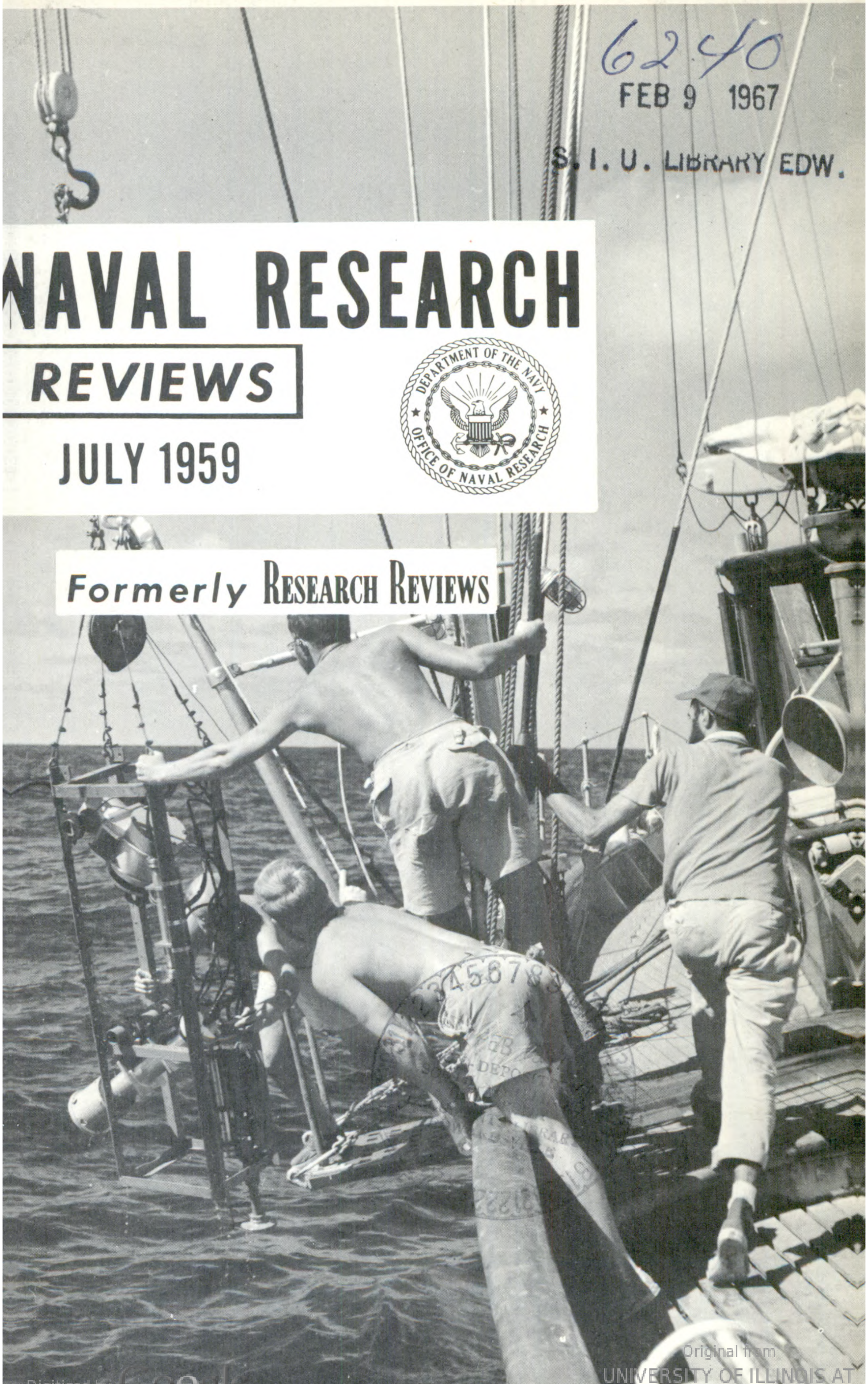
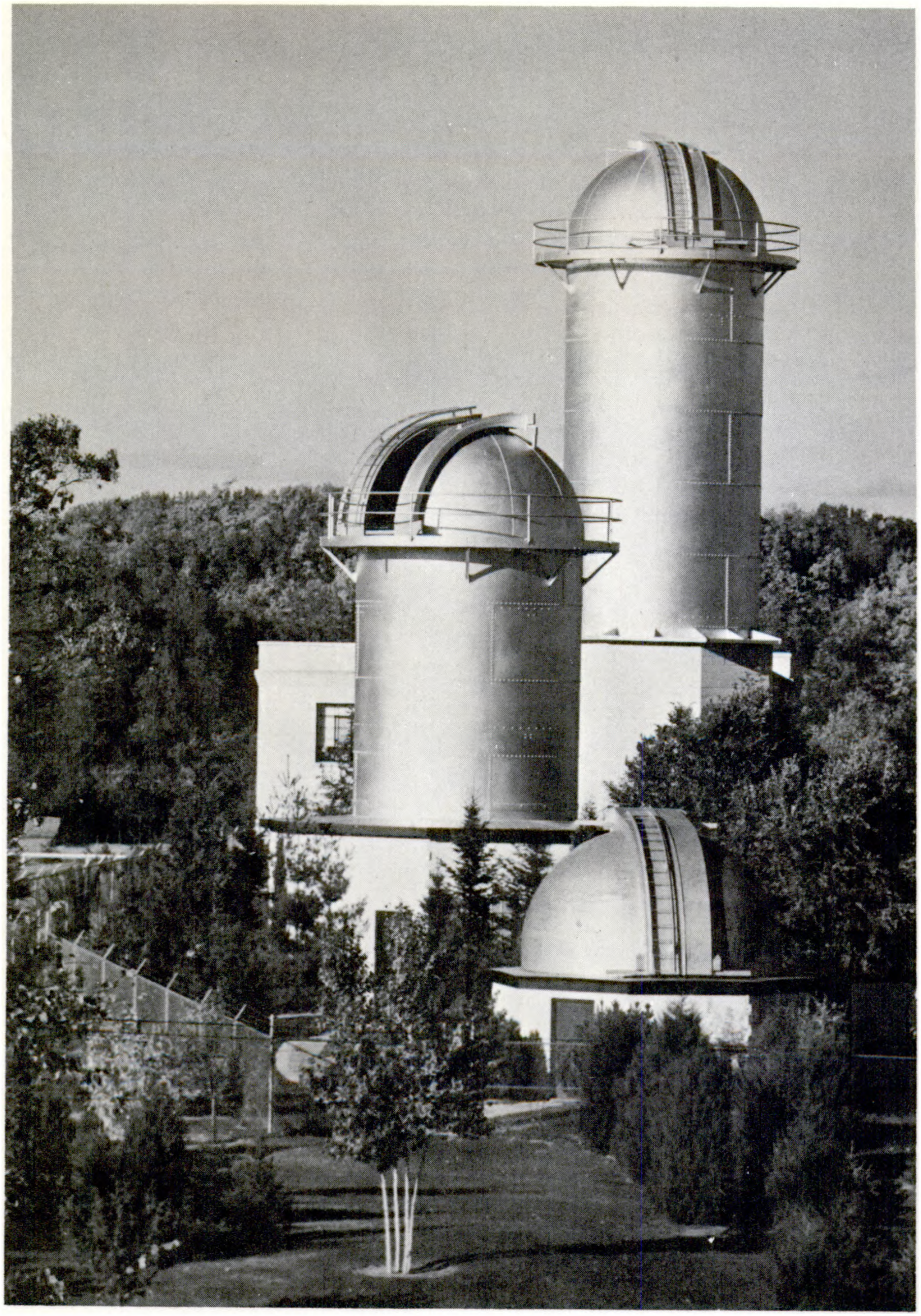
NAVAL RESEARCH REVIEWS

JULY 1959

Formerly RESEARCH REVIEWS





The solar telescopes at the McMath-Hulbert Observatory at Lake Angelus near Pontiac, Michigan, operated by the University of Michigan. The small dome in the foreground houses a flare-patrol telescope. Inside the building of intermediate height is a 50-foot solar telescope. The highest dome houses the McGregor solar tower telescope, which is used with the large vacuum spectrograph described on page 2. Much of the research conducted at this observatory is supported by the Office of Naval Research.

The ONR Contract Astronomy Program

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The interest of the Navy in astronomy is traditional. The navigation of ships at sea, far from shore, would have been impossible without observations of sun, planets, and stars and a thorough knowledge of their motions. The first scientific institution in this country devoted to astronomical observations, the U. S. Naval Observatory in Washington, D. C., was created by the Navy more than a century ago. As will be clear from what follows, the modern Navy has many other reasons for a keen interest in astronomical developments.

Early in its life, the Office of Naval Research began supporting research in several astronomical fields. This started with a few sporadic projects initiated because of their specific interest in relation to other programs of the branches supporting them. Over the years it has grown into an astronomy program of considerable magnitude. Instead of enumerating all projects presently supported, we will divide the field of astronomy into several general areas, and select in each of these only a few representative projects for a closer look.

SOLAR PHYSICS

It has been known for many years that the sun, in addition to providing us with heat and light, has other important effects on the earth. To mention a few, it maintains the ionosphere, which is indispensable to long-range radio communication; it is responsible for irregular changes in the earth's magnetic field, called magnetic storms; and it causes occasional brilliant displays of the aurora borealis. These effects are closely correlated with solar activity, which fluctuates in intensity over a period of roughly eleven years. The degree of activity of the sun is indicated by a number of phenomena, such as sun spots, prominences, and flares, which can be observed on its surface through telescopes. Sun spots are dark areas of lower temperature possessing strong magnetic fields; prominences are bright red clouds of gas seen most easily just beyond the edge of the sun's disk; and flares are bright eruptions of brief duration on the solar surface, usually near sun spots.

It is not difficult to see that a thorough study of the physics of these solar phenomena is required for a better understanding of their terrestrial effects, and that such a study may lead to improved methods of forecasting the effects or may in other ways help man cope with the problems they give rise to. For these reasons, the Physics and Geophysics Branches of ONR have supported, since 1946, researches of this nature at the High Altitude Observatory of the University of Colorado. This observatory is located directly on the Continental Divide near Climax, Colorado, at an altitude of 11,200 feet. The principal instrument used in this work is the coronagraph which, together with various auxiliary equipment, permits the study of the spectrum of the sun's corona (outer atmosphere) and of the details of prominences, flares, and other phenomena at the limb of the sun. Because the corona is extremely faint, every effort has to be made to reduce the brightness of the sky background. Fortunately, this brightness diminishes as one goes to higher altitudes. Until 1930 nobody had ever seen the corona except during an eclipse of the sun, when the moon screens the earth from the blinding light. Then the French astronomer Lyot showed that, by carefully reducing light scattered by the optical components of the telescope itself, it was possible to observe the sun's corona from a high mountain. The mountain from which he made his observations was the Pic du Midi, in the French Pyrenees. He gave the new instrument the name coronagraph. At Climax, with this type of telescope, the staff has concentrated its efforts on studies of motions and temperatures in the solar corona, motions of prominences and their relation to solar magnetic fields, and the spectra of solar flares. The temperature of the corona turns out to be surprisingly high—2,000,000° Kelvin as compared to only 6,000° K. for the sun's surface. Personnel from this observatory have also participated in several expeditions to far-away places for observing total eclipses of the sun.

Another famous center of solar research is the McMath-Hulbert Observatory of the University of Michigan, situated at Lake Angelus near Pontiac, Michigan. As this institution is located practically at sea level, the elusive solar corona cannot be studied here, as it can at Climax. However, much other important work in solar physics is carried out at the observatory with financial support from the Physics Branch of the Office of Naval Research. This includes a very thorough study of the relation between solar radio emission and optical features on the sun's surface. The sun is the nearest star, and as such presents a unique opportunity to study at close range all manner of surface phenomena, the occurrence or nature of which on other stars can only be surmised. Spots, flares, and prominences have already been mentioned. It has been found that the flares especially are very closely associated with strong bursts of radio emission from the sun, and also with geomagnetic disturbances.

The McMath-Hulbert Observatory possesses the only large vacuum spectrograph in the world. When the air is pumped out of the instrument there can be no more air turbulence inside, and so the sharpness of the spectrum is enhanced. With this spectrograph, equipped with a large diffraction grating of excellent quality, high-resolution spectra of unsurpassed definition have been obtained. For the first time the solar absorption lines show a characteristic zig-zag appearance, which is explained by Doppler shifts due to ascending and descending columns of gas at the sun's surface. This appearance corresponds with the grainy appearance the sun's surface has when viewed at high magnification.

CELESTIAL MECHANICS

Another field of interest to the Navy is celestial mechanics. This deals with the accurate computation of the orbits of planets and comets around the sun, and of satellites around planets. But the same laws that apply to the motions of the heavenly bodies in a gravitational field apply also to the paths of ballistic missiles, artificial satellites, and space vehicles. Since 1947, the Mathematics Branch of the Office of Naval Research has supported a large project on the computation of planetary orbits and the improvement of planetary theory. This work is carried out under the joint guidance of Dr. G. C. Clemence, Director of the U. S. Naval Observatory in Washington, D. C., and Dr. Dirk Brouwer, one of this country's foremost experts in celestial mechanics at Yale University. It is certain that the scientific exploration of space by artificial satellites and space vehicles will benefit from a better understanding of planetary motions.

