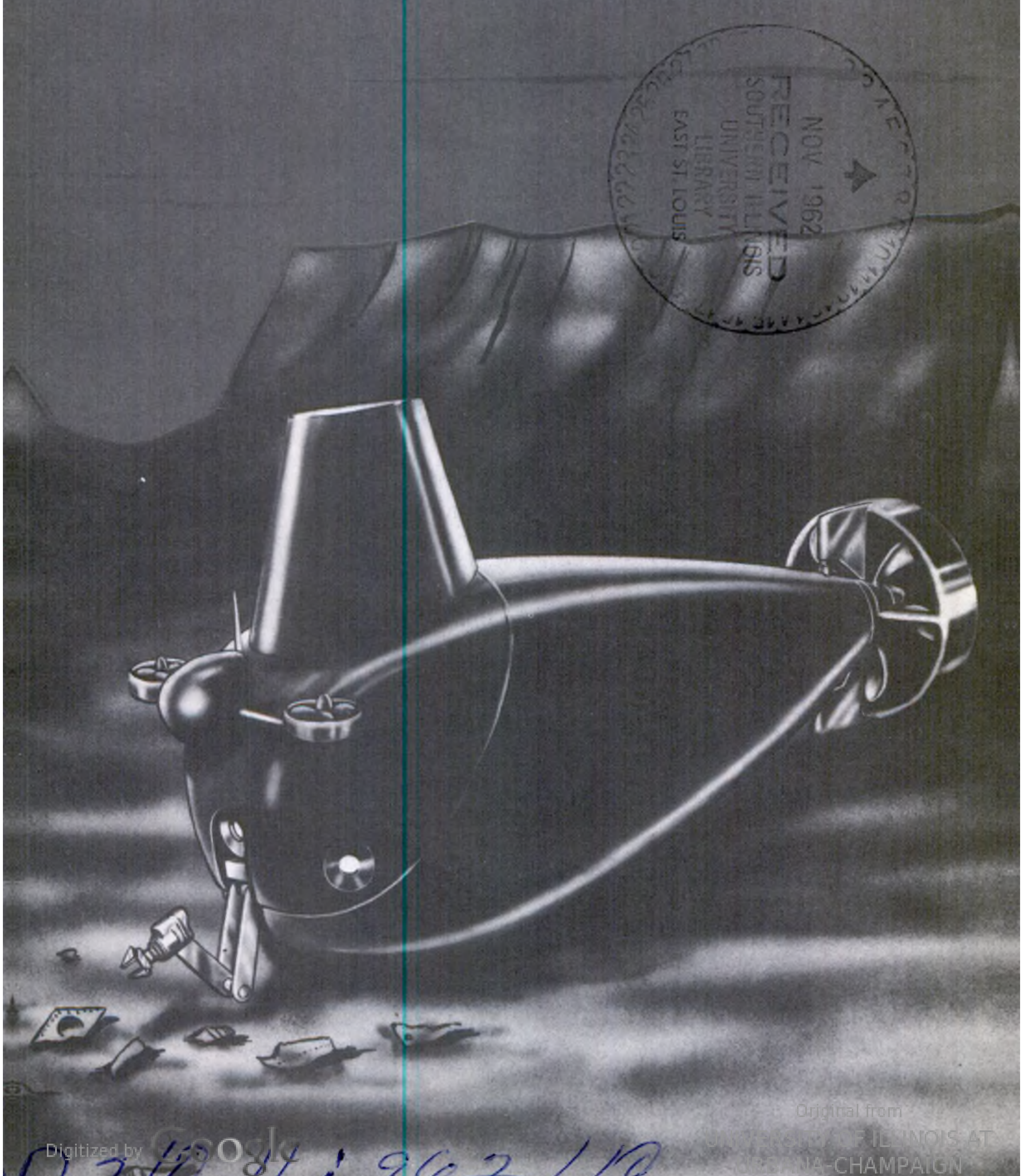
NAVAL RESEARCH REVIEWS

OCTOBER 1962



Technicians check out the 6,300-pound Stratoscope II telescope system which early next year will be lofted by balloon to 80,000 feet–above almost all of the Earth's atmosphere–to make infrared observations of Mars. See article beginning on page 7.

Bioelectronics at M.I.T.

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Only in recent years have scientists taken advantage of the multidisciplinary approach to the solution of their problems. In the last one or two decades they have come to realize that there must be a marriage of various disciplines if science is to obtain maximum benefits from new discoveries.

Thus, at the Research Laboratory of Electronics at the Massachusetts Institute of Technology, biology and electronics have formed a working partnership. The association is geared to improving communication and complex data-processing systems, and to achieving a better understanding of how the senses function in man and animals.

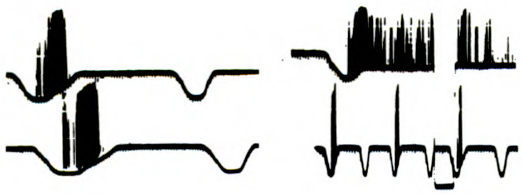
The Research Laboratory of Electronics was an outgrowth of the famous wartime Radiation Laboratory. Since their establishment in 1946, there has been a close association between RLE and the Office of Naval Research. The major portion of financial support for the Laboratory comes from a tri-service contract. This support has grown from an initial $600,000 to approximately $1,200,000 per year, and serves to form a nucleus about which the entire Laboratory's research effort revolves. During the same period, the staff has increased from 250 to 400.

A single tri-service contract provides both the military services and the Laboratory with a number of advantages. For example, use of the same personnel and supporting services permits economical operations. Also, professors can devote more time to research because they do not have to concern themselves with administrative details, such as contract renewals. Moreover, inclusion of many scientific disciplines makes possible a broader interplay of ideas.

