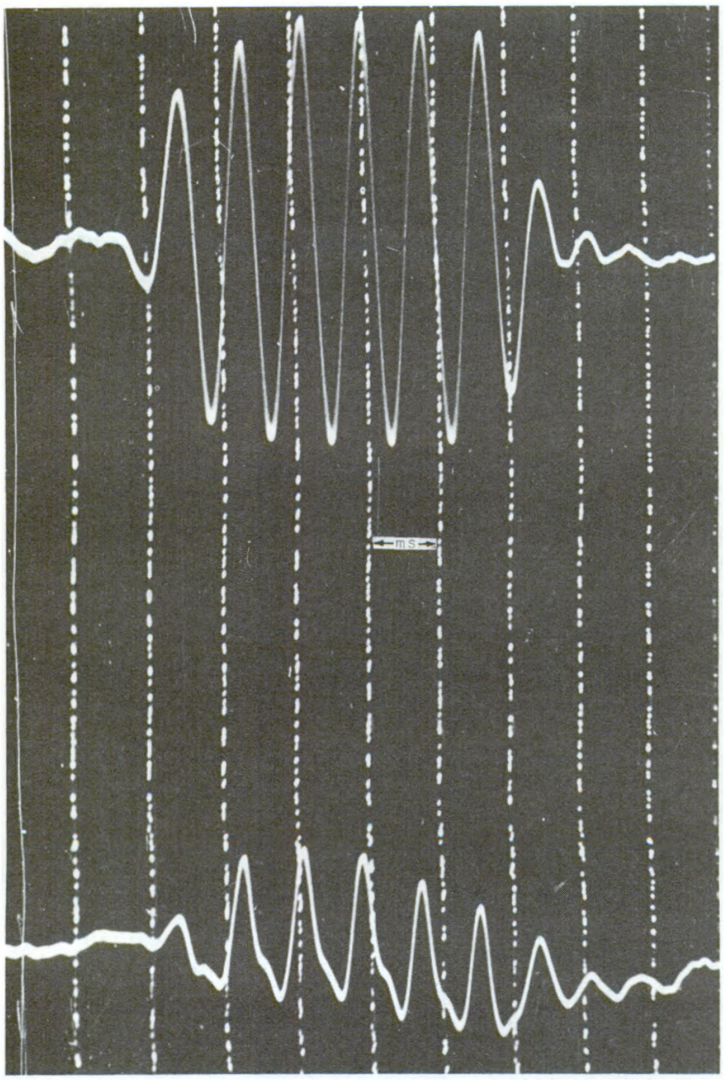

Figure 1 -- Time pulses as received at NRL from a distance of approximately 5000 miles

of the carrier is averaged out or appears as a certain amount of scatter for each measurement. If care is always taken to record the time pulse that shows the least delay in transmission, it is possible to obtain 1/10-millisecond resolution over a path that may be as long as 5000 miles.

Very low frequency (vlf) radio waves (below 30 kc) are more dependable as a long-distance broadcast means than high-frequency radio waves. On the other hand, as frequency decreases below 100 kc, time pulses are increasingly shaped and delayed by the time constants of the high-Q antenna, which is typical of both vlf and lf installations.

If the carrier wave is accurately controlled at the transmitter, phase comparison by using the received vlf carrier yields much more accurate results than does time-pulse measurement for synchronizing the frequency of widely separated precision oscillators. The phase method also is more rapid. One can obtain in 15 minutes sufficient information from transmissions over an all-daylight path in the 15-kc to 25-kc band to correct frequency to $1p/10^9$; with 3 hours of phase-change

information, one can correct frequency to $1p/10^{10}$. It is possible by phase-change measurement at vlf to observe a difference of 1 microsecond, whereas pulse-starting time cannot be observed accurately closer than 0.1 millisecond.

One of the methods used to determine microsecond changes in time is based on observation of the progression of zero voltage (crossover) time of the individual cycles of the received vlf carrier as compared with the cycles of a local frequency standard. The sweep circuit of an oscilloscope can be locked to the local standard to observe the phase changes in terms of microseconds.

Special time-measuring equipment, such as developed at NRL by Bey and Hastings and now being offered for commercial sale by at least one manufacturer, is necessary for determining the time of day accurately. For highly accurate knowledge of the time of day, it is

Figure 2—Cesium beam standard used at NRL for precision frequency control and highly accurate time determination. The research leading to the development of this atomic frequency standard was sponsored in part by the Office of Naval Research.

necessary to correct the apparent time to include the signal delay introduced by propagation from transmitter to receiver and to use correction data for the particular location as obtained from U. S. Naval Observatory bulletins.

ATOMIC FREQUENCY STANDARDS

An outstanding precision frequency instrument developed in the past few years is based on the application of atomic resonance phenomena induced in certain vapors or gases. A device of this nature is commercially produced in this country; this is the cesium-beam type instrument known as the Atomichron. One of these instruments (Figure 2) is being used at NRL as a reference standard. A cesium-beam resonator was constructed and placed in operation at the National Physical Laboratory (NPL), Teddington, England, by Dr. L. Essen, who determined the frequency of this unit to be 9,192,631,830±10 cps in terms of the 1955 second of universal time (UT-2), which is also known as Greenwich Mean Time (GMT). Subsequent data taken at the U. S. Naval Observatory by Dr. W. Markowitz indicate that the frequency is 9,192,631,770±20 cps in terms of the second of Ephemeris Time (ET).

The UT-2 second of time by which we live has small variations as the seasons and years change. Also, it lengthens as the earth's rotation slows down. To standardize frequency, therefore, it is necessary to reference an invariant oscillation, such as that provided by the cesium-beam standard, to some particular second of time in an essentially invariant time system, such as ET, which is defined by the orbital motion of the earth about the sun and measured by the orbital motion of the moon about the earth (see Figure 3). The cesium beam standards at NRL and at the National Physical Laboratory have been used, respectively, since 1956 and 1955 in a cooperative program with the U. S. Naval Observatory for the accurate determination of Ephemeris Time.