GENERAL BASIC ASTRONOMY

Dr. Joel Stebbins, who may be considered the father of photoelectric photometry in astronomy, was director of the Washburn Observatory, University of Wisconsin, Madison, until he reached the mandatory retirement age in 1948. Since then he has been able, through ONR support, to continue his fundamental researches up to the present at the Lick Observatory of the University of California on Mount Hamilton near San Jose. Among other things, he has made the most accurate determination so far of the brightness and the temperature of the sun. He is now finishing his measurements of stellar temperatures by direct photoelectric comparison, in six or more different color bands, with carefully calibrated standard lamps of which the temperature is known to within 5° C. These lamps, which have quartz windows, are manufactured by Philips in Eindhoven, Holland, and are calibrated against the best black-body standards available. As a result of this work, the definitive temperatures of a number of standard stars will soon be published, and astronomers will have for the first time a fundamental stellar temperature scale which is tied in directly with laboratory standards.

At the famous Lowell Observatory near Flagstaff, Arizona, Dr. Harold L. Johnson with the close collaboration of Dr. A. A. Hoag, Director of the Flagstaff Station of the U. S. Naval Observatory, is engaged in an ambitious three-year program of photoelectric photometry of stars in galactic clusters. If for each individual star in such a cluster the brightness is determined in three separate colors (ultraviolet, blue, and yellow), it is possible to plot these quantities in a diagram which will at once reveal the distances as well as the evolutionary stage (age) of the cluster. The uninitiated reader will have to take this statement on faith because an adequate explanation would take too much space. The diagram in question is the renowned Hertzsprung-Russel diagram, also called color-magnitude diagram, and is our most powerful tool in the study of stellar structure and evolution. To perform these measurements for faint stars, Dr. Johnson has developed a sophisticated two-channel photoelectric photometer. Each channel consists of an IP21 photomultiplier and associated amplifiers which count the individual electrons released by the cathode as it is stimulated by the light received. One channel is directed at the star and the other is directed at the nearby sky background, which has to be subtracted. Filters are used to isolate the desired color bands.

For many years Professor W. J. Luyten, of the University of Minnesota, has made an extensive search for faint stars of a special type called white dwarfs. These remarkable objects are the smallest stars known, no larger than the earth or even smaller, but they weigh several hundred thousand times as much as the earth; compare this to the sun whose diameter is 109 times that of the earth, and many other stars with diameters ten or a hundred times that of the sun. Consequently, in the white dwarfs matter exists at the incredibly high density of a million or more times that of water. If we could have one cubic inch of this stuff in our laboratory, it would weigh about twenty tons, but we cannot compress a gas so highly with any means at our disposal on earth. However, we can predict theoretically how matter should behave at such extreme pressures by applying statistical mechanics. It turns out that under these conditions a gas becomes degenerate, meaning that it no longer obeys the ordinary gas laws of physics but follows a different equation of state. Naturally, it has not been possible to check up on this by laboratory experiments, but it can be said that observations of white dwarfs have confirmed the physical theory of degenerate matter. With support from the Office of Naval Research, Professor Luyten has obtained, with the large Schmidt telescopes at Palomar and at the Mexican National Observatory, a number of sky photographs on which he has discovered several hundred white dwarfs including the smallest one known, a star so small that it probably has a diameter less than that of our moon. Not only have these stars become important test objects for physical theory, but they also have great astrophysical significence, for they are the oldest stars known. As all of their nuclear fuel is exhausted, they can no longer operate as thermonuclear furnaces. In this final stage of their evolution, they simply continue to radiate away the heat that is locked up inside them—a process which will keep the stars glowing ever more faintly for 20 or 30 billion years as they gradually die out.

BALLOON ASTRONOMY

The astronomer on the surface of the earth must observe the stars from the bottom of an ocean of air whose turbulence obliterates much of the finer detail his instruments could otherwise show. We cannot get rid of this trouble by locating observatories in the mountains because turbulence extends up to the stratosphere. The Office of Naval Research has pioneered the development of telescope-carrying high-altitude balloons (Research Reviews, October 1957 and May 1958). In the autumn of 1957, using an unmanned Navy SKYHOOK balloon carrying an automatically controlled 12-inch telescope, a team of Princeton scientists succeeded in photographing the sun from an altitude of 80,000 feet, far above disturbing air turbulence. These pictures show the granular structure of the sun's surface with unparalleled sharpness. Further ascents are planned for this year with improved equipment including television scanning to facilitate focussing. A 36-inch telescope is being designed for spectrographic as well as photographic observations of stars, nebulae, and galaxies in the near future.

Manned balloon flights to these high altitudes have also been made to explore the possibilities of utilizing the crew inside the sealed gondola as astronomical observers. Dr. John Strong, of Johns Hopkins University, has designed a special 16-inch Schmidt telescope for mounting on top of the gondola. Through this instrument the observer inside can photograph the infrared spectra of planets and stars. From the surface of the earth this region of astronomical spectra is heavily obscured by wide absorption bands of water vapor in the lower part of our own atmosphere. However, above 80,000 feet there should be extremely little moisture left in the air, and from that vantage point it may be possible to measure, for instance, the small amount of water vapor believed to be present in the Martian atmosphere. The equipment is ready, but a successful flight has not yet been made.

Important as these balloon astronomy projects are in themselves, they further serve as a stepping stone toward the development of instrumentation and techniques that will be used for making future astronomical observations from artificial satellites and space vehicles.

Radio telescope of 85-foot diameter recently completed at the University of Michigan Observatory under ONR sponsorship. A sensitive radio receiver is located at the focus of the parabolic dish.

RADIO ASTRONOMY

In the exciting new field of radio astronomy—the study of radio emissions from the heavens—the Electronics Branch of the Office of Naval Research has made an important contribution by financing the construction of four large installations in the United States. The Owens Valley Radio Observatory of the California Institute of Technology with its twin 90-foot dishes was described and illustrated in the April 1959 issue of this magazine. A second large facility is being completed at the University of Michigan; it possesses an 85-foot parabolic dish antenna and a 28-foot dish, the latter used exclusively for the study of radio radiation from the sun. Construction of another 85-foot dish on a site in northern California will soon be started by the University of California. All these dishes are fully steerable in order to follow the radio sources which traverse the sky in their daily motions. Finally, a unique nonsteerable installation is planned by the University of Illinois on a site near Danville, Illinois. It will be a large fixed parabolic cylinder, 400 feet wide by 600 feet long, obtained by grading the surface of a small valley to the right shape and size and hard-surfacing it with appropriate material. Although this receiver will obviously not be mechanically steerable, it will be possible to shift the beam by electrical phasing. In this manner, observations can be made of any radio source as it goes through the meridian within 30 degrees of the zenith. In view of its huge size, this instrument should be more sensitive than anything presently available and will give accurate positions and spectral information of very distant radio sources.

CONCLUSION

Astronomical research is important because the universe provides for us a laboratory in which to study the laws of nature on a much grander scale than is possible in earthly laboratories. About a century ago it was realized for the first time, by analyzing the characteristic spectral lines of stars, that all heavenly bodies, no matter how far away, are made of the same chemical elements we find on earth. Astronomical observations were indispensible in establishing the fundamental laws of gravitation and of dynamics, and in confirming the theory of relativity. By studying the stars, the laws of thermodynamics can be extended to gases at extreme densities and pressures.

It has been known for about 20 years that stars are thermonuclear reactors, generating energy by the fusion of hydrogen into helium. A great effort is now in progress to duplicate this reaction on earth for the production of power from a cheap and plentiful fuel—water. Success has not yet been attained although it has been possible to construct nuclear reactors operating on a different reaction, namely the fission of a uranium isotope. The new science of plasma physics, which studies the behavior of highly ionized gas in a magnetic field and which is based on much astrophysical evidence, shows promise of important applications in possible future fusion reactors.

These are some examples of valuable additions to man's knowledge of and control over his natural environment which are likely to be made through astronomy. Needless to say, the Navy stands to gain considerably from such achievements.

Fire-Extinguishing Sprinkler System for Use at Polar Temperatures

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Bases in the Arctic are usually erected in reasonably good weather, but they soon become so snowbound that it is not practical to do any fire fighting from the outside of an endangered structure. Also, many of the bases are so small that not enough manpower is available to maintain a constant watch in all structures. For this reason, the operating policy in the Arctic has been to provide enough extra buildings and supplies for protecting personnel and maintaining operations in the event of a widely destructive fire. Another policy has been to space buildings far enough apart to prevent the spread of fire; however, traveling to and from widely spaced buildings is a hazardous as well as an onerous task during severe Arctic weather. If a major facility, such as an aircraft warning station, were inaccessible in bad weather and destroyed by fire, its loss, tactically, could be more expensive than the cost of replacement.

In recent years, operations in the polar regions have expanded so greatly that improved low-temperature fire-fighting equipment is needed to provide continuous protection for buildings. Commercial equipment, in general, is unsuitable, owing, in part, to the fact that many extinguishing agents freeze at Arctic temperatures. For these reasons, the Bureau of Yards and Docks sponsored a program for the development of an automatic fire-extinguishing sprinkler system for use at polar temperatures. The sprinkler system, minus a pressurizer, was developed by the U. S. Naval Civil Engineering Laboratory.

REQUIREMENTS

The problem presented to NRL was to develop a solid-propellant pressurizer to operate a 300-gallon (originally 250-gallon) sprinkler system at temperatures of -65°F and above. The pressurizer was to have a means of automatically starting the sprinkler system and maintaining the proper tank pressure, as determined by the following conditions: With all sprinkler heads of one loop open, the 300 gallons of extinguishant must not be expelled in less than 5 minutes, and during operation of the system, the pressure must not fall below a predetermined level necessary to provide efficient sprinkling. These requirements will permit the tank pressure to vary approximately from 25 psi to 100 psi; smaller variations, if desired, can be achieved by making only minor changes in the pressurizer.

SPRINKLER SYSTEM AND PRESSURIZER

What constitutes the sprinkler system, essentially, is a 325-gallon tank, two sprinkler loops, and the NRL solid-propellant pressurizer.

Figure 1 is a photograph of the tank-pressurizer assembly without the cartridges. The loops are to be located in two different buildings (20 ft x 48 ft), and the tank and pressurizer are to be located outside and adjacent to one of the buildings. (It is assumed that both loops will not operate simultaneously.) The tank is provided with a fire alarm (bell), a safety relief valve, and various other valves and fittings. A flow switch in the 2-inch pipe line, which connects the tank to the sprinkler loops, operates the alarm. The controlling gas pressure, confined to the loop by a frangible disc, is maintained in a standby position at 15 psi in order to start the sprinkler system. In operation, the tank is loaded with 300 gallons of extinguishant, which is automatically expelled by the pressurizer when heat from a fire results in opening one or more of the sprinkler heads. Twelve sprinkler heads are placed strategically around each 104-foot loop of standard-size piping (either 1- or 3/4-inch diameter).

The pressurizer consists of the following: a fuel tube-manifold assembly for burning the solid-propellant grains and confining their combustion gases to the sprinkler system, the solid propellant and igniters, and an automatic firing system for igniting the propellant grains at the proper time and in the proper sequence. Both the manifold and fuel tubes (cartridge cases) are constructed of standard 3.5-inch pipe with flanged connections. Figure 2 shows the manifold and cartridges assembled for a test, but detached from the sprinkler system. In this type of test, a nozzle attached to the manifold outlet provides a manifold pressure which simulates the tank pressure of the sprinkler system. The fuel tubes are made in three different lengths to accommodate, respectively, one, two, and three grains of the propellant.

Shown in Figure 3 is a drawing of an assembled and loaded 2-grain cartridge. The propellant grains are spaced and their positions retained in the fuel tube by steel-ring spacers and a sheet of asbestos packing material, which also serves as a liner for the tube. The nozzle at the flange end of the tube is provided with a frangible disc which ruptures upon ignition. A metal strainer, located between the propellant and nozzle, prevents clogging of the nozzle by cinders from the igniter material. The fuel-tube head is fitted with igniter parts, a safety rupture disc, and a threaded tube for connecting a pressure recorder.

The propellant selected for use in the pressurizer is a solid, double-base compound which has long-term storage stability and satisfactory burning characteristics over a wide range of temperatures (-65°F to room temperature); it also will burn at a relatively low pressure (500 psi). Typical pressure-time curves for the propellant are shown in Figure 4. The propellant grain is a single, vertically perforated cylinder, 4.5 inches long, 3 inches O.D. (without restrictant), and 1 inch I.D. It is restricted on the outer circumference by a layer of cellulose acetate and burns on both ends and on the inner surface. Burning time is approximately 10 seconds, and grain weight (without restrictant) is 1.5 pounds. (Two propellant grains are shown schematically in Figure 3). Each propellant grain is so designed that, with a suitable selection of nozzles, igniters, and fuel tubes, it can be burned singly or in groups of two or three. It is desirable to employ different sizes of cartridges because the tank volume to be pressurized varies widely while the sprinkler system is in operation.