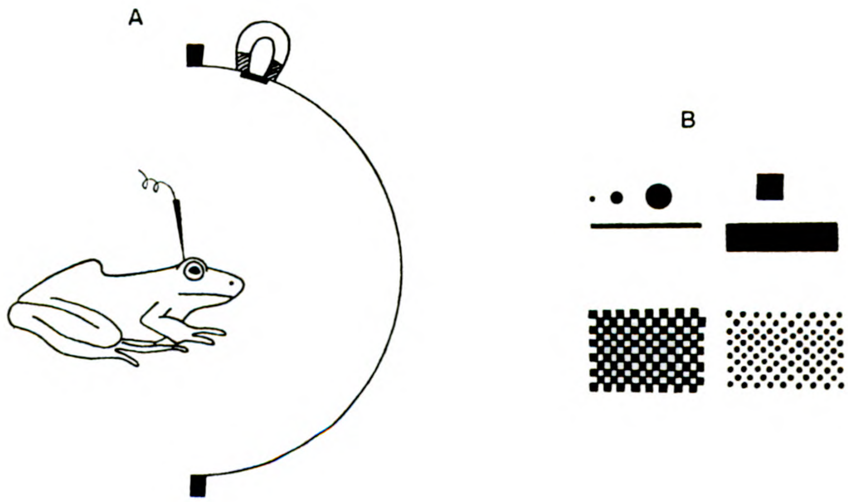
BROAD RESEARCH BACKGROUND

Originally, the departments of physics and electrical engineering provided most of RLE's staff. Now, however, the following departments are included: mathematics, biology, chemistry, chemical engineering, modern languages, nuclear engineering, mechanical engineering, geology and geophysics, and economics. Neurophysiology and other branches of medicine are also represented.

In neurophysiology, the interplay of scientific disciplines is especially apparent—particularly in the relationship of electronics and biology. The close working association and mutual interest in various problems which arise in these fields have resulted in the development of equipment and techniques that are facilitating the exploration of sensory systems and the functioning of the brain.

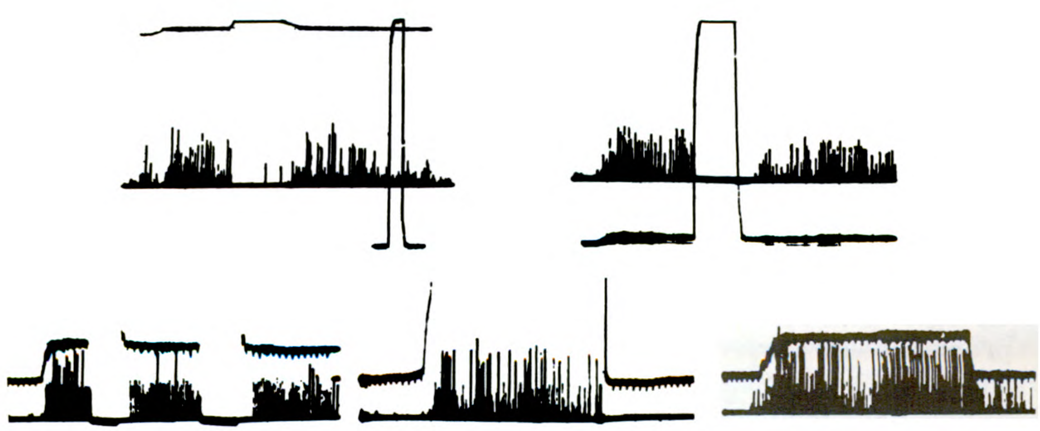


The illustrations across the top and bottom of this page show recordings of signals received from electrodes attached to various fibers of the optic nerve in the frog. Each indicates a response or responses of the nerve to changes in the visual field.



A, schematic drawing of the relations between the frog and the hemisphere that constitutes the experimental visual field.

B, some of the objects used as stimuli in the experimental visual field (hemisphere). These objects have been drawn to the same scale as the hemisphere. Actually, the hemisphere used for the experiments was larger than has been indicated here—14 inches in diameter. Thus, the objects actually used were larger by the same ratio. Reproduced through the courtesy of the <u>Journal of General Physiology</u>, Rockefeller Institute Press.



AIMS

The objectives of RLE are to solve problems of sensory perception and brain functioning. To do this, the scientists are working with such complex subject matter as human groups and specially designed computers. Included among the more sophisticated devices are computers which permit the scientists to analyze data while experiments are going on, and thus to make necessary changes and adjustments immediately, instead of waiting to review and collate the data.

The studies begin with efforts to learn as much as possible about how the brain performs. To gain such knowledge, sensory organs and nervous systems are studied in detail. This work leads to the development of computer technologies which simulate brain functioning. The next step is to examine the process of decision-making when a number of factors and alternatives are presented.

VISION

One of the most interesting animals under study is the frog. When the frog is hungry and must catch food, he selects those items which he can both perceive and digest, and he rejects others. What processes does he use in making his selections? It turns out that he relies primarily on vision. As he can see small moving insects, and they are acceptable food, he preys upon them. Unfortunately for the frog, he cannot see stationary or large moving objects and thus is, himself, easy prey for larger animals.

In studying the frog's eye, one group of scientists used moving silhouettes of different sizes and shapes as stimuli. The silhouettes were cut out of black, white, and gray paper and placed against a variety of backgrounds. By mounting the objects on soft iron washers, they could be moved against the background by magnets. They were viewed by reflected light, whose intensity was varied. Response of a frog's nerve fiber was measured roughly by the frequency and duration of firing (electrical discharge of the nerve cell accompanying the transmission of the impulse). The object was to determine what visual events produced the greatest response and which produced the least; also, what aspects of the image could be changed without varying the response.

Another part of this study involved recording the activity of single nerve fibers. This was done by placing the frog under an anesthetic, exposing his optic nerve, and attaching an electrode (see diagram). After the operation, the frog, which then was able to move and feed like a normal animal, was placed so that one eye was in the center of a hemisphere 14 inches in diameter. Objects having a variety of shapes were moved across the visual field by magnets. At the same time, scientists using a loudspeaker and an oscilloscope were able to listen to the activity of the cells and to record that activity visually.

The study showed that optical ganglion cells form five natural classes. One responds to color, whereas the other four respond to various aspects of moving objects. Certain fibers are sensitive to sharpness of boundary rather than degree of contrast. Other fibers do not respond to changes of lighting if no boundary exists in the field. Objects as small as 3 minutes of arc in diameter can be detected.

A function of the retina is to analyze the visual information. The ganglion cells in the last layer of the retina seem to combine the information from the rods and cones in complex ways. Studies are being made to find a correlation between the different types of ganglion cells and the functions they perform. Other studies are underway to determine why certain fibers respond to specific stimuli and reject others. The purpose of all of this work is to establish a model for vision in the frog.