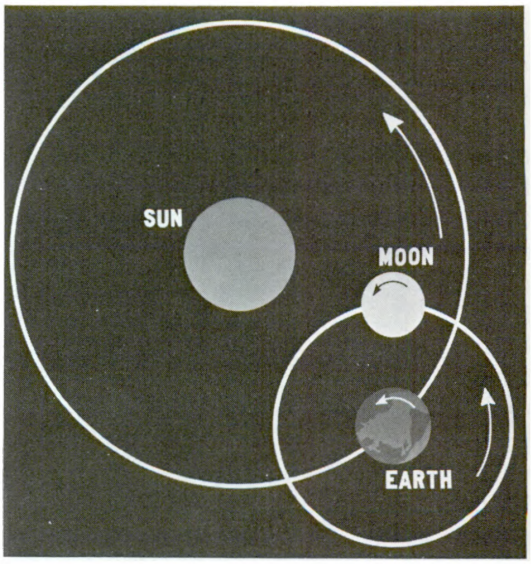

Figure 3 -- The period of the earth's orbital motion around the sun is one year; the astronomer's time reference is the orbital motion of the moon around the earth (29 days). Together these orbital periods serve as an invariant reference (Ephemeris Time). Shorter time intervals are clocked and reproduced by the invariant cesium beam standard shown in Figure 2.

NATIONAL AND INTERNATIONAL COMPARISON OF FREQUENCY

NRL has developed new techniques and provided special instrumentation to the Naval Observatory to aid in the transmission of highly accurate frequency and time information over both short and long distances via constant-frequency radio carrier modulated by precise time pulses. The Laboratory relays atomic frequency data to the Observatory by measuring the phase of the 2.5-Mc transmissions of radio station WWV for 1 hour each day directly against the cesium beam standard at NRL. At the same time, the Observatory compares WWV's frequency to a precision oscillator which is checked against astronomical observations. The Observatory is then able to provide time in terms of the number of cycles of the cesium standard that occur in the standard second of time, and it is possible to duplicate that second anywhere by reference to a cesium standard. NRL also provides the National Bureau of Standards at Boulder, Col., with daily readings of the carrier frequency of station WWV to assist in maintaining that station on constant frequency and time.

By comparing the 18-kc time pulse broadcasts of the Navy's very low frequency radio station NBA (Balboa, Canal Zone) with the 16-kc time pulse broadcasts of radio station GBR (Rugby, England), it has been possible to compare the NPL cesium standard, which is used to control GBR, with the cesium standard at NRL that controls NBA through the Naval Observatory. Similar comparison of British and U. S. A. standards has also been made by high-frequency radio time transmissions. Consistant agreement to about $2p/10^{10}$ have been achieved in the measurements.

By recent arrangement between the Naval Observatory and the Greenwich Observatory, cesium standards will be used to maintain the U. S. Navy and British vlf stations on constant frequency and synchronized time. The two Observatories will consult and correct time simultaneously when it becomes necessary to make any change.

AIDS FOR PRECISION FREQUENCY AND TIME DETERMINATION

In its cooperation with the U. S. Naval Observatory, NRL has developed various new electronic devices. One of these is a precision time standard for keying transmitters at Annapolis, Md.; Balboa, Canal Zone; San Francisco, Calif., and Guam. Similar equipment has also been developed for use by the observatories at Washington, D. C., and Richmond, Fla., to monitor the transmitted time signals and to provide time instructions to the transmitting stations when necessary. These equipments provide a resolution of 0.01 millisecond, with time correction capability up to the instant before time signal transmission starts. One of the interesting features provided in the Observatory equipment is a combination mean and sidereal divider that produces two outputs with a constant ratio of 1.0027379091 from one accurate 100-kc source. Thus, any correction of the source corrects both the mean and sidereal frequency at the same time.

An instrument for accurate comparison of the phase of 2.5-Mc and 5-Mc carriers has also been provided to the Observatory for monitoring the phase of station WWV (or any other transmissions of similar nature). The measurement, however, is not accurate for distances greater than 20 miles because of the multipath and doppler shift effects that occur in the space between transmitter and receiver in high-frequency systems.

NRL has provided the electronic instrumentation and technical assistance needed for Navy station NBA to transmit the highly precise time and constant frequency broadcasts at 18 kc which started on a scheduled basis on December 1, 1959. As the necessary equipment becomes available and is installed, four other U. S. Navy vlf stations will begin operation to provide coverage of the world with a constant-frequency carrier in the 15- to 25-kc band. This coverage will be accomplished without impairing the communication capability of the stations, thus providing most economical use of the limited facilities of the vlf spectrum.

Geologists Study Eocene Sediments

Sediments dating back to the Eocene epoch of roughly sixty million years ago have been found for the first time in New England by a team of geologists from the Woods Hole Oceanographic Institution. The sediments were brought up from depths of 86 to 264 feet in two wells drilled into the Cape Cod sands near Provincetown, Mass. Their age was determined from fossil remnants.

Dr. John M. Zeigler, Research Associate in marine geology at the Institution, said the discovery is significant in that it extends the known range of Eocene deposits, which previously had been located no further north than New Jersey. Knowledge of the existence of Eocene deposits will assist scientists in their explanation of the geological origin and history of Cape Cod.

Working with Dr. Zeigler on the project are Dr. W. S. Hoffmeister of the Jersey Production Research Company in Tulsa, Okla., and Graham Giese and Herman Tasha of Provinctown.

The wells were drilled as part of a continuing study of Cape Cod's geology under a contract from the Office of Naval Research. One hole was drilled in Pilgrim Springs State Park and the other on private property.

Navy Communication with ECHO

While developing the Navy's communication by moon relay (CMR) system,* Naval Research Laboratory scientists envisioned supplementing the Moon with large manmade satellites. These would serve as radio reflectors when the Moon was not in "view" at the Earth stations. The National Aeronautics and Space Administration's project ECHO has afforded the Navy a most welcome opportunity to cooperate in experiments which would test this concept. The results have been highly gratifying.

Navy scientists at Stump Neck, Md., listen to a playback of successful communication via the ECHO satellite

The NRL satellite communication research installation at Stump Neck, Md., has been one of the three stations taking prearranged part in the ECHO I experiment. Communication was established shortly after the self-erecting, 100-foot diameter, 1/2-mile-thick, plastic-film balloon achieved orbit in its roughly circular path about 1000 statute miles above the Earth. The Jet Propulsion Laboratory's (JPL) station at Goldstone, California, operated under NASA control, and the Bell Telephone Laboratories' (BTL) station at Holmdel, New Jersey, operated under contract with NASA, were the other other two stations in the system.

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* NavResRev, Mar/60, pp. 17-20.

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The experimental transmissions between these stations will continue until ECHO I fails. Here are some of the initial results:

- At first, precise information regarding satellite position was not available and a heavy cloud cover prevented optical tracking. However, the BTL station may have heard the early NRL transmissions.
- On the seventh pass of the satellite, although drive tapes for the antenna tracking computer were still not entirely accurate, BTL received a continuous wave (cw) emission from Stump Neck via ECHO I. Heavy cloud cover still prevented optical tracking.
- From the beginning of the second night's operation, accurate tracking tapes were available and optical tracking also became feasible. All operations of the station were successful and excellent communication was achieved.