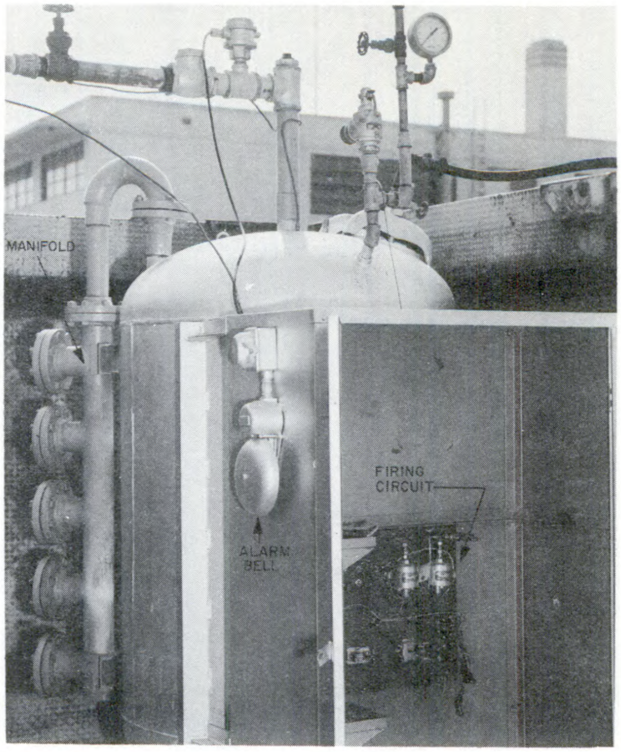
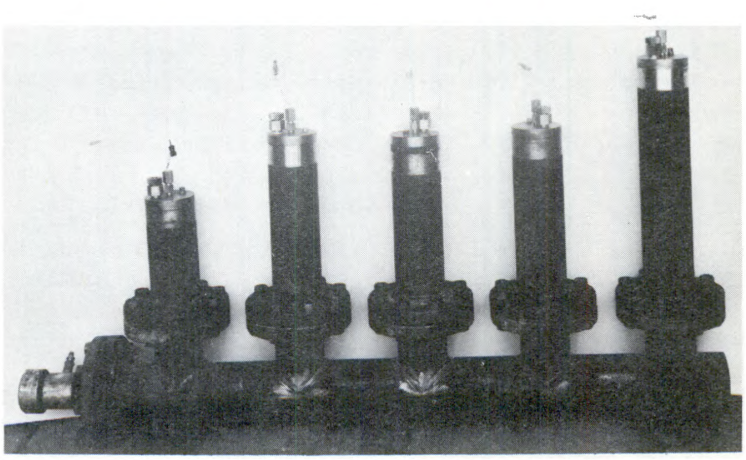


Figure 1--Sprinkler tank and pressurizer assembly.

Figure 2--Pressurizer manifold and cartridge.



The igniter is made up of an electrically activated initiator (McCormick-Selph M-75 squib) and a two-stage booster. The booster consists of 3.5 grams of black gunpowder plus a cake of metal-oxidant mix on each propellant grain. The amount of metal-oxidant mix per grain varies from 35 to 55 grams, depending on the number of propellant grains in the cartridge. This design provides adequate starting at -65 °F without producing excessive ignition pressures at room temperature. (The igniter components are shown in Figure 3.)

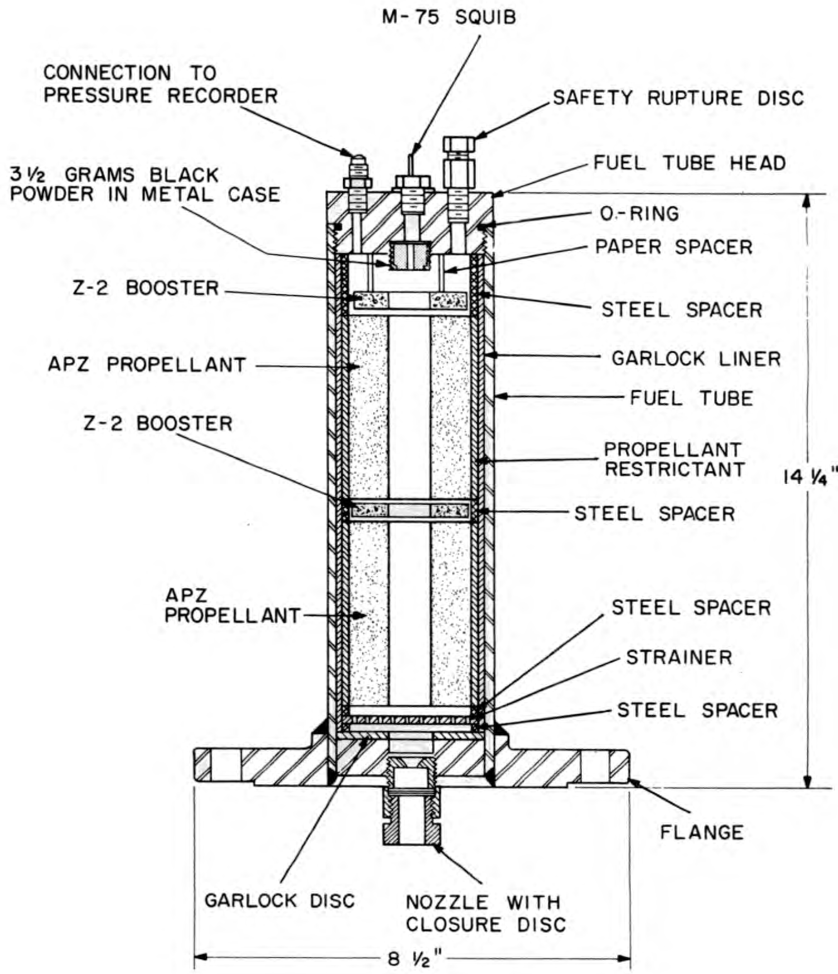
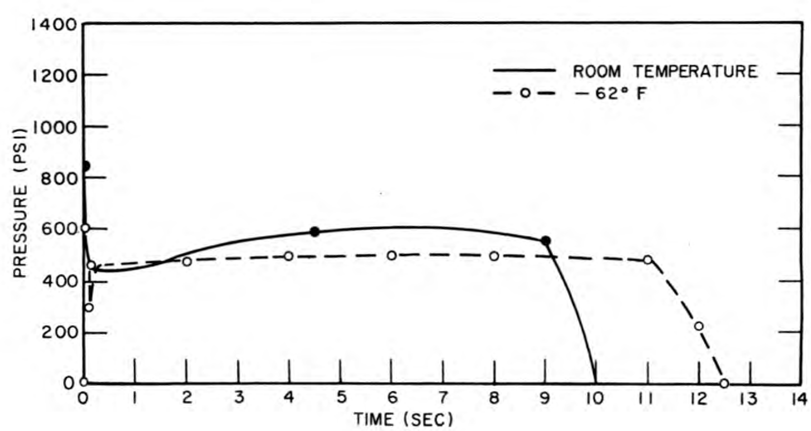
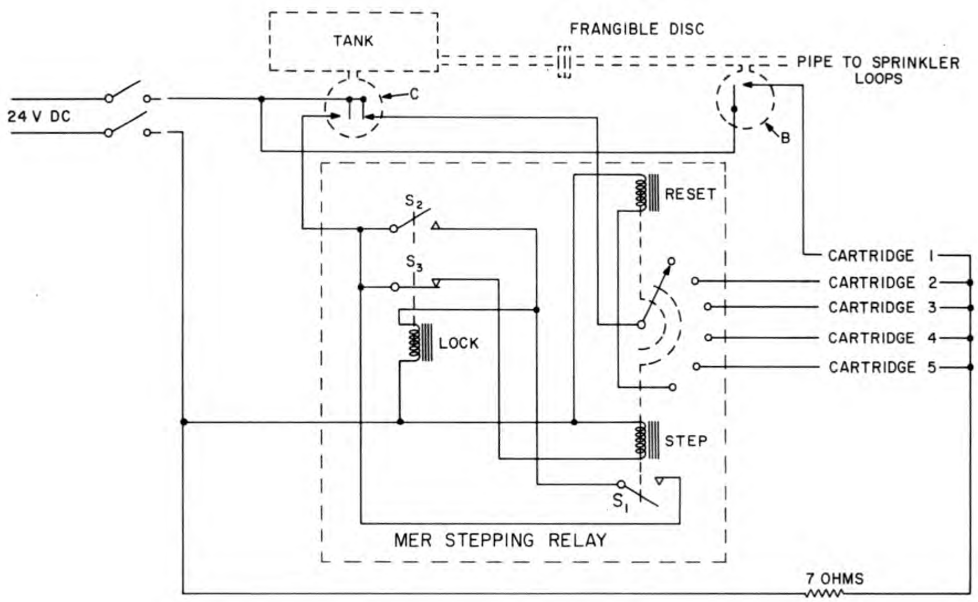


Figure 3--Two-grain propellant cartridge.

Figure 4--Pressure-time curves for the solid propellant cartridge.



The firing system is designed to ignite automatically a single cartridge at any time the sprinkler system needs to be pressurized. The basic elements of the firing system are two pressure switches and a stepping relay. In reality, there are three pressure switches, but since two of them are mounted in a single housing, they are referred to collectively as a double switch. The wiring diagram of the firing circuit is shown in Figure 5. To initiate operation of the system, or to fire the first cartridge, about 15 psi controlling gas pressure is maintained in the sprinkler loop. To avoid the requirement of providing controlling pressure for the tank void, the loop is separated from the tank by a frangible disc in the pipe line. When the controlling pressure is reduced to about 5 psi by opening a sprinkler head, pressure switch "B" closes and fires the first cartridge. The pressure produced by the first cartridge ruptures the frangible disc and closes the normally open pressure switch "C," which rearms the system by stepping the relay to the cartridge No. 2 position. Cartridge 2 is then fired when enough fluid has been expelled to close the normally closed armature on pressure switch "C." The system then continues to arm with high pressure and



B-SINGLE-POLE NORMALLY CLOSED PRESSURE SWITCH, CLOSED 5 PSI AND BELOW

C-DOUBLE PRESSURE SWITCH. SINGLE-POLE NORMALLY CLOSED SWITCH, CLOSED 35 PSI AND BELOW. SINGLE-POLE NORMALLY OPEN SWITCH, CLOSED 50 PSI AND ABOVE.

OPERATION OF MER STEPPING RELAY

SWITCH S_1 CLOSES AT END OF STEP-MAGNET STROKE AND ENERGIZES LOCKING COIL. LOCKING-COIL MAGNET THEN CLOSES SWITCH S_2 BEFORE OPENING SWITCH S_3. SWITCH S_3 OPENS AND DE-ENERGIZES STEP COIL TO OPEN S_1. LOCK COIL REMAINS ENERGIZED AND STEP COIL DE-ENERGIZED UNTIL END OF PULSE. WHEN PULSE IS ENDED BY PRESSURE SWITCH C, S_2 OPENS AND S_3 CLOSES. RELAY IS THEN READY FOR NEXT PULSE.

NOTE-SYSTEM SHOWN AS IF READY TO FIRE FIRST CHARGE.

Figure 5--Wiring diagram of the automatic firing circuit.

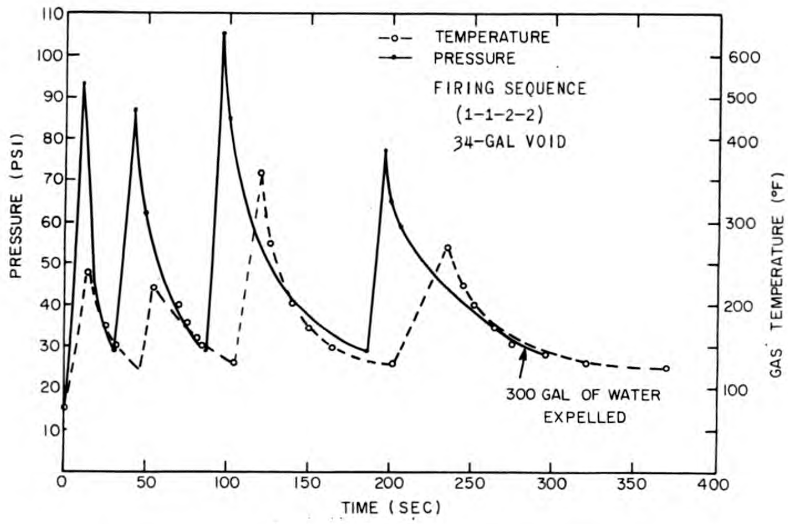


Figure 6--Pressure-time and temperature-time curves for 1-1-2-2 firing sequence with six 1/4-inch sprinkler heads open.

fire a cartridge with low pressure until all the cartridges are fired or until the line switch is opened manually. Switch "C" can be adjusted to fire the cartridges at any desired pressure within its range (1 psi to 92 psi). The three switches incorporated in the stepping relay serve to divert the current from the stepping coil to a locking coil. This makes the stepping relay capable of being cycled without injury, since the energization time for the stepping relay is severely limited.

PERFORMANCE

The pressurizer was thoroughly tested at NRL, first independently of the sprinkler system. In these tests, the propellant and the igniters performed satisfactorily and reproducibly over the temperature range from -65°F to room temperature. Also, the hardware was found to be adequate and the firing system was reliable.

The pressurizer was then assembled with the sprinkler system for a series of tests of the complete device. These tests were made at room temperature and water was used as the tank fluid. Although not concerned with fire extinguishment or efficient nozzle sprinkling, the tests did provide experience which permitted the selection of a series of cartridges of the proper size to maintain the operating tank pressure within the desired limits for the required length of time. The tests also pointed out some possibilities of improvement in the design of the firing circuit and of the igniter. These improvements were incorporated, and the resulting pressurizer was as described above. It was also learned from the tests that a strainer should be installed at some convenient place in the sprinkler system to prevent the frangible closure discs from entering the loop and clogging the sprinkler heads.