Research is also being conducted on the human eye. The pupil was selected for study because its motor mechanism can be measured easily. Also, changes in the intensity of visible light, to which the pupil responds, are easy to control and can be regulated so as to be painless to the subject; therefore, experiments can be conducted without using anesthetics and can be performed easily.

Employing a special type of pupillometer, while using a biteboard to keep the subject's head absolutely still, scientists obtained continuous recordings simultaneously of the pupil area and the electronically controlled light stimulation. In one experiment, sinusoidal changes in light intensity were used to study the behavior of the pupil system. Another investigation showed that the pupil system contains much "noise." This noise apparently comes from some part of the brain at present unknown. An analog of the pupil system has been programmed on a digital computer and various interactions are being analyzed.

Another experiment concerns a person's periodic response to a rapidly moving visual field. Such a response occurs, for instance, when one gazes from a train window at passing fence posts or telephone poles. The involuntary reflex which occurs in animals when subjected to such a visual field has been measured to determine visual acuity. To make the measurements on human subjects, a pattern of moving stripes was made to pass across the monitor's face. Responses to the pattern, which was varied by changing the number, velocity, width, and intensity of the stripes, were then recorded and analyzed.

SENSE OF SMELL

Because the majority of the elements of the nervous system consist of fibers with very small diameters and very small cells, it has been necessary to design and construct new types of microelectrodes to obtain accurate measurements. Since the larger neurons probably carry different information than the smaller neurons do, definite measurement of small fibers and cells is of utmost importance. Platinized metal microelectrodes have been used in studies of the optic nerve of the frog and octopus and of olfactory mucosa and the olfactory nerve. Even more refined microelectrodes are being developed to increase the ability to distinguish relevant signals from "noise."

Scientists are also using platinized electrodes to record, from single cells in the frog's nasal cavity, the animal's response to different chemical stimuli. Several cells, subject to different chemical stimuli, can be observed simultaneously. Some cells respond to one chemical but not to another that is very similar to it. Some respond only to one particular chemical. The electrodes tell by way of the signal they put out, what chemical is near. Once the pattern of responses to different odors has been deciphered, the next step is to devise a chemical theory for olfaction–an extremely difficult problem.

MUSCLE COORDINATION

To investigate the human muscle-coordination system, scientists devised a method to measure wrist rotation. The method involves the use of a so-called light-coordination machine, which measures inputs and outputs while a subject aims a pointer at a target–a moving strip of light. As the target moves, the subject follows it with the pointer by rotating his wrist. The experiment is carried out behind a black curtain, which screens the subject from external light and distractions caused by the experimenter. By means of such methods, the investigators hope eventually to create a mathematical representation of human motor coordination.

NERVE PATHWAYS

Another group of investigators is studying sensory-projection pathways. Sensation originating in the skin is of particular interest. Because of the prevalence of such afflictions as headaches and facial neuralgia, special emphasis has been given to responses to skin stimulation of the face. Under study is the fifth pair of cranial nerves of the cat–the nerves which receive the sensory news from the face. Responses to heat and cold were measured. Except in the nasal cavities, cells that responded to pressure did not respond particularly to heat; but cells that responded to cooling, also responded to pressure. No pain cells per se could be found.

Other studies of sensory-projection pathways are designed to examine the reasons large nerve fibers have different properties from small nerve fibers. The number of branches on the end of each fiber may cause the differences. Research on small cells, particularly in the spinal cord, is being undertaken, as heretofore little work has been done with the small cell.

Sensory systems of both skin and muscle are studied to determine how the sensory parts of the central nervous system are connected. In experiments with tadpoles, an attempt has been made to determine the change of central nerve pathways which occurs during change of behavior. Certain areas of the tadpole's skin that respond to a particular stimulus are transplanted to the abdominal area. When metamorphosis occurs, the transplanted area still responds to the stimulus it responded to originally, rather than to some other stimulus.

Development of nerve-cell tissue culture is enabling scientists to study the interaction between nerve cells and other cells which determines the formation of junctions. Also under study is the mechanism by which relay stations in sensory pathways act as filters.

SPECIAL METHODS AND EQUIPMENT

RLE scientists strive constantly to improve their apparatus or to devise new methods and tools to obtain data. One device recently developed is a circuit that measures pulse interval on a logarithmic scale. Another is a heart-lung device that keeps the isolated head of an octopus alive for many hours. A microtransducer for muscle, previously developed at RLE, has recently been simplified to permit better measurement of muscle response.

Just as studies of olfaction may eventually lead to creation of an artificial nose that can detect and recognize odors, so studies of the auditory system may lead to creation of an artificial hearing system. Thus, in specially designed sound chambers, the hearing system of cats is being studied. Other unique equipment has been devised to study the cochlea of guinea pigs.

COMPUTERS

Both general-purpose and special-purpose computers are required in bioelectronics research. The former permit scientists to use a number of different approaches to a problem; the latter can perform a given calculation more efficiently.

Among the computers in use at RLE, especially in the study of brain waves, is an analog correlator. Similar to the correlator is the Evoked Response Detector. Since this computer requires long computation time, an Average Response Computer was developed to compute averages of responses during an experiment. It is a fast, transistorized, special-purpose digital computer having a magnetic-core memory.

The Amplitude and Latency Measuring Instrument with Digital Output, designed and built at RLE, combines and improves upon two earlier devices. It measures characteristic well-defined neural responses and presents the results in digital form.

As more information is obtained about the functioning of the nervous system, improved computers can be constructed. Conversely, advanced computers will enable RLE scientists to learn more about the nervous system.

Many other research projects concerning bioelectronics are underway at RLE. As new problems arise and more sophisticated instrumentation becomes necessary, even more spectacular growth than has been described here may be anticipated. Thus RLE will maintain its position as a leader in the task of furthering man's knowledge of the nervous system and the senses.

36-Inch Telescope to View Planets from Stratosphere

Ever since telescopes were invented, astronomers have known that they could not hope to obtain clear views of the planets and stars while looking through the earth's atmosphere. But until recently, the best they could do to reduce the effects of the atmosphere was to place their instruments on high mountains. Now, of course, vehicles are available to lift instruments of various kinds above all or most of the atmosphere. Telescopes, however, have not been easy to adapt to the vehicles: they are large, thus requiring considerable lift to take them to the heights necessary to achieve good "seeing;" they are very costly, meaning that they would have to be returned intact; and they must be held virtually motionless with respect to the object to be viewed, therefore requiring highly intricate accessory equipment. Moreover, either a man must accompany the instrument or complex equipment must be carried aloft capable of automatically focusing on the object to be viewed and taking photographs.