A few sample entries from the station log follow.

Second Night

First Pass: 17 minutes of transmission to BTL including CW and wide band frequency modulation (WBFM). A prerecorded voice message by Dr. R. M. Page, Research Director of NRL, and live voice were transmitted. Every word came in loud and clear at Holmdel.

Second Pass: 15 minutes of uninterrupted voice transmission from a prerecorded test tape. Excellent communication.

Third Pass: 22 minutes of transmission, including music and an intelligibility word list. Excellent results.

Fourth Pass: First use of double relay; voice bounced from NRL to BTL and immediately re-bounced from BTL to JPL. Good communication.

Fifth Pass: Single-channel, 60-wpm teletype message sent from NRL to BTL. 100 percent copy.

Third Night

JPL again transmitting after a period of silence. Tests made with live voice and prerecorded messages with various types of modulation including frequency, phase, and amplitude modulation. Best performance obtained with frequency modulation in these tests. On following nights results included excellent reception of CW by BTL with only 500 watts radiated by NRL. Solid reception of FM voice was maintained at BTL when NRL transmitter power was reduced from ten kilowatts to one kilowatt. In one test, BTL received simultaneous transmissions from both JPL and NRL.

A passive (reflector) satellite such as ECHO can bounce any number of signals simultaneously without mutual interference, provided that they are separated in frequency as in ordinary terrestrial practice. The number of words or amount of information that can be communicated is therefore essentially unlimited.

The major factor in scheduling communications is mutual visibility time. A large amount of information can, however, be transmitted in a short time at the ultra and super high frequencies (UHF and SHF) used in the ECHO system. For instance, if the satellite is simultaneously "visible" at two terminals for 25 minutes, one station could transmit via 32-subchannel teletype the complete text of a document containing 80,000 words.

There are certain structural limitations peculiar to a balloon-type satellite. For instance, when ECHO's path is not directly in sunlight, the volatile gases inside will tend to revert to the solid state and the aluminum coated plastic sphere may collapse, becoming a variable reflector of radio signals and useless from the point of view of continuity and constancy. However, the limitations are not too formidable. There are various possible means for insuring that the balloon will remain inflated; for example, one involves the use of "ribs" like those of an umbrella.

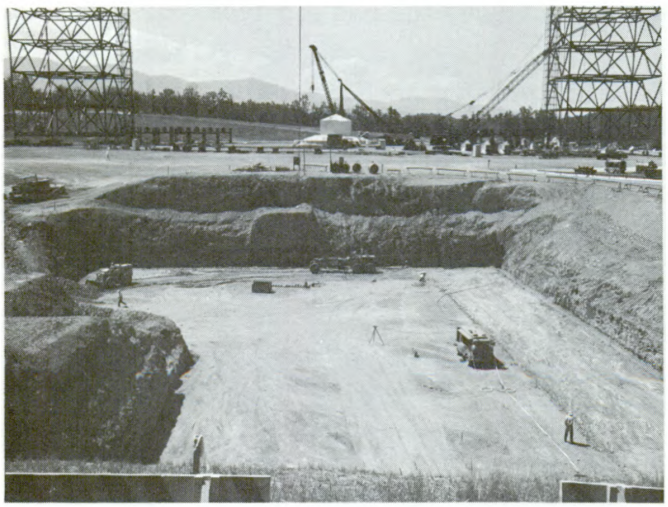
It can confidently be expected that such limitations will be overcome in the not-far-distant future and the communication capability of the Navy and the world will be increased manyfold.—WML.

"Paving Material" of the Ocean Floor

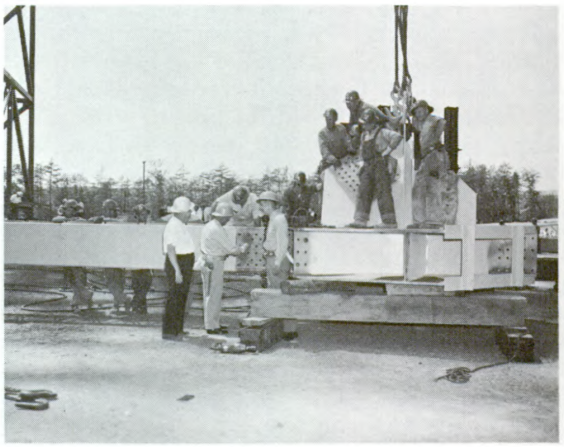
Millions of square miles of the floor of the Pacific Ocean may once have been paved with volcanic ash, according to research being conducted at The University of California's Scripps Institution of Oceanography. The paving material was shot out of underwater volcanoes and distributed by ocean current, says Henry W. Menard, Jr., Associate Professor of Geology at Scripps and the Institute of Marine Resources. He bases his theory on the recovery by dredges of numerous slabs of the material, once ash, now consolidated as rock, throughout large areas of the Pacific and on photographs of the slabs on the sea floor. A characteristic slab is one inch thick and 5 inches across, Menard says. None has been found resting on another. Menard believes that the layer was once continuous, but that it was broken up first by physical-chemical changes and then by worms and other bottom-dwelling creatures hundreds of thousands of years ago. The slabs bear a coating of manganese oxides an inch thick on their tops. Billions of tons of nickel and cobalt are associated with these vast manganese deposits. Rounded manganese nodules of more recent origin dot the areas between the slabs.

Progress Report at the Naval Radio Research Station

On July 21, a construction landmark was passed in the building of the 600-foot radio telescope at Sugar Grove, West Virginia. On that day RADM H. B. Jones, CEC, USN, Officer in Charge of Construction for the Fifth Naval District, wrenched tight the first bolt to begin the steel work of the vast antenna. The pieces joined were a 20-ton, 74-foot beam and a weldment, or joint, where several structural members meet. About 13,000 pieces will have to be positioned and bolted together before the massive structure is complete.