Figure 6, in which tank pressure and temperature are plotted against time, shows the results of a typical test. Here it is seen that the cartridges are sized and arranged so as to maintain the operating tank

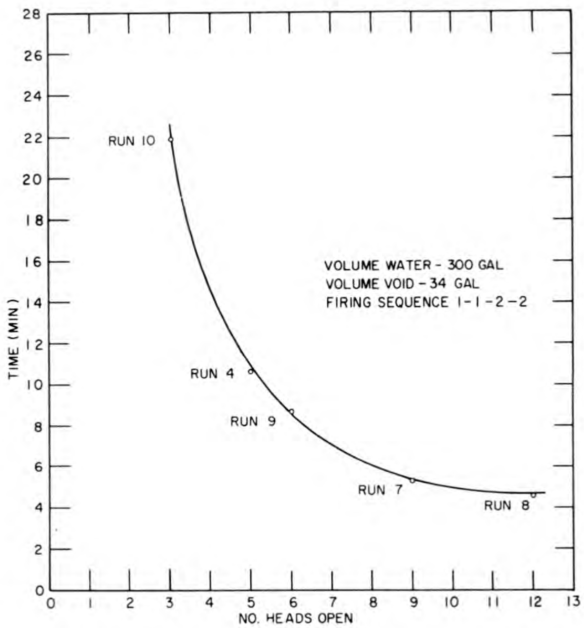


Figure 7--Operating time of 300-gallon sprinkler system as a function of the number of 1/4-inch sprinkler heads open.

pressure within the desired limits. The cartridge arrangement is shown by the series of numbers (1-1-2-2) labeled "firing sequence," which is the number of grains in each cartridge arranged in the order in which the cartridges were fired. The 34-gallon void includes the void in the pipe lines as well as empty tank space. It is this void, combined with the size of the cartridge, which largely determines the maximum tank pressures. Minimum operating tank pressure is controlled by making a simple adjustment of pressure switch "C." The temperatures were measured by a thermocouple located in the gas space at the top of the tank and do not represent the temperature of the tank wall, which does not become too hot to touch.

A series of tests similar to that shown in Figure 6, but with various numbers of sprinkler heads open, made it possible to plot the data shown in Figure 7. Here the operating time of the 300-gallon system is shown as a function of the number of sprinkler heads open. It is seen that the operating time with all twelve heads open is approximately 5 minutes.

Test results indicate that the pressurizer in its present form can be used to provide efficient and reliable pressurization of the sprinkler system throughout the specified temperature range (room temperature to -65°F). If desired, there are some possibilities for refinement: The manifold could be eliminated and the cartridges attached directly to the tank. Operating time could be increased by the installation of a pressure regulator in the pipe line between the tank and the sprinkler loops. Finally, tank pressure could be controlled within narrower limits than those presently used by adjusting the pressure switch and using smaller cartridges.

The editors wish to thank the following persons for their help in compiling the sets of photographs which appear on pages 14 through 20 and 21 through 25: Mr. Jan Hahn, Woods Hole Oceanographic Institution; Dr. Harold E. Edgerton, Massachusetts Institute of Technology; Dr. Francis P. Shepard and Dr. Henry W. Menard, Scripps Institution of Oceanography; and Mr. Carl J. Shipek, Navy Electronics Laboratory.

STRANGE SIGNS OF ACTIVITY ON THE OCEAN BOTTOM

Ocean Botto

Beneath the oceans lies a v unexplored realm. The words "va and "unexplored," as used here, a indeed appropriate, for the ocean b toms comprise an area more than tw the size of the continental surfac and as yet we can say only in gene terms what most of them are like. F example, we know that they have t mendous relief, ranging from sea le to depths greater than 35,000 feet.

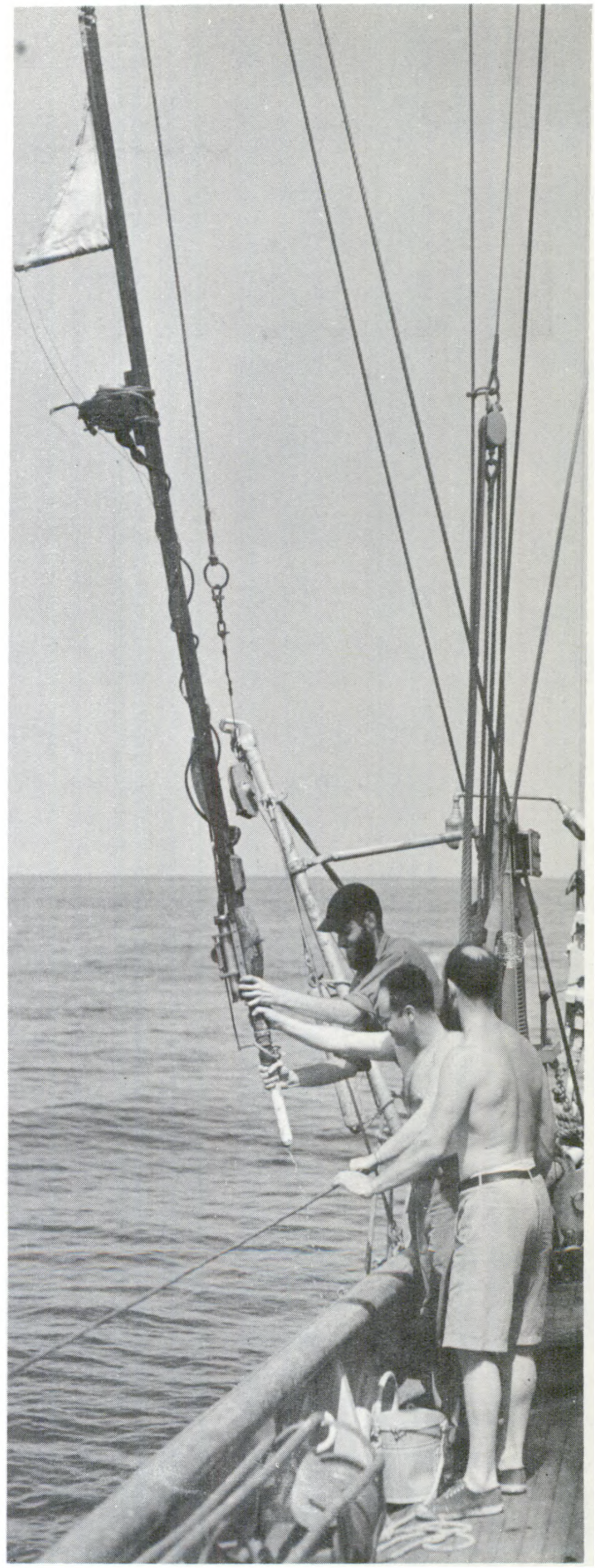
Side of a steep scarp at a depth o 6,600 feet in the Gulf of Mexico. In the foreground is a crinoid, or sea lily, and gorgonians (a stalked form of animal life). Apparently due to a hangup, the camera exposed this picture while on its side. In the extreme foreground the light unit and the line leading to the camera's tripping weight can be seen. The ridge in the background is estimated to be 15 feet away. Photo by D. M Owen.

This mysterious trench, about 3 fee in length, was photographed on the ocean floor of the Gulf of Mexico a a depth of 4,500 feet. It is impossible to determine how the depression was formed. Photo by D. M. Owen

hotography

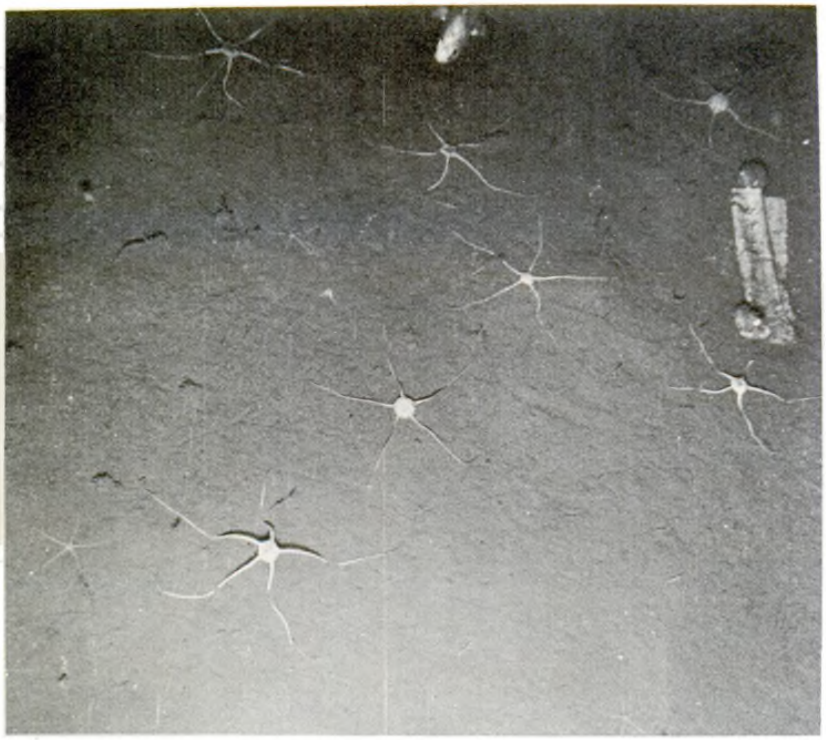
ow, too, that they consist of all man-r of topography, from extremely gged mountains to flat plains. Some rts, we have learned, are inhabited flora and fauna, while others are eak and barren; and some parts—the allower areas—are bathed in light, iile the remainder lie in total dark-ss. We could go on, of course, enu-erating other general features of is realm, but we could give few par-ulars about it.

One way investigators are dis-osing the secrets of the ocean depths through ocean-bottom photography. me excellent examples of this work e given on this and following pages. e photographs were taken of ocean ttoms in many parts of the world by ecially designed undersea cameras.



An underwater camera is readied or lowering into the sea from the leck of the research ship ATLANTIS f the Woods Hole Oceanographic nstitution.

A perfect "bull's eye" at a depth of ,208 feet in the Aegean Sea. It is ot known what animals inhabit these oles. Photo by D. M. Owen.



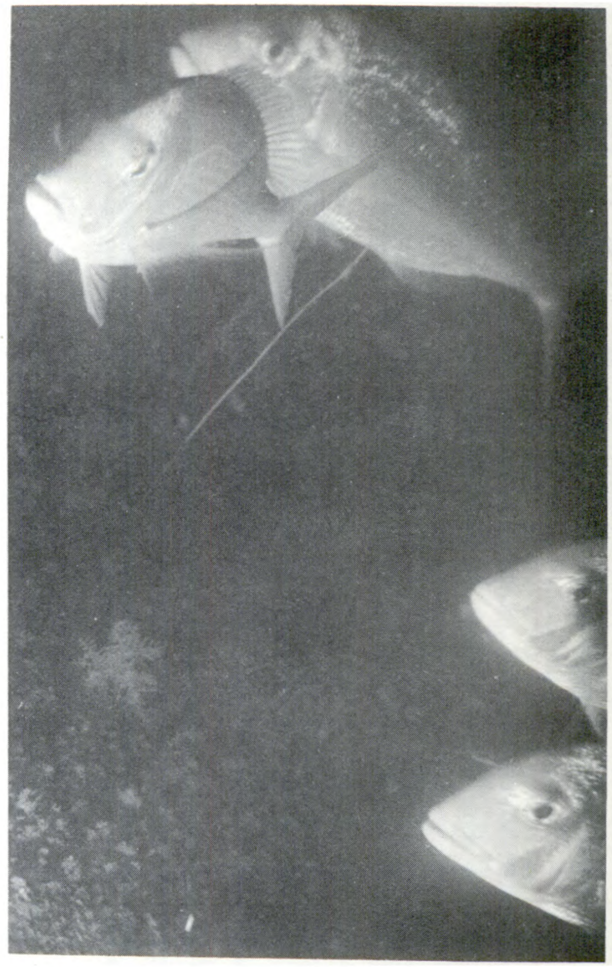
Mud bottom of the S
Diego Trough near ba
of Coronado Bank, P
cific Ocean. Small a
large brittle stars a
pear with a species
small bottom fish
top edge of photo) and
unidentified object
right edge of phot
From left to right, t
picture covers abou
feet of ocean botto
Photo by Carl Ship

A SEA SPIDER, BRITTLE STARS, STRANGE MARKINGS, AND UNIDENTIFIED OBJECTS

A 28-inch sea spider (Pycnogonid) and some brittle stars at a depth of 18,156 feet in the Atlantic Ocean off the coast of New York. The fine scratch-like marks and indentations on the bottom indicate rather strong biological activity. Field of view is about 5-1/2 feet from left to right. Photo by D. M. Owen.

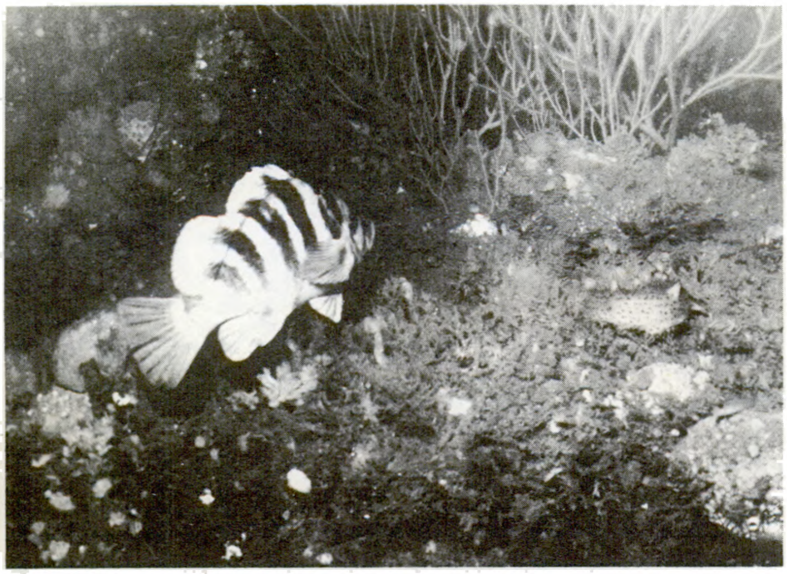
EEL, SCUP, AND SHRIMP

30-inch eel swims across the
ratched and pitted floor of the Gulf
Mexico at a depth of 2,100 feet.
hoto by D. M. Owen.