The three vehicles available to carry instruments above all or most of the atmosphere are balloons, rockets, and satellites. Balloons have seen the longest and most varied service because they are the simplest to launch and the least expensive. Physicists, for example, have been sending balloons aloft for decades to measure radiation and other phenomena. The Office of Naval Research has been the leading pioneer in developing high altitude plastic balloons for such purposes and supporting research conducted by means of them.

STRATOSCOPE I

One day in 1946, Dr. James Van Allen, discoverer of the radiation belts of the earth, lunched with Professor Martin Schwarzschild of Princeton University's Department of Astronomy. Their discussion centered on the usefulness of balloons for scientific purposes. Dr. Van Allen, who for years had been conducting investigations by this means sponsored principally by the Office of Naval Research, suggested to Dr. Schwarzschild that he might use the vehicle profitably, too.

Astronomers did have such problems which could be solved by this technique, and, curiously, Dr. Schwarzschild was even then working on one of them–a question about the sun. One of the major uncertainties regarding the interior of the sun was the efficiency with which convection–the gross vertical motion of the solar material under the influence of heating from below–carries energy to the outer layers. The finer details of the patterns of motion could not be observed from the surface of the earth because of the optical distortion induced by the earth's atmosphere. However, theoretical analysis indicated that a balloon-borne telescope operating at 80,000 feet could take photographs that would answer the question.

The Office of Naval Research agreed to support the project which began to take form–called Stratoscope I. A 12-inch telescope was built, and in 1957 this instrument was successfully flown to 82,000 and 83,000 feet successively, utilizing plastic balloons furnished by the Navy. The total lift-off weight of the system was 1,400 pounds. Subsequently, a more refined telescope was constructed and carried by balloon to the high atmosphere on several occasions in 1959. Its total lift-off weight was 1,700 pounds. Hundreds of outstanding photographs were taken, including superb time-sequence pictures of specific sun spots.

STRATOSCOPE II

Although Stratoscope I was an unqualified success, providing a wealth of new solar information, scientists immediately began thinking about applying the system to the observation of fainter astronomical bodies, such as the moon, planets, star-clouds, and galaxies. But to do this effectively, a much larger, more sophisticated–and expensive–instrument would be required. A 36-inch telescope was thus envisioned. For this instrument to operate successfully, the system would have to incorporate the most refined optical techniques and highest possible tracking precision. The telescope would also have to be adapted to an extremely large balloon system utilizing new materials and launching techniques.

Stratoscope II thus evolved. Like the preceding project, it is directed by Professor Martin Schwarzschild of Princeton University and sponsored by the Office of Naval Research. The National Science Foundation, which joined ONR in sponsoring Stratoscope I in 1959, also provides support, as does the National Aeronautics and Space Administration.

DESIGN AND CONSTRUCTION

Responsibility for designing and building the telescope system itself was turned over to the Perkin-Elmer Corporation of Norwalk, Connecticut, the firm which developed the optics and camera for the 12-inch Stratoscope I instrument. The new instrument was completed only last month–a 6,300-pound, 36-inch aperture optical system capable of providing a photographic resolution of 0.1 second of arc–equal to the ability to distinguish two objects 30 inches apart at a distance of 1,000 miles.

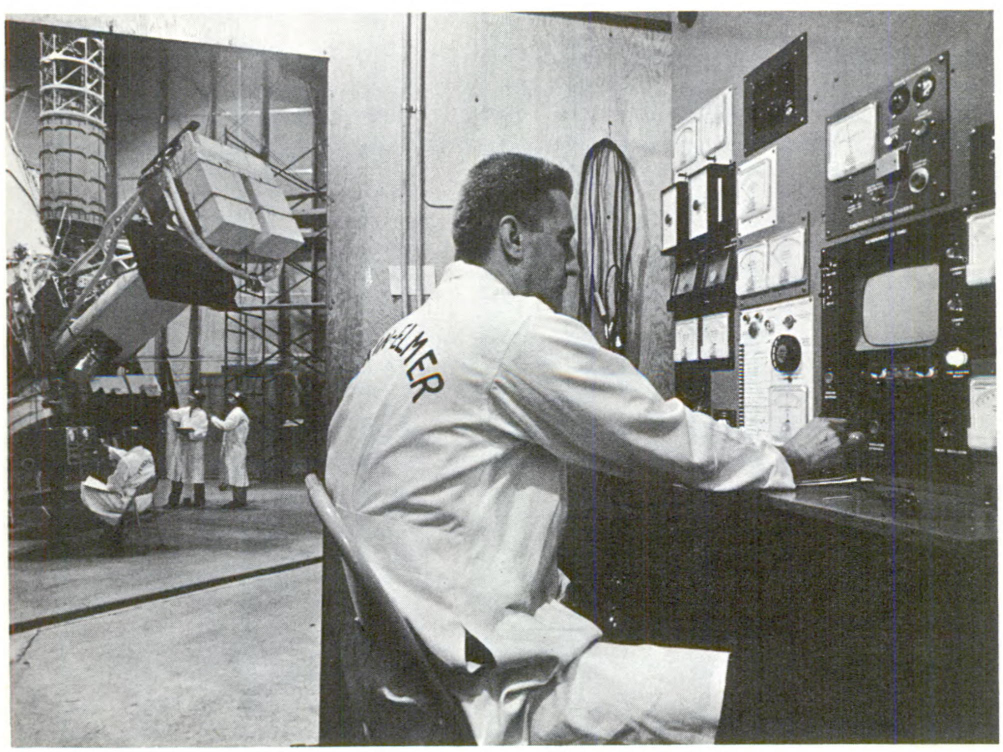
The assembly consists of an 18-foot main tube and an 11-foot side arm which together form a fixed L-shaped structure. The basic telescope is housed in the main tube with the objective mirror, the secondary mirror, which is also the focusing element, and a television camera with a 10-degree field, used to locate the general section of the sky to be studied. The side arm assembly holds the guidance package, camera equipment, and another television camera, this one with a 1-degree field, which looks through the reflecting telescope and fixes the specific celestial object to be photographed.