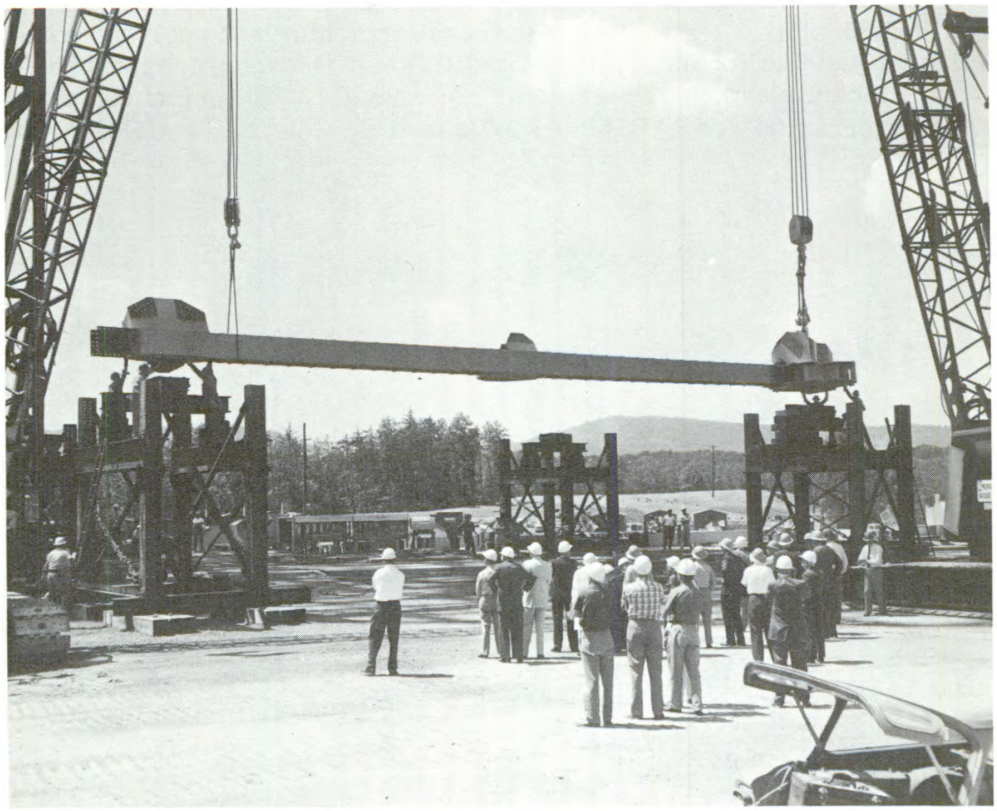
Excavation for the Laboratory-Administration building. The white object in the center background is the temporary covering for the pintle foundation; left and right are the twin 400-foot towers which will be used in erecting the telescope.



Placing the first bolt

Station development thus far has included completion of a 60-foot auxiliary antenna, laying the reinforced-concrete foundations for the concentric tracks on which the main antenna will rotate, laying the foundation for the center pintle, excavation of the big hole in which will be erected the laboratory-control building, and completion of a

cable tunnel that will be a subway from the control building to the pintle. The building will be completely underground, buried under thick layers of coke rubble and packed earth to insure that none of the radiation from instruments and machinery will interfere with the faint cosmic signals detected from outer space.



Raising the first joined members. (See the photo, inside back cover.)

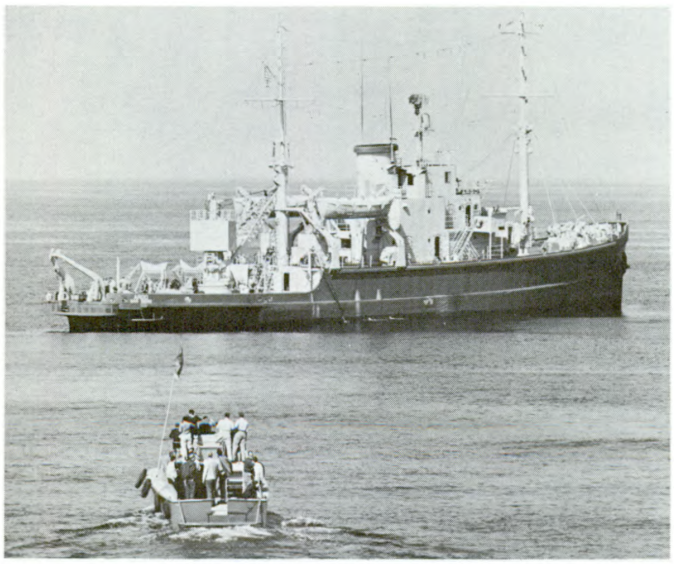
Instruction By Closed-Circuit TV

At the National Naval Medical Center, Bethesda, Md., closed circuit television was recently employed as a technique for simultaneously teaching an entire class in "The Care and Use of Lens Measuring Instruments." With the cooperation of the Television Project of the Center, the Ophthalmic Technician School of the Naval Medical School presented the lecture demonstration in the TV studio for viewing by the students in a remote classroom. Instruction in lens measuring instruments presents a difficult problem to the classroom teacher because of the many small details of operation. In this instance, through television, all students were able to view the various dials and working parts as they were described and demonstrated by the lecturer. In addition, all students could clearly see the target patterns for various types of lenses as though they themselves were looking through the eyepiece of the instrument. The facility of TV in bringing out small details in operation of these instruments was clearly demonstrated. Other programs are in the planning stages; these include a video tape of this presentation for repeated use for future classes.—U. S. Navy Medical News Letter.

Research Notes

Scripps New Research Vessel ARGO

Commissioning ceremonies for the Research Vessel ARGO—newest and largest of the eight ships of the oceanographic fleet operated by the University of California's Scripps Institution of Oceanography—was held at the Embarcadero, San Diego, Calif., on August 13. The principal speaker on the occasion was RADM Rawson Bennett, II, Chief of Naval Research.



The Research Vessel ARGO, newest and largest of the oceanographic fleet operated by the University of California's Scripps Institution of Oceanography

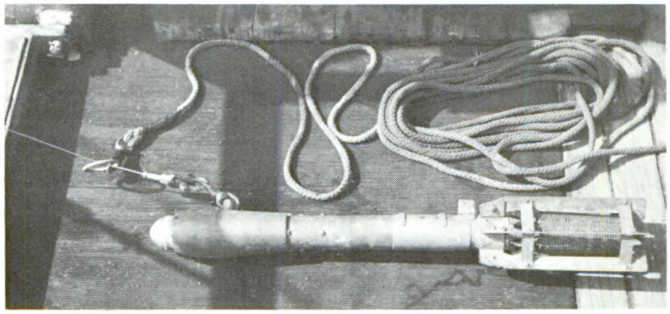
ARGO's name comes from Greek mythology. Jason's "Argo" sailed from Greece to Colchis in search for the golden fleece—the first voyage of oceanographic exploration. There is a secondary connotation: ARGO's first long voyage was slated for late August from San Diego to participate in the Monsoon Expedition, an international scientific study of the world's least known area—the Indian Ocean. At least 20 vessels of various nations will be involved in this expedition. The ship will carry out a program of investigations designed to study the sea floor, the crust beneath it, the ocean waters and their movements, the living things in the water, and the atmosphere over the sea. The voyage will take more than 6 months to complete.