Four scup, or northern porgy, appear to be aware of the deep sea camera as it photographs them in the Gulf of Mexico, 500 feet below the surface. Photo by W.H.O.I.

A shrimp estimated to be five inches long is shown at a depth of 2,100 feet in the Mediterranean. Note tracks, indicating presence of other forms of life. Photo by D. M. Owen.



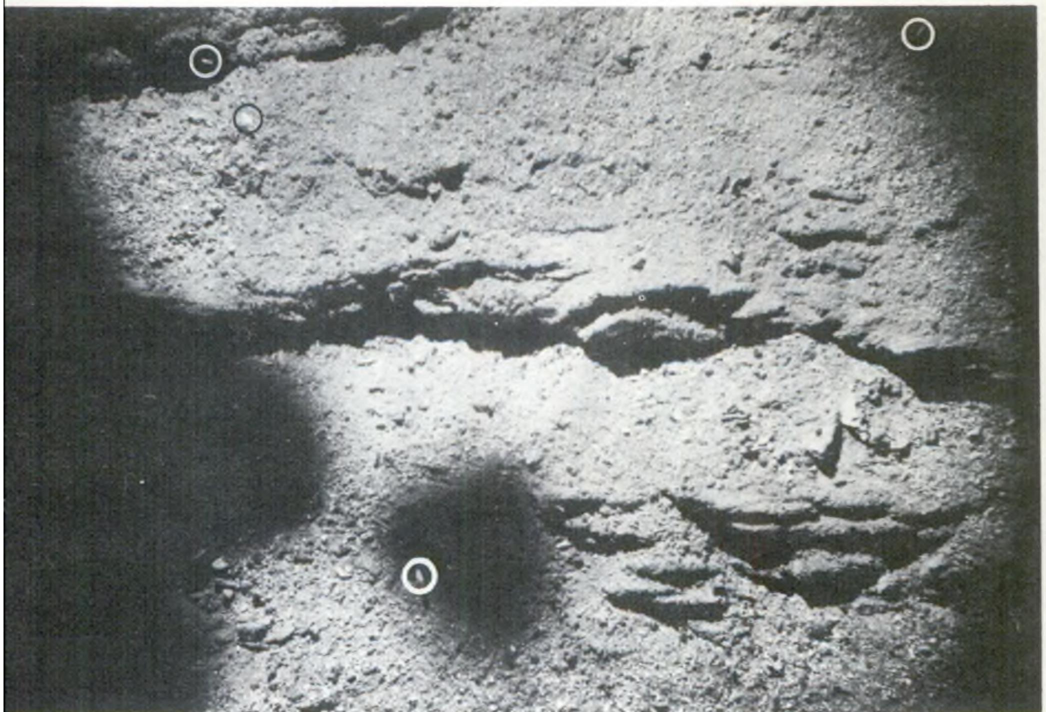
Many forms of life inhabit this terrace on the side of Scripps Canyon off the coast of Southern California. The depth is 60 feet. Photo by F. P. Shepard.

IN THE GARDENS OF THE DEEP

Here the ocean bottom apparently has been terraced by su marine landslides or water currents. Scientists were su prised by the fresh appearance of these irregularities, su gesting erosion. Several whitish organisms (circled) appea verifying that life exists even in the deepest abysses. T animal at upper left seems to have filamentlike legs feelers. Photo by Harold E. Edgerton. © National Ge graphic Society.

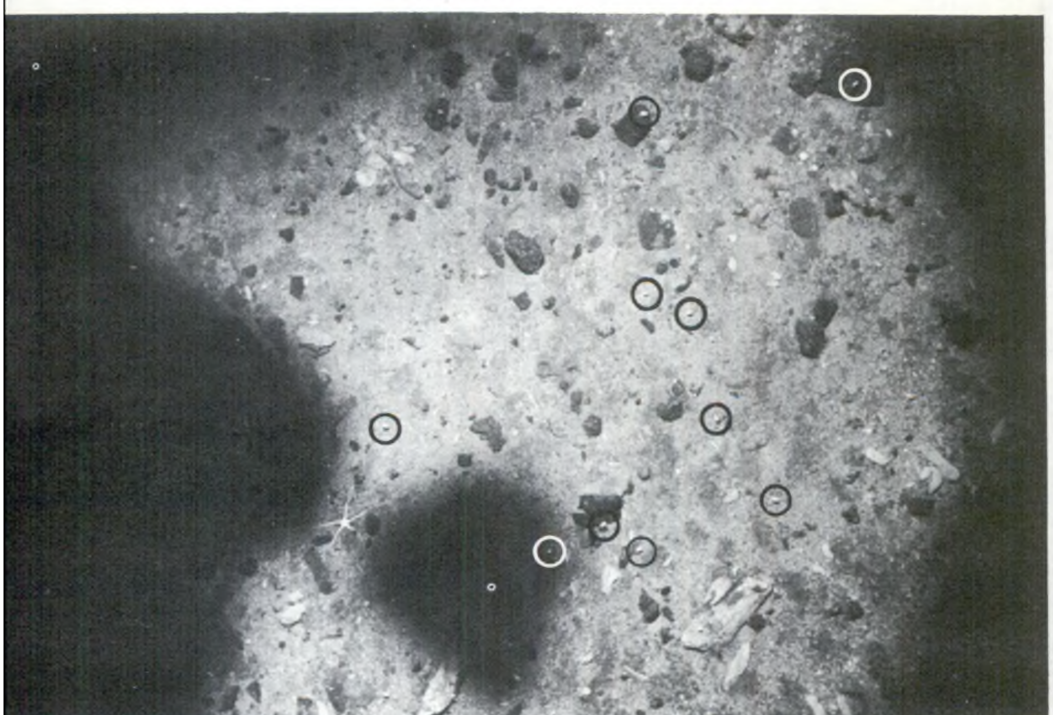
Angular pebbles litter the Trench's ice-cold floor. A bri tle star appears between two mud blots at lower left. Sma unidentified animals (circled), showing white under the ele tronic flash, cast shadows on the bottom. Living organisr had never before been photographed at such a depth. Phc by Harold E. Edgerton. © National Geographic Societ

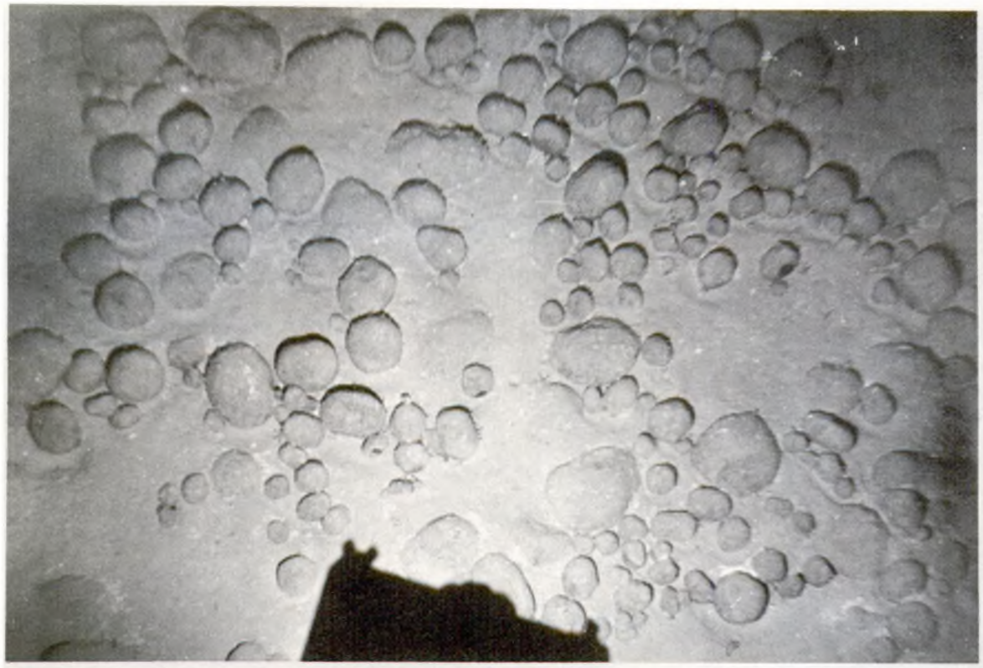
This "garden" on the Blake Plateau off the South Carolina coast is made up of colonies of Bryozoa (a form of animal life). The depth is 2,700 feet. The field of view is about 2 feet by 2 feet. Photo by Woods Hole Oceanographic Institution.



HE FLOOR OF THE
CEAN AT A DEPTH
OF 24,600 FEET

These remarkable photographs show the floor of the Romanche Trench in the Atlantic Ocean off the Ivory Coast of Africa. The electronic flash reveals about 9 square feet in each picture. Mud clots on the camera window cause the dark blotches.



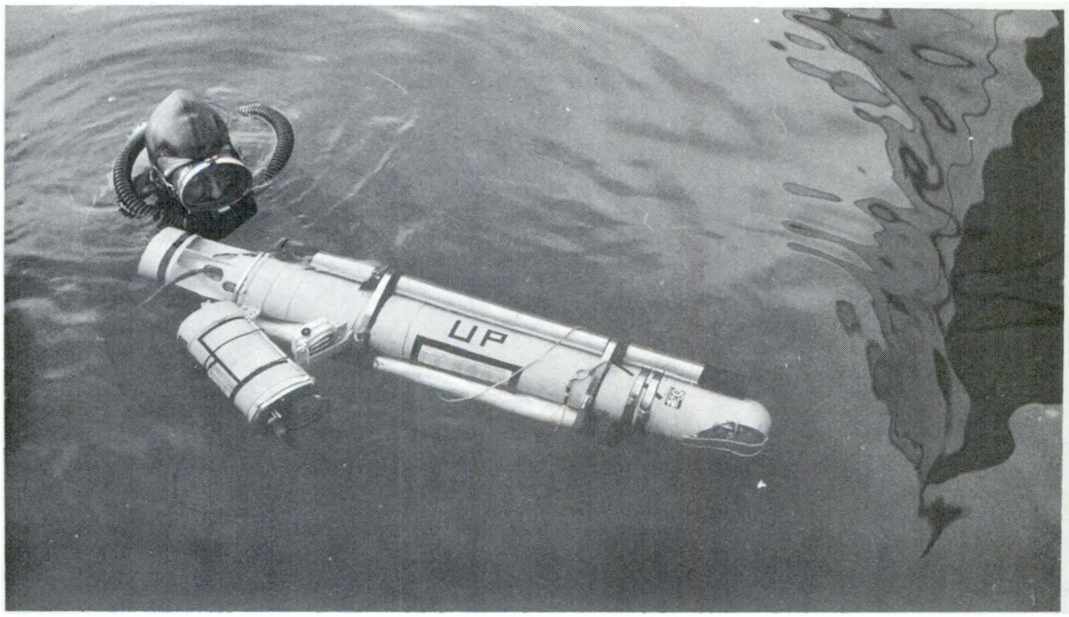


MANGANESE NODULES

Below: Manganese nodules resting on a calcareous ooze on the floor of the Southwest Pacific Basin at a depth of about 14,500 feet. Note the wormlike organism near the large nodule at lower left corner of photo and the criss-crossing trails in the ooze (seen best at top center of photo). The fresh-looking surfaces of the nodules suggest ineffective deposition. Distance between large nodules in lower left and upper right corners is about three feet. Photo by Carl Shipek.

eft: The rounded objects in this photograph are apparently manganese nodules. he picture was taken of the floor of the Atlantic Ocean several hundred miles outheast of Bermuda at a depth of about 18,500 feet. The objects are about ve inches in diameter. Notice the scour marks adjacent to some of the odules, indicating the existence of a bottom current. The shadow at bottom f photo is made by the light unit of the camera. Photo by D. M. Owen.

←



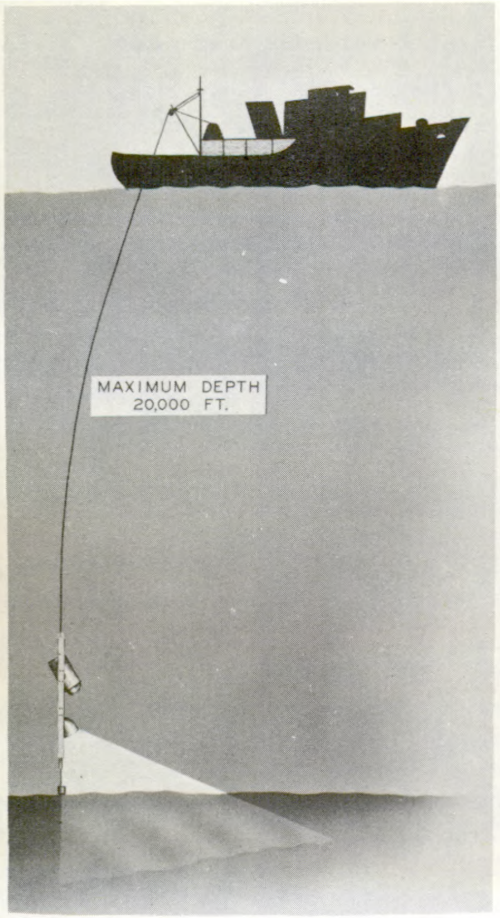
Aqua-lung diver with foreign-made (Rebikoff:France) underwater motion picture camera. The unit has a continuous light source of 600 watts.