The two television cameras used in the system were specially designed for Stratoscope II by the Radio Corporation of America. They operate at 20 frames per second and 400 lines per frame, as compared with commercial TV cameras which scan the field at 30 frames per second and 525 lines per frame. The primary reason for the lower scan rate is to make possible transmission of information on a narrower bandwidth at lower powers. An interesting feature of the system is that information is broadcast in short "bright spot" pulses, thus assuring that the cameras transmit only when a star or other bright object is in their view.

GUIDANCE, COMMAND, TELEMETRY

The telescope's guidance system has been designed to track an object in the sky and hold it fixed in the image plane to within 0.02 second of arc for as long as one hour. The telescope can be guided by a single star as dim as ninth magnitude (by comparison, the human eye cannot see stars that are dimmer than sixth magnitude). Automatic tracking, however, is achieved by "locking" the telescope onto two guide stars by means of two similar systems, one holding the image fixed along the optical line of sight, and the other preventing rotation of the telescope.

Seated at an instrument panel in a mobile ground control van, an engineer operates the remote-control system of the 6,300-pound Stratoscope II telescope (background). The system will enable astronomers to guide the telescope by stars as dim as ninth magnitude and to hold a photographic target fixed in the image plane to within 0.02 second of arc for as long as one hour.



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The command and telemetry system permits many functions of the telescope and related equipment to be controlled remotely. The command system, for example, has 40 channels, and the telemetry system, 64. Two complete radio links are employed to carry out command activities, the channels being divided equally between them. If one link fails, commands normally carried by it can be switched to the other link.

NEW BALLOON FABRIC

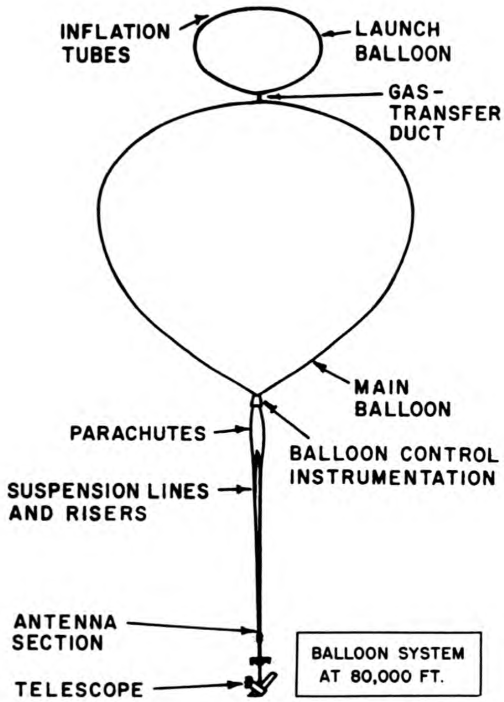
In planning Stratoscope II, one of the prime considerations was to construct a balloon strong enough to lift the heaviest weight yet proposed for such vehicles to the required altitude of 80,000 feet. Polyethylene film, commonly used for balloons, is limited to a load-carrying capacity of about 4,000 pounds, and thus was unsatisfactory for Stratoscope II. To meet this problem, the G. T. Schjeldahl Company, under contract to ONR, began research on reinforced laminated plastic film having high tensile strength and tear resistance. The requirement was that the material be no heavier than 2-1/2 mil polyethylene. Schjeldahl experimented with Mylar, which has 10 times the tensile strength of polyethylene, and developed a material known as S-10. This is 1/4-mil Mylar upon which is superimposed a dacron scrim. The material is very light, having a weight equivalent of 1.7 polyethylene.

DUAL-BALLOON SYSTEM

Schjeldahl also developed, specifically for Stratoscope II, a new balloon system capable of lifting the heavy telescope payload off the ground quickly while remaining unbuffeted by ground winds as high as 15 knots. The system employs two balloons–a small one and a large one, with the former mounted on top of the latter. The small balloon is composed of a 1/2-mil Mylar and dacron laminate called S-12, and it has a volume of 250,000 cubic feet. The main balloon consists of a 1/3-mil Mylar and dacron material known as S-11; it has a volume of 5,250,000 cubic feet. The two balloons are connected by a 2-1/2 foot metal tube, 3 feet in diameter, attached to a 3-foot hole in each balloon. Only the small balloon is inflated at launch. However, it is capable of lifting off the ground the total Stratoscope II load–about 13,000 pounds. This includes the weight of the two balloons, totalling 3,300 pounds; the ballast, amounting to 2,200 pounds; and the payload, which weighs 6,300 pounds. As the balloons ascend, the helium in the small balloon is transferred to the main balloon.

Unlike the procedure followed during the Stratoscope I flights, the telescope is lowered gently to earth by the balloons, rather than by parachute. Nevertheless, two cargo parachutes are provided for emergency use. The balloon system is valved down to 5,000 feet, stabilized at that altitude, then brought down to 2,000 feet, where it is again stabilized, and finally it is eased onto the ground.

STRATOSCOPE II
BALLOON SYSTEM CHARACTERISTICS



LAUNCH BALLOON
MATERIAL: S-12
.5 MIL MYLAR
DACRON SCRIM (4 x 6 STRANDS / INCH)
TENSILE STRENGTH 40 LBS. / INCH
TYPE BALLOON: FULL SUPERPRESSURE CYLINDER
VOLUME: 305,000 FT^3

MAIN BALLOON
MATERIAL: S-11
.35 MIL MYLAR
DACRON SCRIM (4 x 6 STRANDS / INCH)
TYPE BALLOON: TAILORED NATURAL SHAPE
VOLUME: 5,250,000 $FT.^3$