The 213-foot, 2000-ton former Navy auxiliary rescue and salvage vessel, was leased to Scripps by BuShips and her conversion to an oceanographic research ship was supported by ONR. The new ship carries a scientific party of 24 and a crew of 21. She is the first vessel operated by Scripps which is capable of conducting research in very rough weather. Among her special features are a 6-ton crane, step-tapered cables which can reach bottoms of the deepest trenches, and three laboratories, including an air-conditioned and soundproofed laboratory for delicate electronic instruments. She carries the first scanning-type search sonar ever to be used on a research vessel.

(See NavResRev, Jan/59, pp. 1-7, "Ships for Research.")

A Trick with the Bathythermograph

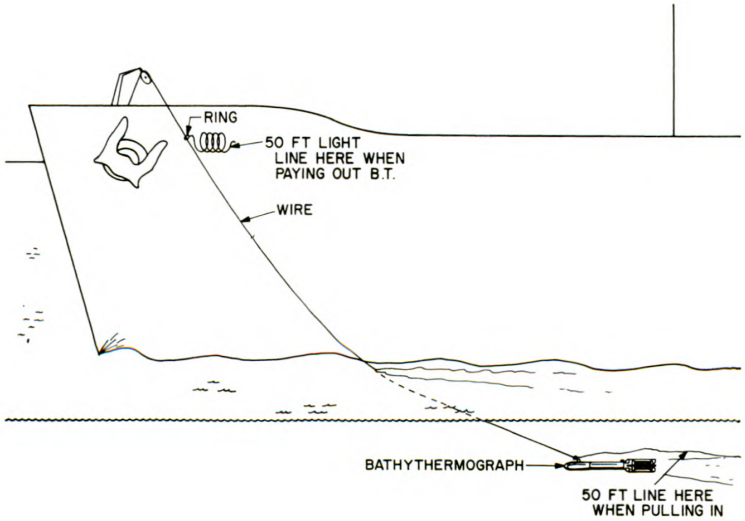
When a bathythermograph* is hauled aboard one of the larger oceanographic vessels while the ship is underway, the wild and uncontrolled swinging of the bathythermograph from the high boom frequently results in damage to the instrument. This problem has been solved by Arthur D. Raff, an associate engineer on the staff of Scripps Institution



A bathythermograph with some 50 feet of light line attached to the tow wire

of Oceanography, who has invented a simple device to effectively damp the swinging motion. Earlier this year, while working aboard the USC & GS Survey Ship EXPLORER, Mr. Raff tested his "bathythermograph antiswing device." Right away the device worked well, and it was apparent that he "really had something." The inventor's description on how to rig the antiswing device follows.

"A slip ring or snap is placed on the tow wire between the sheave and the bathythermograph (BT). To this ring is securely fastened about 50 to 75 feet of light line, the length of the line depending on



The problem as solved by Mr. Raff

* Bathytheromograph: "bathy" (sea depths) plus "thermograph" (a self-registering thermometer).

how the line is arranged. The line is kept on the deck while the BT wire pays out, letting the wire slip through the ring. When the wire is being pulled in and the BT is nearing the surface, the line is dropped into the water. The ring slips to the BT. As the BT is hoisted upward to the sheave, the line trailing in the water will effectively damp the swinging motion."

Natural Shark Repellant ?

If an Office of Naval Research sponsored project pays off, Navymen who find themselves in the water for whatever reason will be secure in the knowledge that they are as near alike to a sea cucumber as science can make them. The project is determining the properties of a toxin known as holothurin. Sea cucumbers secrete the toxin to protect themselves from their enemies. If it is successfully used by man to repel sharks or other carnivorous and noxious marine animals, it could result in increased safety for skin divers, survivors of shipwrecks and aircraft accidents, rescue parties, and marine salvage workers.

Related projects can possibly benefit mankind in general. Dr. Ross Nigrelli of the New York Zoological Society is one of the principal investigators. Studies of the chemical structure and pharmacological activity of holothurin and similar substances are being conducted by Dr. Harry Sobotka of Mount Sinai Hospital, New York. Dr. Seymour Freiss of the Naval Medical Research Institute is attempting to determine the biological effects of this substance.

According to Dr. Nigrelli, studies have shown that holothurin also has powerful nerve-blocking properties and increases the clotting time of blood. In laboratory tests it has stopped the growth of tumors in white mice.

During World War II, the Navy's chemists developed a synthetic shark repellant that was, and still is, a standard component of survival kits. Peacetime tests have indicated, however, that the substance is less objectionable to sharks than was at first thought. At any rate, the search for a better repellant will be continued until a more satisfactory substance is found.

NNMC Celebrates 18th Birthday

The National Naval Medical Center, Bethesda, Md., celebrated its 18th birthday August 31. The Bureau of Medicine and Surgery also celebrated an anniversary on the same date with a slightly older 118th birthday. NNMC, a younger member of the Medical Corps, was officially commissioned in February 1942; however, President Roosevelt dedicated the buildings August 31, which at that time commemorated the 100th anniversary of BUMED.

Navy Pursues Indefinite Preservation of Blood

The Linde Company of Tonawanda, N. Y., is in the advanced phase of a program that may result in the first practical procedure for freezing, storing, and thawing whole blood—as part of ONR's long-range program to develop a technique for indefinite preservation of blood. Linde scientists began to explore this problem some three years ago. Their aim was to devise methods applicable to large-scale processes, believing that "a process for the indefinite preservation of blood at low temperatures is a practical possibility." The greatly accelerated program supported by the Office of Naval Research is destined to benefit not only the Government and industry but also medical science, thereby solving a major problem on hand since World War I.

Several years ago, under the sponsorship of ONR and the Bureau of Medicine and Surgery, a basic technique was devised by which it might be possible to preserve whole blood for indefinite periods; this technique used liquid nitrogen to freeze blood rapidly to 195 degrees below zero Centrigrade. Liquid nitrogen was selected as the refrigerant because it is economical and it provided the most satisfactory temperature. At that temperature no natural chemical or physical changes takes place in the blood, and no deterioration or change in the properties of the blood occurs when it is reconstituted and administered to patients.

Now, in developing a practical process by which whole blood can be frozen or thawed rapidly, Linde scientists are storing whole blood in inexpensive, sterile, one-pint containers at the specified temperature (-195°C) and not varying more than one degree. Under the Linde procedure, freezing can be accomplished in volumes of one pint in less than 30 seconds, as compared to 55 minutes required by conventional methods. Blood thus frozen can be stored for weeks, months, or longer in the special containers and then thawed. Tests have demonstrated that about 85 percent of the cells are alive at the time of transfusion after long storage, compared with about 70 percent functional cells after 3 weeks' storage by conventional methods. With this process, blood can be thawed with approximately equal rapidity and then brought to body temperature just before being transfused.