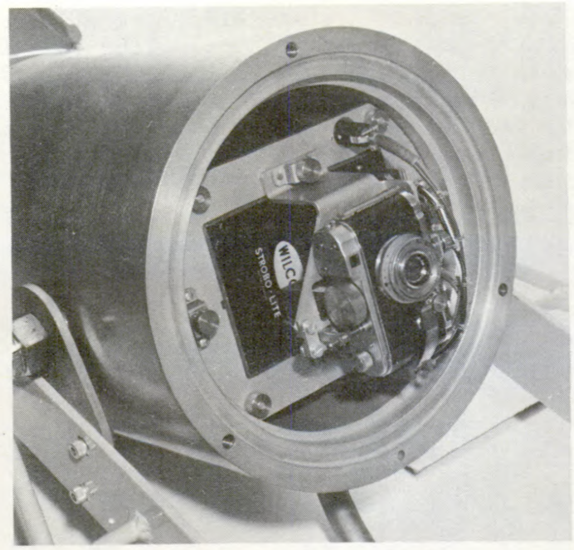
Undersea Cameras

Depending upon what man has wanted to look at beneath the surfaces of the oceans, he has devised many different types of cameras and camera assemblies. For example, to see features of the ocean bottoms in relief, he has built stereoscopic cameras; to photograph changing features, such as ripple marks on a sandy bottom, he has designed time-lapse cameras; and to take pictures at great depths, he has built equipment capable of withstanding very high pressures (equivalent to one atmosphere for each 32 feet of depth).

In order to operate these and many other different types of undersea cameras, man has had to solve a number of special problems. As there is no light deep in the oceans, it has been necessary for him to prepare special lighting equipment. To enable him to take a number of pictures in succession, so as not to have to haul the camera in after each exposure, he has had to devise special shutter-tripping mechanisms. These are only a couple of the problems. However, they may serve to point out that both the equipment and the procedures involved in this work are rather complex.

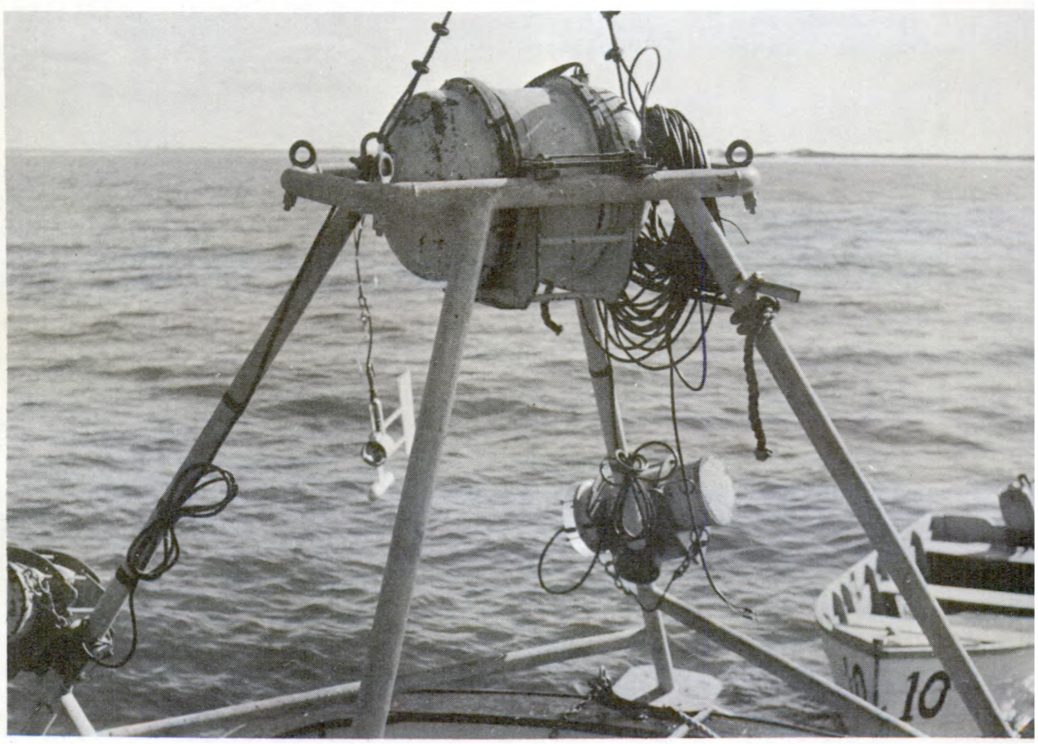
A brief pictorial introduction to undersea cameras and camera techniques is given on the following pages.





DEEP-SEA CAMERA

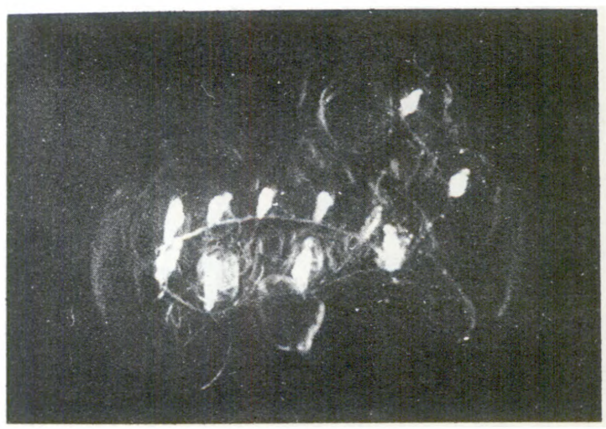
The 35-millimeter robot camera shown above is used in the manner indicated at left. It can operate at depths as great as 20,000 feet. By means of a special tripping switch, at least 24 bottom pictures can be taken on a single lowering. The camera assembly was prepared by the Navy Electronics Laboratory



LUMINESCENCE CAMERA

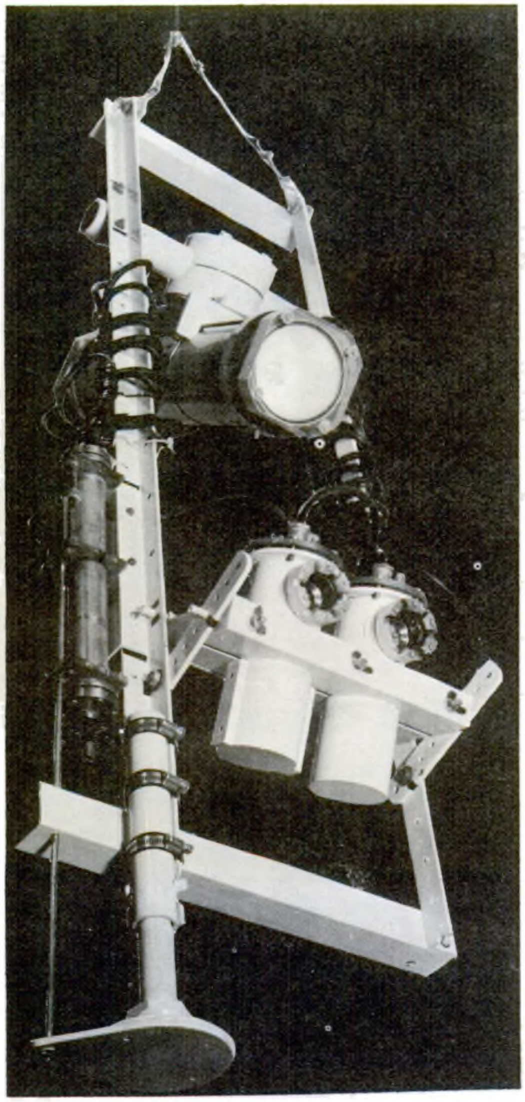
Right, Dr. George L. Clarke and Dr. Harold E. Edgerton examine the luminescence camera. The instrument, designed and built by Dr. Edgerton and Lloyd Breslau of the Massachusetts Institute of Technology, photographs luminescent animals below the level of light in the sea. It consists of two watertight tubes mounted at right angles to each other, one holding a photo-multiplier tube and an electronic flash bulb, and the other a 35-millimeter camera. When a luminescent animal swims or drifts through the field of view of the camera, its emitted light is picked up by the photomultiplier tube, which sets off the electronic flash and exposes the film.

Right, a luminescent jelly fish (siphonophore) as "seen" by the luminescence camera. The fish is about 5 centimeters in diameter. Photo by George L. Clarke.



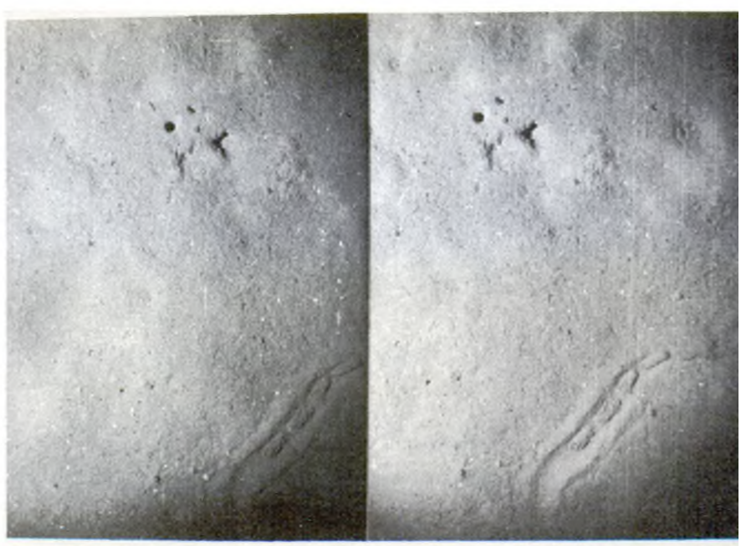
ME-LAPSE CAMERA

 8,000-shot deep-sea time-lapse camera designed by the Woods Hole ceanographic Institution is shown here mounted on a quadruped frame support. hen lowered to the ocean bottom, this assembly permits the camera to reain focussed on a small section of bottom for periods as long as eight days. hen frames originally exposed (with electronic flash) at 1-1/2-minute interls are projected at the rate of 16 frames per second, changes in bottom conguration may become apparent within seconds of screen time.



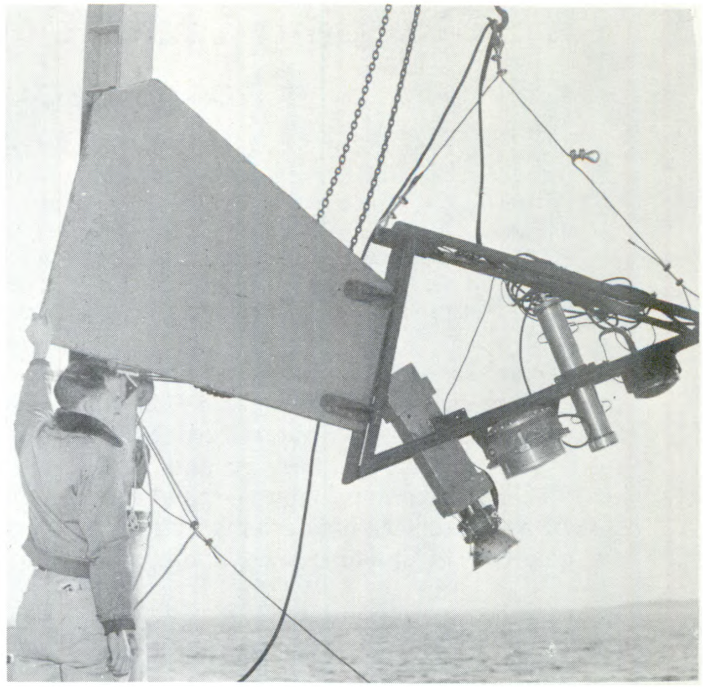
With a stereoscopic camera, such as the one shown at left, objects on the ocean floor can be photographed in three-dimensional relief. Unidentified holes and markings can be seen in the stereo-pairs below, while a shrimp appears in the two photos above. The pictures were taken by John W. Graham in the Red Sea at a depth of about 4,000 feet.

STEREOSCOPIC CAMERA

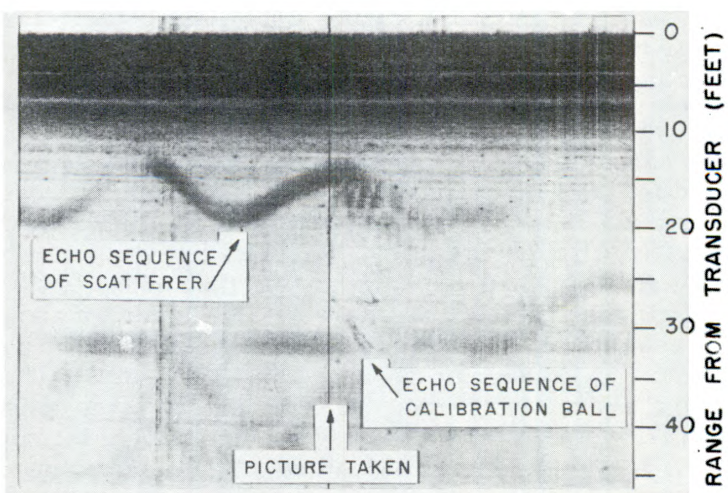


ACOUSTICAL VIEWFINDER

By combining an underwater camera with acoustical apparatus it is possible to photograph some of the organisms that scatter or reflect sound waves transmitted by echo sounders aboard ships. The "acoustical viewfinder" pictured at right was designed at W.H.O.I. to help identify some of these organisms and to photograph other midwater life. It consists of a frame containing a camera, an electronic flash unit, and a sound transducer with a short range.



Photograph and simultaneous acoustic record of eight unidentified fishes at a depth of 100 feet in 6,000 feet of water. Photo by Woods Hole Oceanographic Institution.



Stopping Tooth Decay with Phosphorous

An important advance was made recently in the struggle by medical scientists to find a way or ways to prevent tooth decay. Working on a contract for the Office of Naval Research, two investigators have isolated a substance which, when added to the diet of experimental animals, stops decay. The following account, adapted from an article by Warren Korenberg which appeared in the Boston Sunday Herald, May 17, 1959, describes this achievement.