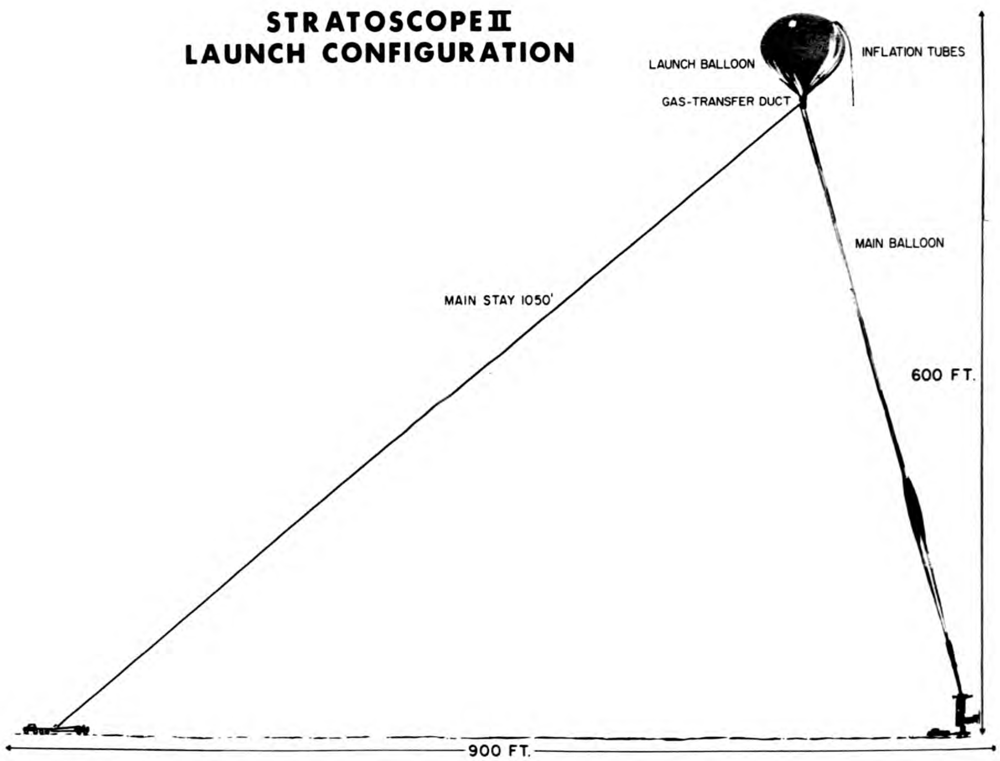
LENGTH OVERALL
AT LAUNCH: 660 FT. AT 80,000 FT.: 480 FT.

WEIGHT
PAYLOAD: 6300 LBS. OVERALL: 13,250 LBS.

GROSS LIFT: 14,575 LBS.

FREE LIFT: 1325 LBS.

STRATOSCOPE II
LAUNCH CONFIGURATION



The Launching Site

Launchings now planned for Stratoscope II will be made from the new 183-acre Scientific Balloon Flight Station at Palestine, Texas—the first year-round facility devoted exclusively to scientific ballooning. The station is administered by the National Center for Atmospheric Research (NCAR; a 14-university non-profit management corporation) under contract with the National Science Foundation.

Preparation of the launching area, construction of the "Strato-port," which will house the 36-inch telescope, and the erection of a two-story operations and laboratory building began in June of this year and will be completed this month. The launching area consists of 6-1/2 acres of asphaltic concrete arranged in "fingers" radiating from a central area so as to allow launchings to be made regardless of wind direction, and 60 acres of graded soil capable of handling large-tire vehicles of the type used in the Stratoscope II launching method.

The Scientific Balloon Flight Station is part of the NACR National Balloon Program, established last year to help make the unique qualities of balloons for scientific research more readily available to scientists and to spur improvement in balloon technology for use in scientific experimentation. Other phases of the NCAR National Balloon Program are the fostering of balloon research projects on such subjects as better balloon fabrics, launching techniques, and tracking and telemetry methods, as well as the dissemination of current information about ballooning.

The station, which is administered by the NCAR Balloon Development Group, is open, within practical limitations, to all scientists with balloon experiments to fly. In many cases NCAR will provide a scientist utilizing the station with a variety of technical assistance and field service, so that he will not have to take the time to become an expert in the details of balloon technology.

NCAR has a three-fold mission: first, to attack in an interdisciplinary and comprehensive way some of the large, fundamental problems about the behavior of the atmosphere; second, to provide sponsorship, support, and facilities for investigations in the atmospheric sciences; third, to provide, or arrange for the provision of, research facilities (such as the Scientific Balloon Flight Station) for which there is an established and urgent need, and which are too complex in scope for an individual university or research group to build and maintain.

THE FIRST EXPERIMENT

The first Stratoscope II flight, after testing the system with a dummy telescope, is scheduled for early in 1963 and will be made from the new 183-acre Scientific Balloon Flight Station at Palestine, Texas. Its purpose will be to analyze the infrared spectra of light received from Mars, and incidentally, the Moon. The experiment is based on the fact that light reflected from each chemical substance shows a characteristic arrangement of wavelengths in spectral analysis. Therefore, the spectral patterns observed are expected to give scientists important clues as to the amount of water vapor and other gases in the Martian atmosphere and the possible occurrence of organic molecules on the planet's surface. No photographs of Mars will be taken at this time.

This investigation has been assigned first position in the Stratoscope II series so that it may coincide with the opposition of Mars to the Earth—the biennial period when Mars makes its closest approach to its neighbor plant and when the energy from the reflected light of Mars reaches its greatest intensity on the Earth. The experiment will be conducted by the University of California through a grant from the National Aeronautics and Space Administration.

The specific objectives of other individual flights have not yet been established. Each will depend upon the time the flights are scheduled and the relative positions of celestial objects that astronomers wish to observe. However, some of the objects that are now being considered for future flights are listed in the following paragraphs.

VENUS

The planet Venus, our closest neighbor in the solar system with the exception of the Moon, has about the same mass and radius as the Earth. The planet is continually blanketed by diffuse and changing cloud patterns whose nature is still a vigorously disputed question. One group of scientists believes that these clouds are water droplets and ice crystals, while others hold to the theory that they consist of dust stirred up from the surface. Each of these theories is associated with a different model of the surface and atmospheric structure of Venus.

Telescope observations have been made of cloud patterns that remain the same for several weeks. The nature of these apparently stationary patterns is also a mystery. It is believed that high-resolution photographs from the Stratoscope II instrument will be able to clarify the nature of the cloud patterns.

JUPITER

Jupiter is the largest of the planets, with a mean diameter of 87,000 miles—more than 10 times the size of the Earth. Its density of 1.34 matches closely that of the entirely gaseous sun. The most characteristic telescopic feature of Jupiter is the system of dark belts encircling the planet parallel to the equator. These belts change rapidly in form and intensity. With higher magnification it is possible to see details of various sizes and shapes in the belts. Jupiter's surface features are thus highly complex and are generally believed to be made up of immense cloud formations. Because of the low density of Jupiter, it is believed that this planet is composed mainly of the lighter elements, hydrogen and helium. The liquid and solid phases would be present at great depths.