Development of such a system would revolutionize present-day blood banks. Current procedures for storing whole blood, for transfusion pruposes, depend on the collection of blood in a suitable anticoagulant solution and storage in the liquid state at 4 degrees Centigrade. Under these conditions blood can be preserved 21 days, after which it becomes unsuitable for transfusion. Even under the best conditions, a sizeable portion of whole blood collected cannot be used in 21 days. Although part is processed to obtain blood plasma, some is lost. And the total such loss for a year amounts to $10 million.

Life is no matter of half measures for the 17 U. S. Navymen and civilian scientists wintering at Hallet Station, tiny Antarctic outpost. Not long ago the station was struck by its worst recorded storm, with gusty winds estimated in excess of 140 miles per hour. Two anemometers were blown down, one indicating gusts of 119.8 mph before it fell. Huge pieces of canvas covering were blown from the tops of some of the station buildings, and flying debris punched a hole in the side of one of the structures.

Clinical Use of Frozen Red Cells

As early as 1947 it was shown that tissues exposed to glycerol and other polyhydric alcohol subsequently could be frozen and thawed without significant harm. The implication of this observation to blood banking was readily apparent, but practical considerations prevented its immediate translation to methods of red cell preservation. This was chiefly because glycerol must be removed from the red cells before transfusion.

Developed in 1951, the Cohn fractionator for preparation of blood into its component parts was found to possess certain features which made it uniquely applicable to the glycerol processing of red cells prior or subsequent to preservation in the frozen state. Preliminary studies showed its value; human blood processed in this way could be maintained in the frozen state for periods up to at least 28 months and subsequently transfused with normal in vivo survival. Present study evaluated clinical applications.

Survival of the red cells has varied between 68 and 98 percent with a mean of 83 percent immediate posttransfusion recovery. No difference in survival characteristics as a function of storage time has been demonstrated. The T/2 decay time has approximated the normal range of 30 days.

The average yield of red cells has been 82 percent of the original donor's blood. For a period of one year, there has been no decrease in final cell yield that can be related to duration of storage.

Recipient effects have been satisfactory in all cases. The rise in hemoglobin, red cell count, and hematocrit has been equivalent to what would be predicated from the volume of cells transfused. There have been no side effects of an undesirable nature; no chills, fever, urticaria, hepatitis, or hemolysis. It is believed this unexpectedly good tolerance of the blood is not related to freezing per se, but rather to the method of glycerolization and deglycerolization, which involves washing the red cells and consequent removal of the intercellular proteins released from dead leukocytes and platelets.

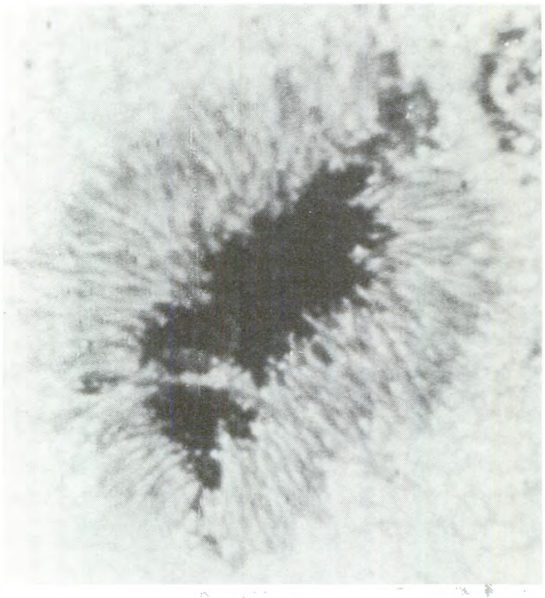
The unique advantages of this method of blood freezing are versatility of the method, whereby the red cells may be suspended as "packed cells" in albumin or as whole blood in the original native plasma; complete bacteriologic safety, reproducibility, and simplicity of method; elimination of donor reaction; elimination of wastage through outdating; availability of rare blood types; and establishment of a true "bank" whereby an individual can store his own blood for later use.

—U. S. Navy Medical News Letter.

STRATOSPHERE Photograph Reveals Evidence of Structure in Sunspots Umbra

This STRATOSCOPE photograph of the center (umbra) of a sunspot which shows clearly for the first time white gaseous dots within the umbra was released by the Navy and the National Science Foundation. The photograph was taken by the Princeton University astronomy team, headed by Dr. Martin Schwarzchild, during the final balloon-borne observations near Minneapolis, Minn., on September 24, 1959. Earlier flights last summer produced the clearest sequences of photographs ever recorded of the sun's surface and the areas immediately surrounding sunspots. These flights were jointly supported by the Office of Naval Research and the National Science Foundation.

Because sunspots are more than 1000 degrees cooler than the sun's surface or photosphere (whose temperature is about 5700 degrees K), they consequently produce much less visible light. A different film was used in the telescope-camera during the final flight, therefore, to bring out the characteristics of the umbra while "washing out" the typical granulations surrounding the spot.



"We can now see plainly that there are bright dots in the umbra. While we do not yet know much about them, we know that they are very small—less than 200 miles in diameter. There is a possibility that they are convection cells, strongly suppressed by the magnetic field of the sunspot. Much detailed analysis remains to be done before we can make conclusions about their characteristics," said Dr. Robert Danielson, member of the Princeton team. The long distance of the umbra in which the dots appear is about 8000 miles, or, roughly, the diameter of the earth. Lifetime of the dots—possibly rising gases hotter than the bulk of the umbra—is roughly one half hour, which is about the same as the lifetime of the gaseous filaments in the penumbra (outward-reaching luminous lines around the edges of sunspots). While previous astronomical observations had hinted at the existence of these dots, no clear photographic evidence of them had previously been obtained.

STRATOSCOPE I, a 12-inch telescope carried aloft by a balloon, made four flights in the summer of 1959 from Lake Elmo, Minn., in a project jointly supported by NSF and ONR. Photographs from the first three flights have been under intensive analysis by Dr. Schwarzchild's group, and only recently have they begun to turn their attention to the results of the last flight.

STRATOSCOPE II, a 36-inch telescope system, is at present under development and it will be used primarily for observing stars, galaxies, and planets. NSF has granted an additional $500,000 for support of STRATOSCOPE II, and ONR is also continuing its support of the project. For this phase, they have been joined by the National Aeronautics and Space Administration, which recently announced a $100,000 grant for the project.