From among the large number of minerals that the human body needs, two medical investigators have discovered one that may prevent tooth decay. The two men—Professor Robert Harris of the Massachusetts Institute of Technology and Dr. A. E. Nizel, Boston dentist and M. I. T. research associate—found that doubling the phosphorous in the diet of hamsters reduced dental caries by 95 percent. By again doubling the quantity of phosphorous, decay was completely eliminated.

Elsewhere in the world, Dr. Harris says, the experiments are being duplicated on humans, and early indications are that the results are the same.

Hamsters—tiny rodents which were the rage as pets a few years ago—were used because their molars more closely resemble those of humans than do those of other laboratory animals. The phosphorous has no ill effect, the scientist noted, because the body is set up to handle it. He said the body uses only that portion of the phosphorous intake needed for nutrition. Excess amounts are not absorbed and are passed out of the body. More than having healthy teeth, he noted, his hamsters living on a phosphorous-enriched diet also had better looking teeth. "They had that lustrous, pearly look that everyone wants," he said.

The Harris-Nizel experiments on the relation of minerals to tooth decay began 10 years ago with the speculation that other substances besides fluorine might have similar decay-inhibiting effects. In the areas of the country where tooth decay was minimized naturally, they discovered, food samples indicated significant differences from those grown in other areas.

In the process of feeding some hamsters corn and milk from the Texas panhandle while feeding others New England corn and milk, they noted that fewer caries developed in the Texas group. As part of their attempt to isolate the factors contributing to the greater decay resulting from the New England diet, they burned food samples at high temperatures, thus eliminating all organic matter. What was left was the mineral component of the New England food, which was then added to the diet. "Instead of getting more caries," Dr. Harris said, "when we added the minerals to the diets of the hamsters we got 90 percent less."

This changed the direction of the research, and for three years the scientists concentrated on minerals. Using spectrographic techniques, they were able to measure only 11 of the two or three dozen minerals present in natural food. The quantities of the others were too minute.

The doctors then manufactured a "synthetic food ash" with these 11 minerals, and added it to the diet. It had the same anti-carious effect as did the natural food ash.

Breaking the 11 measured chemicals down into groups, they found that potassium, strontium, barium, calcium, and sodium fitted into one group and that magnesium, aluminum, manganese, zinc, and iron fitted into another. Phosphorous alone constituted the third group.

When minerals of the first group were added to the diet, tooth decay increased, and when minerals of the second group were added, a slightly larger increase occurred. On the other hand, when phosphorous was added to the diet along with the other ten minerals decay was virtually eliminated. Adding the ash of the first two groups without the phosphorous caused the decay rate to shoot up far beyond that characteristic of the "natural diet" range.

"So it looked like phosphorous might be the key to dental decay in these experiments," Dr. Harris said.

Further experiments are being conducted by the M. I. T. research team to determine two more things. First, the investigators would like to know how phosphorous protected the hamsters against decay. Second, they want to know if the effect is a local one in the mouth or a systemic one, involving the body as a whole. So far, Dr. Harris said, it looks like both.

The best effects of the phosphorous, the scientist explained, are achieved when it is included in the diet of the very young animal. In fact, he noted, if the mother's diet is enriched during pregnancy, the young animal will be born with a higher resistance to dental decay. This is further reinforced if the enriched diet is given the youngster before the teeth form and mature. However, he said, highly satisfactory results were also achieved with young adult hamsters whose teeth had already formed.

Chemical Aspects of Vision

Dr. George Wald, Professor of Biology at Harvard, was this year's recipient of the Rumford Premium of the American Academy of Arts and Sciences. For several years Dr. Wald has worked for the Office of Naval Research on a contract concerning some of the chemical aspects of vision. The award consisted of a gold medal and a duplicate in silver, together with a check for $5,000.

Upon receiving the award, Dr. Wald addressed the Academy on "The Evolution of Vision." He took as his point of departure the basic fact that the energy used in biological systems is derived from sunlight through the process of photosynthesis. "It is of the utmost importance," he said, "that photosynthetic plants find the light, that herbivores find the photosynthetic plants, and that carnivores find the herbivores." This finding activity is mediated by phototropism in plants and vision in animals. These processes are correspondingly important for survival, and in the course of evolution have been rigorously subjected to the processes of adaptive selection. Although evolution is generally thought of in terms of structural changes, Dr. Wald pointed out, even more basic aspects of the process take place at the molecular level.

--ONR Branch Office, Boston

On the Naval Research Reserve

Eleventh Annual ONR Reserve Research Seminar

The eleventh Annual Naval Reserve Research Seminar, sponsored jointly by the Office of Naval Research and Naval Reserve Research Company 5-8, convened at Washington, D.C., on May 31, 1959, for a two-week period. During the meeting, 108 reserve officers were brought up-to-date on current research and development activities and informed of future plans for the Navy in what has been called the "space age." Of the officers in attendance, 70 were in the Naval Reserve, 20 in the Air Force Reserve, and 18 in the Army Reserve. CDR William M. Smedley, a member of NRRC 5-8 and professor of chemistry at the U.S. Naval Academy, served as seminar chairman.

As in the past two seminars, the program was divided into two phases: naval orientation and scientific-technical. At the opening orientation session, CAPT A. B. Metsger, USN, Deputy and Assistant Chief of Naval Research, welcomed the group on behalf of RADM Rawson Bennett, Chief of Naval Research, and delivered an address on the "Objectives and Program of ONR." CAPT Metsger pointed out that only by having a properly balanced and administered program in basic research and in development could the rapid evolution of new weapons systems and techniques in warfare be assured. The most perplexing task involved in achieving this proper balance is the establishment of ONR's appropriate level of participation in basic research. Seminar reservists were called upon to offer suggestions toward solving this problem.

Other speakers at the opening session included the Honorable J. B. Macauley, Deptuy Assistant Secretary of Defense for Research and Engineering, who, assisted by Dr. Orr Reynolds, talked about "The Role of the Department of Defense in Research;" CAPT W. H. Groverman, USN, Assistant to the Deputy Chief of Naval Operations (Development), who explained the "Research and Development Concepts of OPNAV;" CDR Robert Munroe, Jr., speaking for RADM John E. Clark, USN, on "The Military Role in Space Research;" and CAPT R. A. Fitch, USN, Patent Counsel for the Navy, speaking on "ONR's Patent Responsibility."

During the remainder of the general session (scheduled on the second, sixth, and last days), speakers heard by the reservists included:

Speaker	Topic
RADM W. E. Ellis, USN, Director, Air Warfare Division, CNO	"Air Warfare Concepts"
RADM F. V. H. Hilles, USN, Director, Surface Type Warfare Division, CNO	"Surface Warfare Concepts
RADM L. R. Daspit, USN, Director, Undersea Warfare R&D Branch, CNO	"Undersea Warfare Concepts"

Speaker	Topic
BGEN G. R. E. Shell, USMC, Deputy Chief of Staff (R&D), Headquarters, U.S. Marine Corps	"R&D Program of the Marine Corps, with Special Emphasis on Amphibious Warfare"
RADM W. F. Raborn, USN, Director, Special Project Office, BuOrd	"Current Aspects of the Polaris Project"
RADM F. L. Ashworth, USN, Director, Atomic Energy Division, CNO	"Atomic Energy in the Navy"

Other speakers at the general session included RADM G. R. Donaho, USN, Director of the Logistics Plans Division, CNO; RADM W. D. Irvin, USN, Commander, Operational Development Force, U.S. Atlantic Fleet; CAPT A. R. Matter, USN, Assistant to Director, Long Range Objective Group; CAPT P. H. Horn, USN, Director, Naval Research Laboratory; CAPT E. A. McDonald, USN, Deputy Commander, U.S. Naval Support Forces, Antarctic (TF 43); CAPT W. T. Sutherland, USN, Special Assistant to Chief of Naval Personnel for Leadership; Dr. A. K. Brewer, Office of Naval Intelligence; and Dr. F. J. Weyl, Research Director, ONR.

In the scientific-technical session, the officers were divided into four groups for an intimate look at current and future developments in four fields:

Group I - "Research on Anti-Submarine Reconnaissance, Surveillance, and Communications"
Presiding: CDR C. N. Crandall, USN, of the Undersea Branch, ONR

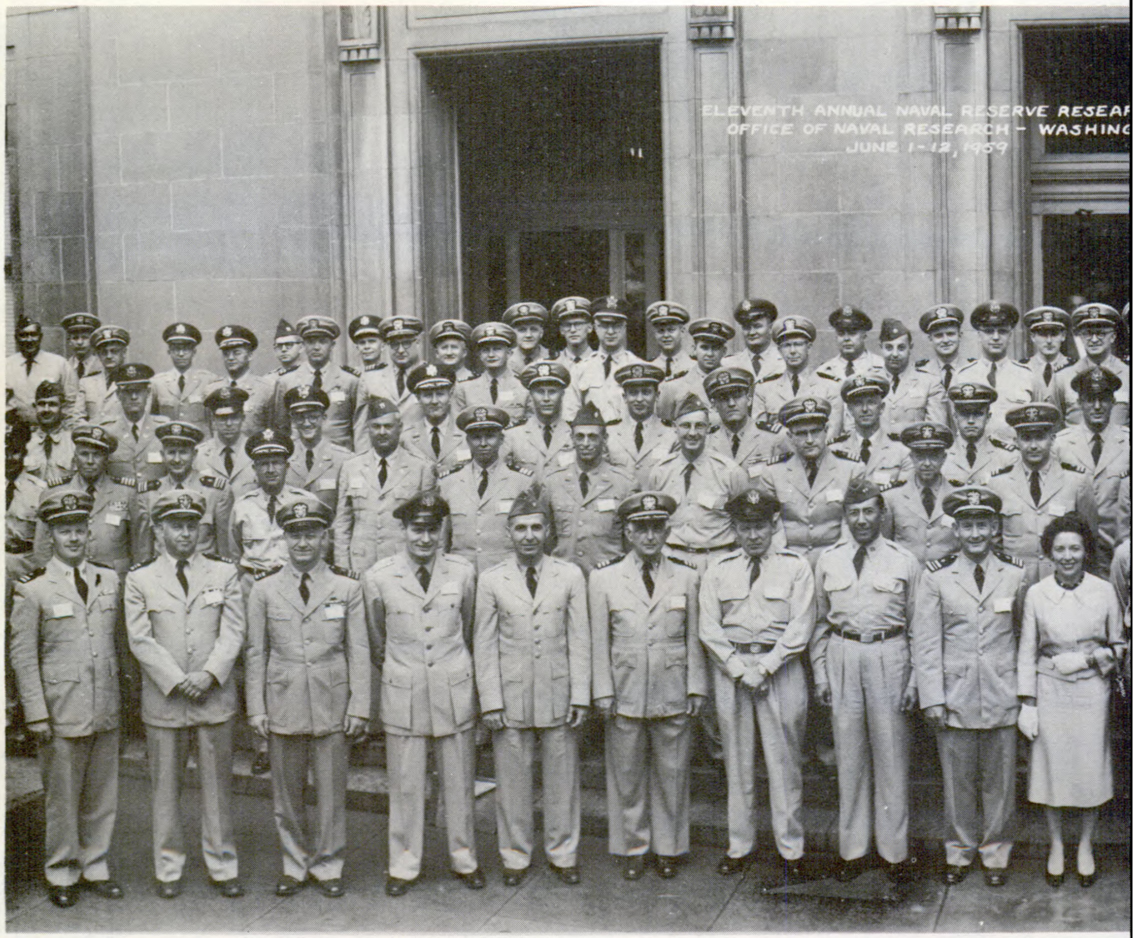
Group II - "Methods and Applications of Operations Research"
Presiding: Mr. J. F. Harrington, Naval Analysis Group, ONR

Group III - "New Concepts of Power and Propulsion"
Presiding: CAPT F. C. Wiesner, USNR (Ret.), Head, Power Branch, ONR
Assisting: Mr. J. R. Patton, Mr. A. G. Lundquist, CAPT W. T. Sawyer, USN, all of the Power Branch, ONR; and Mr. F. B. Isakson, Physics Branch, ONR

Group IV - "Biological Aspects of Military Environments"
Presiding: Dr. Roger D. Reid, Director, Biological Sciences Division, ONR
Assisting: Dr. D. D. Smith, Dr. Max Lund, CAPT C. F. Gell, MC, USN, Mr. Joseph Saunders, Dr. S. R. Galler, and Dr. H. J. Carlson

The list of speakers at the various group meetings would read like a "Who's Who in Science and Engineering"..... small wonder that those attending found the meetings rewarding and intellectually stimulating.