A most interesting and mysterious feature of Jupiter is the "Red Spot," probably first observed in the 17th century and, with varying visibility, followed continuously since 1831. About 30,000 miles long and 7,000 miles wide, it appears to drift in longitude with respect to the cloud systems. Its color and variations are not yet explained; one theory is that it represents an effect in the atmosphere of a deep-lying permanent surface feature.

Studies of the sudden atmospheric changes in Jupiter, and of the Red Spot, may be assisted by work undertaken with Stratoscope II.

SATURN

Saturn has the lowest density of any of the planets, at seven-tenths that of water. It must also be composed of the light elements, hydrogen and helium. Relatively few spots among Saturn's clouds are definite enough to permit determination of its rotation period, but they confirm that the period is shorter at the equator than at higher latitudes, as is the case for Jupiter's clouds.

Saturn is surrounded by a number of concentric rings–broadly speaking, three main rings. These rings are probably composed of billions of tiny particles too small and too close together to be seen individually, each behaving like an individual satellite. In addition, Saturn has nine satellite "moons."

The increased resolving power available with Stratoscope II may well clarify the reported but thus far unverified division of Saturn's three rings into several lesser rings, as well as revealing detail in the Saturnian atmosphere that is entirely unknown at present.

MARS

Telescopic views of Mars show dark areas, usually gray, near the equatorial regions of the planet. Relatively bright orange, ochre, or buff colored areas cover most of the remainder, with a white cap at each pole.

The bright areas are generally identified as deserts, and the polar caps as hoar frost. After reaching a maximum size late in the Martian winter, the polar cap diminishes and may even vanish during the spring and summer. They appear alternately at opposite poles because the Martian seasons are similar to those on the earth, though about twice as long. Telescopic observations of Mars have also shown what appear to be rectilinear patterns in the bright areas. These, the famous "canals" of Mars, are seen under the very best observing conditions to be broken up into mottled patterns, the nature of which remains unclear. The theory that these markings are Martian "canals" is therefore no longer accepted by most scientists.

At such time as the Stratoscope II instrument may be used to observe Mars, the fact that its high resolving power is not diminished by the small amount of the earth's atmosphere above the telescope should make possible clarification of the structure of the "canals" as well as increase the amount of information available about the surface features of the planet.

It should be noted that after the infrared measurements are made of Mars early next year, the planet will not be in good opposition until 1965. Photographic observations of the planet will thus be deferred until then.

OTHER PLANETS

The two planets Uranus and Neptune offer good possibilities for Stratoscope II observations. Uranus has a diameter of 3.8 seconds of arc, and Neptune 2.2 seconds of arc. With the Stratoscope II resolving power of 1/10 second of arc, photographs of these planets may be achieved that are roughly equivalent to a photograph of Jupiter at 1 second of arc resolution. Stratoscope II has the potentiality of being able for the first time to take photographs of these planets that will show some detail.

Photography of Mercury, with its diameter of 8 seconds of arc, may possibly reveal some details of the craters on the tiny planet.

Pluto, which is farthest away and has a diameter of only 0.25 second of arc, may be captured in a photograph that shows its disc larger than the discs of stars can be shown.

NEBULAE

Bright gaseous nebulae–the nebula in Orion is an example of one–are vast clouds of material, dust as well as gas, that are found throughout the galactic plane. They do not "shine" or produce light themselves, as do stars; the bright nebulae depend for their luminescence upon the radiation of nearby stars. Dark nebulae may also be seen, silhouetted against patches of more distant stars or, against bright nebulae.

These nebulae are of utmost interest to astronomers, because they are areas where new stars are in the process of formation.

Close examination by Stratoscope II of nebulae and other apparently related phenomena in our galaxy will help to provide possible clues to the ways our own sun was formed.

GLOBULAR STAR CLUSTERS

Studies of stellar evolution may well be greatly advanced by observations of globular star clusters. These clusters contain both red giants–large, bright stars in an advanced stage of evolution–and stars in the "horizontal branch" of stellar evolution charts, a branch not yet understood. The latter are yellow and white stars, next to the red giants in brightness, and may be at the next evolutionary step after the red giant phase. Observations to show the relative distributions of the two types of stars in globular clusters, including the dense inner portion, would help clarify this evolutionary study. To make such observations, higher resolution is needed than can be obtained from the ground; the theoretical resolution of Stratoscope II opens up the possibility of obtaining useful information of this nature.

ANDROMEDA GALAXY

The great nebula in Andromeda, M31, is a spiral galaxy believed to be much like our own galaxy, the Milky Way, in age and number of stars. One of only three extra-galactic objects visible to the naked eye, it has been determined that M31 is about 1.5 million light years distant from us. It is of particular interest to astronomy because of its similarity to the Milky Way and because of its nearness compared with other spiral galaxies. In the nuclei of such galaxies the star density is large compared with that in the spiral arms in the plane of the galaxy. Ground-based telescopes possibly have resolved the M31 nucleus, but Stratoscope II with its greater definition will be able to make the details much clearer.

Through its application to the study of these many important subjects, Stratoscope II is destined to play an important role in the future of astronomy. Until instrumented and manned rockets actually go to the "nearby" places and report back in much more detail, the 36-inch stratospheric telescope should provide astronomers with considerable new and exciting information.

For centuries our nearest neighbors in and about the solar system have been virtual strangers to us. It is fitting that we should get to know them much better before–over the next few decades–we get to know them well.

Scripps to Have New Ship and Building

A grant of $923,000 has been made by the National Science Foundation to the Scripps Institution of Oceanography, LaJolla, California, for the construction of both a ship and a three-story building.

The new ship, which will cost $653,000 before being outfitted, will displace 300 tons. It will carry aquaria which will contain refrigerated sea water for keeping specimens of sea life alive. The facilities on board will also include a machine shop and a glass-blowing laboratory. The ship is expected to be completed within two years.

The new building will be devoted to physiology. The two lower floors will be used by Scripps marine physiologists, and the top floor will be used by the Brain Research Institute of UCLA. Adjacent to the building, a circular towing pool, 70 feet in diameter, will be built. It will feature a central observation laboratory and a towing beam.