The telescope and the telescope-camera for both STRATOSCOPE I and STRATOSCOPE II have been developed and manufactured by the Perkin-Elmer Corp., Norwalk, Conn. Television equipment to accompany the flights was developed and manufactured by the RCA Laboratories, Princeton, N. J.

Tethys Expedition

An oceanographic expedition designed to study marine animals that live in the deep waters of the eastern Pacific has left San Diego for Hawaii. Tethys Expedition will take the research vessel SPENCER F. BAIRD, of The University of California's Scripps Institution of Oceanography, south of the equator and then northward to Honolulu. She will then sail southwest of Hawaii for geological studies. The return voyage from Honolulu will again be concerned with deep-water marine creatures. The expedition takes its name from Greek legend: Tethys was a sea nymph.

Leader of the biological work on the expedition is John A. McGowan, Graduate Research Biologist at Scripps. William R. Riedel, Assistant Research Geologist, will head the geological investigations. The distribution of creatures living near the surface has proved to be a good indicator of surface circulation patterns, McGowan says. He is seeking to determine whether creatures that live as much as 2 miles deep may in the same way offer clues as to the properties of the deep water and its circulation pattern. To do this, he will collect specimens at frequent intervals along the route and map their distribution.

Elephant Seal Chews Tobacco

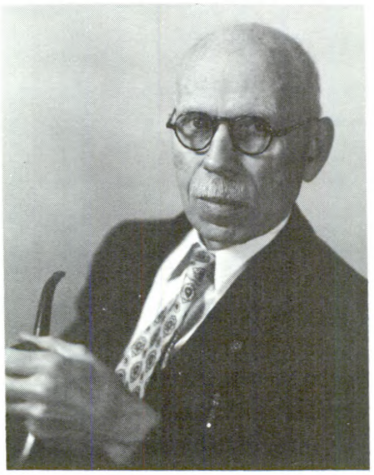
What is probably the first recorded instance of an elephant seal chewing tobacco has been reported by a scientist who accompanied a recent expedition of the Scripps Institution of Oceanography to Guadalupe Island, 160 miles off the Baja California coast. Reid V. Moran, botanist from the San Diego Natural History Museum, twice observed one of the island's colony of elephant seals eating the leaves of the Indian tobacco, a common weed on the West Coast. The plant contains nicotine. Elephant seals grow as long as 20 feet and can reach eight tons in weight. Arthur L. Kelly, student of mammals at Scripps, says that plant remains are often found in their stomachs. Usually the plant is kelp, because there is so much of that in the sea, but if they can reach land plants, they probably will eat them. ONR, Pasadena.

On the Naval Research Reserve

Research Reserve Award Program

RADM R. Bennett, USN, Chief of Naval Research, has announced the establishment of national competition among Research Reserve Companies through two awards: the A. Hoyt Taylor Award and the Naval Reserve Research General Excellence Award. The purpose of these awards is to improve training within the program and encourage good administration. Competition is by fiscal years, the first to begin on 1 July 1960 for award as soon as practicable after 1 July 1961.

- A. Hoyt Taylor Award. The award is named in honor of the Navy's first "Chief Physicist" and an early supervisor of that small group of radio engineers who developed radar in this country. Dr. Taylor was on active duty from 1917 to 1923 and was an officer in the Naval Reserve for many years, retiring with the rank of Commander. After the founding of the Naval Research Laboratory in 1923, he was appointed Superintendent of the Radio Division, a position he held until the end of World War II. The Taylor Award will be based on the best scientific or technical study submitted by a Research Reserve Company. The award will occur only when justified, but not more than once annually.



Dr. Taylor

- Naval Reserve Research General Excellence Award. The award will honor the company which best fulfills the Research Reserve's assigned mission. Nominations for this award will be made yearly by each Naval District Commandant supporting Research Reserve Companies. In selecting the recipient, the Chief of Naval Research will consider such criteria as inspection reports, annual reports, training schedules, and reports of visits by Branch Office Reserve Assistants. He will then recommend to the Commander, Naval Reserve Training Command, the Research Company which he feels is best qualified for the award. The Chief of Naval Research, or some other official representing the Department of the Navy, will present a trophy to the winning company for each award. The following year the trophy may be rotated, but a emblematic plaque will be retained by each winning company.

Idaho Falls Seminar

Forty-seven reserve officers attended the Seventh Annual Nuclear Sciences Seminar, 24 July through 6 August, in Idaho Falls. Of this total, 9 civilians sponsored by the U. S. Atomic Energy Commission attended the seminar—in addition to the 26 USNR, 8 USAR, 10 USAFR, and 3 USPHS reserve officers. Participants in the annual seminar became acquainted with operations at the U. S. Atomic Energy Commission's National Reactor Testing Station, located near Idaho Falls, and were brought up to date on current developments in reactor technology.

The seminar, planned and conducted by Naval Reserve Research Company 13-6, in Idaho Falls, was sponsored by the Office of Naval Research. The Commandant, Thirteenth Naval District, furnished logistic support. Cooperating with the Idaho Falls Naval Reserve unit were the Idaho Operations Office of the Atomic Energy Commission and all major operating contractors at the National Reactor Testing Station.

RADM Frank T. Watkins addresses the Idaho Falls Seminar

Prior to the beginning of technical sessions, the reserve officers were welcomed by CDR V. V. Hendrix, USNR, Seminar Chairman; Mr. Allan C. Johnson, Manager of the AEC's Idaho Operations Office; Mr. Vernon S. Johnson, President of the Idaho Falls City Council; CAPT T. J. Wadsworth, USNR, Commanding Officer, NRRC 13-6; and RADM F. T. Watkins, USN, Commandant of the Thirteenth Naval District.

Forty technical presentations covered such fields as health physics, basic nuclear physics, specific nuclear facilities at the National Reactor Testing Station, and the over-all Atomic Energy Commission organization, operations, and objectives. The nature of the lectures, although principally of reactor technology, applied science, and engineering, amply covered nuclear fission patterns, theoretical nuclear science, medicine, and ecology.

Tours through the world's largest and most varied collection of reactors were conducted by 36 lecturer-guides representing the several major operating contractors—Aerojet-General Corporation; Argonne National Laboratory; Atomics International; Combustion Engineering, Inc.; General Electric Company; Phillips Petroleum Company; and Westinghouse Electric. Four days were devoted to some 450 miles of tours through NRTS facilities, including research, testing, power, propulsion, and support types.

CAPT Julius W. Jockusch, Jr., USNR, special Assistant to the Chief of Naval Research (Research Reserve), made a very interesting closing presentation, after which he presented certificates to all officers completing the two weeks training.