On the final day of the meeting, CDR Walter C. Avery, USN, Training Officer for Research Reserve, ONR, spoke of the many "Research Reserve Training Opportunities," and CAPT John P. Aymond, USN, the



ATTENDEES OF THE ELEVENTH ANNUAL NAVAL RESERVE RESEARCH SEMINAR, HELD AT THE

Row I, Left to Right

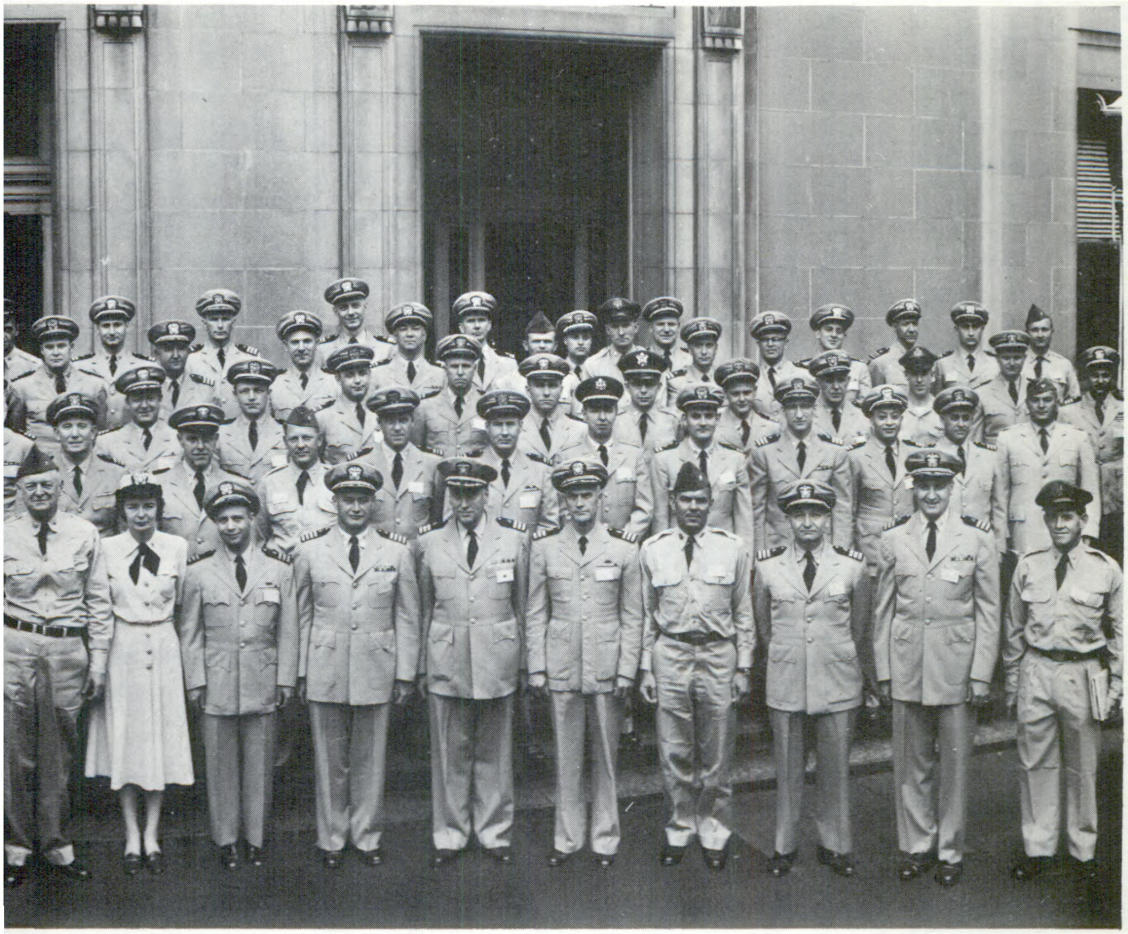
LT J. R. Loughrey
LCDR R. P. H. Winder
LCDR B. O. Propeck
MAJ W. M. Ritchey, Jr.
MAJ M. M. Mardirosian
CDR J. R. Maloney
CAPT W. P. Conrardy
CAPT L. Rendon
LCDR P. C. Lightle
LCDR E. F. Kehoe
COL W. L. Deemer
COL W. H. Weir
LCDR M. E. Hawthorne
CDR W. M. Smedley
CAPT J. P. Aymond
CDR H. M. Golden
CDR M. Krauss
MAJ C. F. Eno
CDR H. V. Nutt
CDR W. C. Avery
MAJ D. C. Madrid

Row II, Left to Right

CAPT J. L. Harp, Jr.
CAPT J. M. Amberson
LCDR R. B. Eads
LTCOL G. R. Kingsley
CAPT T. G. Broskie
CDR B. Zimmerman
LTCOL W. V. Lobenstein
MAJ E. H. Mayo
CDR J. F. Kelley, Jr.
CDR W. F. Anderson
LT F. J. Lees
LTJG J. N. Fiske
CDR J. H. Willett
LCDR F. E. Wyman, Jr.
MAJ F. P. Nelson
LCDR R. R. Neill
LCDR R. M. Hodges
Not Identified
LT R. E. Heistand
CDR M. E. Taylor
CDR R. R. Goldberg
CDR K. S. Rizk
CAPT S. M. Needleman

Row III, Left to Right

CAPT L. J. Brown, Jr.
1st LT W. T. Danker
1st LT J. B. Reed
1st LT D. H. Strietzel
MAJ D. H Etsler
LCDR J. P. Meiners
LTJG R. W. Mainellis
Not Identified
LCDR W. Footrick
LT K. G. Henize
1st LT J. M. Moellenber



OFFICE OF NAVAL RESEARCH, WASHINGTON, D. C., JUNE 1 TO 12, 1959.

Row III, Continued

CDR B. Schmidt
CDR J. H. Lloyd
LCDR R. H. Kyser
LCDR J. J. Gennari
LCDR W. J. Leonard
LTJG D. J. Beynon
2d LT M. A. Gedwill, Jr.
LCDR G. L. Stambach
CDR M. L. Johnson
CAPT C. W. Dent
CDR E. J. Cook
CDR E. J. Zellmer

Row IV, Left to Right

MAJ H. R. Penny
Not Identified
CAPT A. J. Shanahan
MAJ F. Sipos
LT M. C. McLean
CDR H. W. Gilbert
Not Identified
Not Identified
LCDR W. E. Radford
CWO G. Vasen
MAJ E. M. Vaughan
MAJ J. A. Zumberg
Not Identified
CDR T. P. McCullough, Jr.
LT J. E. Housiaux
CDR J. G. Larson
LT L. L. Kupferberg
LCDR G. Desocio
CAPT E. Kozik
LTJG A. L. Clavel
LT R. F. Raymond
LCDR P. F. Smith
LCDR R. V. Austin
LCDR A. F. Bridger
MAJ L. C. Hammond

Row V, Left to Right

LTJG J. V. Marron
CAPT J. W. Vennes
MAJ W. C. Banning
LCDR A. I. Jacobson
LCDR J. H. Kovarik
LT R. F. Lockman
LTJG O. E. Hall
MAJ O. J. Minnich
Not Identified
LCDR T. J. Brevik
LT B. F. Kremp
LT D. S. Serice
CAPT G. A. Bischoff
LT R. E. Walker
CDR C. N. Smith
LCDR E. G. Kovach
LTJG C. B. Gustafson
CAPT S. E. Bolt
LT A. Devolpi
LCDR H. E. Troxell

Special Assistant to the Chief of Naval Research (Research Reserve), explained the overall "Mobilization Plan for the Research Reserve."

RADM Rawson Bennett, USN, Chief of Naval Research, delivered the closing talk, cautioning the scientists on too much "chrome plating" on operating research tools.

In addition to the activities described above, various groups visited the Naval Research Laboratory; the David Taylor Model Basin; the Naval Ordnance Laboratory; the Naval Medical Research Institute, including the Navy Tissue Bank; the Naval Air Rocket Test Station, Lake Denmark, New Jersey; and the Biological Warfare Laboratories at Fort Detrick, Maryland.

The seminar was one of several of its kind held throughout the country and sponsored by the Office of Naval Research during fiscal year 1959 to provide active-duty training for reserve officers.

Research Reserve Officers Selected for Advancement in Rank

Forty-seven officers of the Research Reserve Program were among the 3014 Reserve officers selected for promotion to the grade of Lieutenant on April 14, 1959. The names of those selected are given below:

Abt, W.V.	5-10	Graham, J.G.	9-7	Merkadeau, R. M.	9-8
Almgren, F.J.	1-2	Hansen, H.H.	4-3	Nelson, D.C.	13-6
Aymonin, F.G.	6-10	Hazelwood, D.H.	13-3	Newlan, B.M.	12-3
Baker, G.A.	11-6	Heckler, G.F.	1-2	Paulson, D.V.	11-9
Barger, T.W.	12-3	Hill, B.E.	9-5	Peterson, J.F.	9-1
Belvin, F.	1-1	Hilvety, N.	6-3	Raney, J.P.	9-7
Borst, W.B.	9-23	Hoffman, J.N.	4-5	Robbins, H.G.	12-3
Cheney, G.D.	1-7	Huffman, S.D.	8-9	Robertson, R.R.	8-5
Coleman, C.N.	8-4	Impink, A.J.	1-1	Russell, R.C.	8-4
Curtis, H.B.	12-2	Karohl, J.G.	9-5	Schwarz, J.K.	12-3
Davis, R.H.	8-1	Kedl, R.J.	6-3	Stuart, D.M.	9-7
Dixon, S.C.	5-1	Kenney, R.W.	1-7	Vassar, D.D.	13-3
Eissenberg, D.M.	6-3	Lofgren, F.W.	1-1	Willis, R.E.	1-1
Fulcher, C.W.	8-5	Mainellis, R.W.	9-1	Wilson, L.K.	6-1
Glahn, G.L.	8-8	Mann, L.W.	8-9	Wundrack, W. A.	9-8
Gleason, B.J.	9-5	Marez, J.	11-5		

Four Medical Service Corps officers were promoted to the grade of Lieutenant Commander by the selection board which convened April 28, 1959. The names of those selected are indicated below:

Aurand, L.W.	6-6	McElroy, O.E.	5-10
Hendler, E.	4-2	Vanness, G.B.	5-10

The selection board for the Civil Engineers Corps convened April 28, 1959, selecting LT Robert A. Meyer, USNR, 3-9, to the grade of Lieutenant Commander.

The selection board for Warrant Officers, W-1, convened May 12, 1959, selecting James R. Pfenninger, USNR, 13-6, to the grade of Chief Warrant Officer, W-2.

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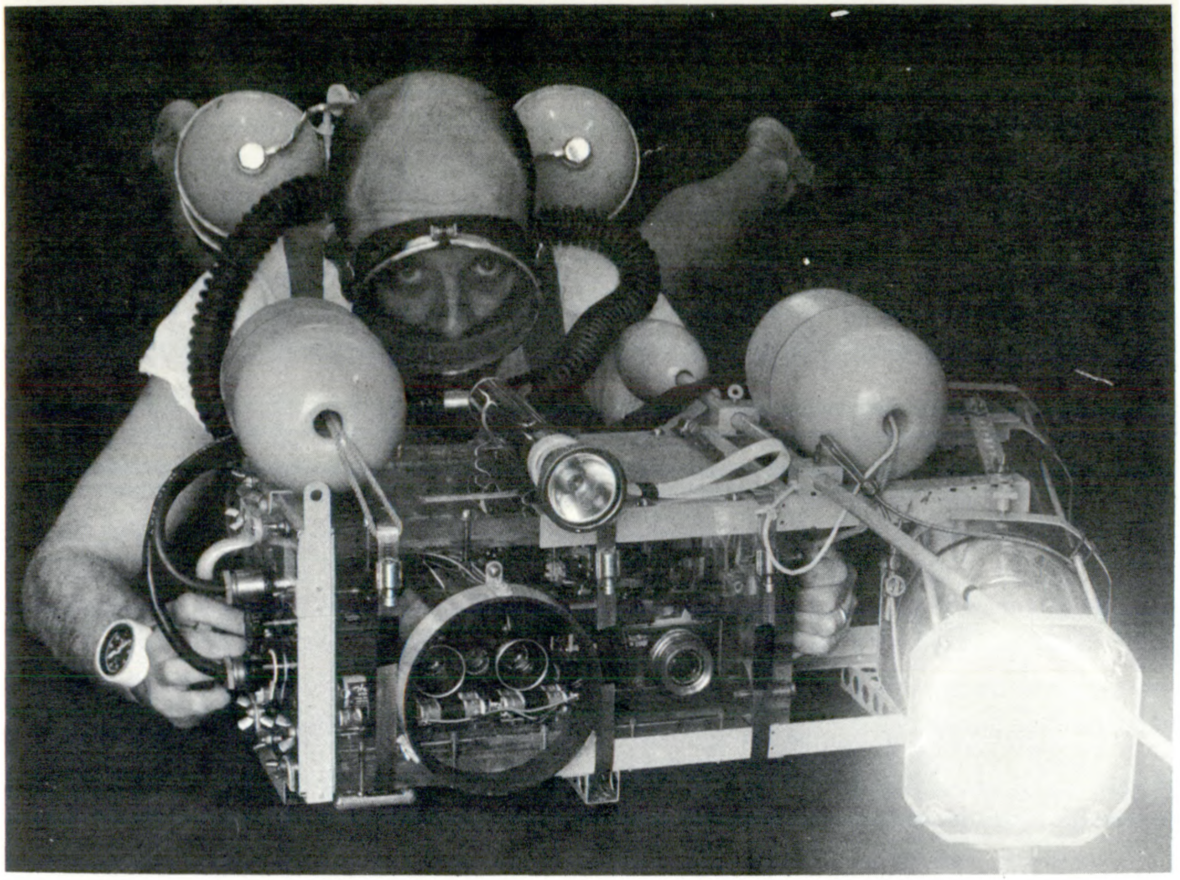

A diver's hand-held stereoscopic electronic-flash camera is shown in this illustration. A second automatic camera (ROBOT) enclosed in the same Plexiglas housing (1 inch wall thickness) permits the diver to use both black and white and color film on the same dive. Seine floats provide very slight positive buoyancy and horizontal stability. The assembly has withstood a pressure equivalent to that at a depth of 400 feet. Other cameras used underwater are illustrated on pages 21 through 25.

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.

An underwater camera is lowered from the deck of a research ship off the Atlantic coast of South America. Pictorial descriptions of ocean-bottom photography and undersea cameras begin on pages 14 and 21 respectively. Photo by R. Munns.