In a letter commenting on the Seminar, RADM Watkins stated, in part: "I was impressed with the excellent arrangements that you and the officers of Naval Reserve Research Company 13-6 made for the Seventh Annual Nuclear Sciences Seminar and considered it an honor to address this group. These annual seminars are important to the scientific education of our Reserve Officers, and I congratulate you on the manner in which they are conducted."

Speakers at the Idaho Falls Seminar, left to right: CAPT T. J. Wadsworth, RADM F. T. Watkins, Mr. Allen C. Johnson, and Mr. Vernon S. Johnson

U. S. Naval Training Device Center
Conducts Tenth Annual Seminar

Thirty-five Army and Navy Research Reservists from all over the United States attended a training device seminar, 17-30 July, at the U. S. Naval Training Device Center, Port Washington, New York. The Seminar, tenth in an annual series, was designed to bring reservists up to date on the Navy's far-reaching technical, scientific, and research and development program.

During their intensive "cruise," the Reservists heard top-ranking military and civilian speakers. Also, the latest developments in training devices were discussed with engineer's and scientists responsible for the Navy's training device program. A highlight of the tour included a two-day visit to the U. S. Submarine School, New London, Connecticut, where the group witnessed the operations of submarine training devices.

CAPT E. C. Callahan, USN, Commanding Officer and Director of NAVTRADEVCEN, supervised the Seminar. Chief N. E. Corbin, of the Center's TRADEVMAN Advisory Group, was Seminar Coordinator.

Participants at the tenth training device seminar held at NAVTRADEVCEN, Port Washington, New York

1961 Selection Board

Selection Boards to be convened to consider Naval Reserve Officers on inactive duty for promotion during the fiscal year of 1961 have been scheduled as follows: Captain to Rear Admiral (Line and Staff Corps), 1 November; (60); Commander to Captain (Line), 4 January; Lieutenant Commander to Commander (Line), 4 January; Commander to Captain (Staff Corps), 21 February; Lieutenant Commander to Commander (Staff Corps), 21 February; Lieutenant to Lieutenant Commander (Line), 14 March; Lieutenant to Lieutenant Commander (Staff Corps), 25 April; Lieutenant (junior grade) to Lieutenant (line), 11 April; Lieutenant (junior grade) to Lieutenant (Staff Corps), 23 May; Warrant Officers (in grade), 9 May.

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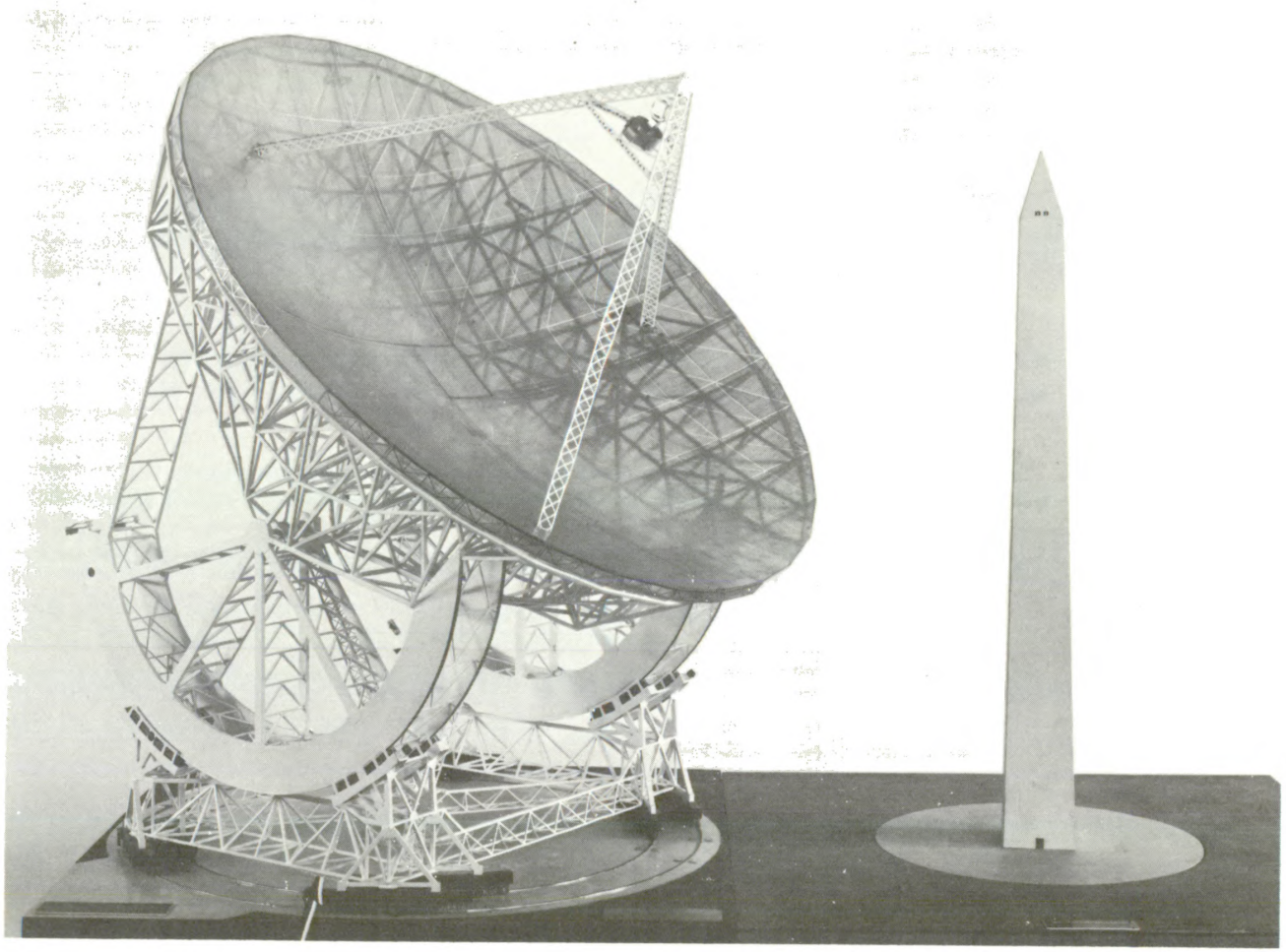

Scale model of the Sugar Grove, W. Va., radio telescope with the 555 foot Washington Monument reduced to the same scale. The arrow points to a model member corresponding to the 74-foot beam shown on Page 17.

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. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

A "satellite spotter" goes upward to the optical tracking station of the Navy's 60-foot-diameter, dish-type antenna at Stump Neck, Maryland. See page 13.