Both the building and the tank are scheduled for completion in 1964.

–ONR Regional Office, Pasadena

Life Without Germs*

The theories that made LOBUND (Laboratories of Bacteriology, University of Notre Dame) possible were formulated many years ago–by Antony von Leeuwenhoek, who discovered microorganisms (which he called little animals) in the 17th century; by Louis Pasteur, who proved the germ theory of disease in the 19th century; and by the thousands of other naturalists, chemists, botanists, and zoologists who extended our knowledge of the world of microscopic organisms. Through their efforts, we have learned that animals are hosts to many kinds of bacteria from the time they are born until they die, and that they develop certain immunities to all but the most virulent of them. Although it was generally believed that some types of bacteria perform valuable functions that are essential to life, the question of whether higher animals could exist without bacteria remained unsettled. Several biologists had tried to raise small animals completely uncontaminated by bacteria, but the seemingly insurmountable technical difficulties involved led to failure. Even Pasteur had toyed with the idea, though he admitted he had a "preconceived notion that life under such conditions would be impossible."

In 1928 a young pre-medical student at the University of Notre Dame, James A. Reyniers, walked into his dean's office with a plan. He explained that he was disturbed over the lack of precision in some of the methods and procedures adopted by bacteriologists. Bacteriology dealt with living things, and in life there were always variations. Thus, in order to solve the problems of this science, some knowledge must be gained of its units–the single bacterial cells. Reyniers wanted to try to discover the nature of the cell, but first he had to develop intricate instruments with which to isolate the cell. The dean, the Reverend Francis J. Wenninger, listened to Reyniers' plan and decided to help, giving the young man a corner of his own laboratory in which to begin his work. In 1930, Reyniers received his B. S. degree, and Father Wenninger, impressed by his progress, offered him a position as instructor at Notre Dame while working for his master's degree.

By this time Reyniers had made a fair start of piecing together equipment that would enable him to study the single bacterial cell under a microscope. In order to keep unwanted bacteria from invading his cultures, he constructed a chamber and hood that could be sterilized and maintained tightly sealed. As a check on the tightness of his apparatus, he tried to raise germfree animals in it. Thus was born his interest in the old question, "Can animals survive if they do not harbor microorganisms?" Reyniers felt that these animals would not be mere biological curiosities–they would be useful tools for science. But he anticipated that the many problems involved could not be solved overnight; so he laid out a detailed work plan. That plan is still in effect, although it has now spanned 30 years.

*This article was prepared from information provided by Dr. Morris Pollard, present Director of LOBUND Institute and Professor of Biology, University of Notre Dame.

Gradual refinements of equipment and techniques confirmed Reyniers' hypothesis that such animals as chickens, mice, and rats could live "normal" lives and produce young without being contaminated with bacteria and other microorganisms. As soon as practical problems were solved and necessary facilities were provided, he evaluated the techniques employed and established a standard procedure for maintaining life in a germfree environment. This procedure is outlined in the following paragraphs.

Obtaining germfree animals. Animals were first introduced into the germfree environment in one of two ways: mammals were delivered by Caesarian section from normal animals by means of steam-sterilized operating units; germfree chicks were obtained by sterilizing the shells of fertile eggs and allowing the eggs to hatch in germfree cages. Later, reproduction by smaller germfree animals proved successful. Reproduction by germfree rabbits was achieved for the first time in 1961.

Keeping the animals germfree. The early basic equipment for working with germfree animals consisted of a steam-sterilized steel cylinder, or isolator, with Pyrex viewing window. Arm-length rubber gloves were sealed into the sides of the cylinder for manipulating the animals. A sterile lock on the cylinder enabled the caretaker to pass sterilized materials to the animals and to remove the animals, waste materials, and cultures without contaminating the environment. Later refinements initiated by Philip R. Trexler, an early associate of Reyniers, led to the development of plastic isolators of similar design but which could be chemically sterilized. Now, large plastic-jacket isolators capable of housing whole colonies of germfree animals are in use. These large units are serviced by attendants wearing protective garments after first entering through a germicidal bath.

Rearing the animals to maturity. Raising chicks and other fowl and birds hatched from eggs is relatively easy to do. The temperature and humidity of the cage are carefully controlled; air is supplied through filters; sterilized food and water are passed through the sterile lock.

Raising mammals is much more difficult. Because the young could not be permitted to suckle the contaminated mother, special formulas that were almost identical to the mother's milk and that could be sterilized under steam pressure had to be prepared. This steam-sterilized food sometimes caused nutritional deficiencies, which, if not corrected promptly, shortened the animal's life span or caused sterility. After reproduction by the germfree animals was successfully accomplished, thus permitting mothers to suckle their young, the work routine of LOBUND staff members was lightened considerably.

Detecting contamination. Once or twice a week, specimens are obtained from orifices of the animal's body; samples of hair or feathers, food, milk, water, urine, and feces are collected. These samples are sealed in test tubes, removed through the sterile lock, and subjected to rigorous laboratory tests for any sign of living microbes. If contamination is detected, studies are made of the effect of that particular organism on the animal.

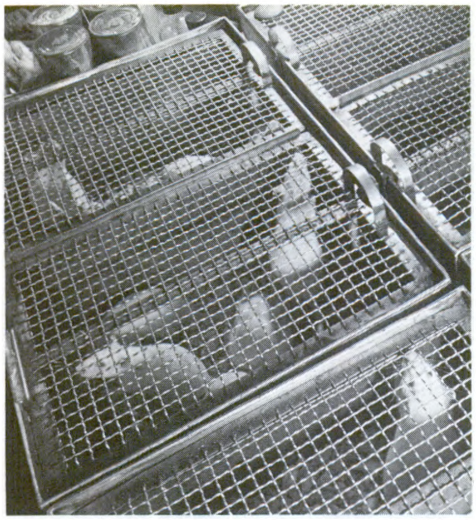
Studying the germfree animal to establish a work norm. In order to insure the greatest possible value of germfree animals, detailed studies and reports are made of the similarities and differences between germfree and normally contaminated animals. This is important because a scientist who is not aware of the differences could easily lapse into serious errors of interpretation while working with the germfree animals. Animals are contaminated by spraying the desired organism into the unit housing the animal. Studies of the effects are then carried on behind the safety of a sealed glass window and with the protection provided by the built-in rubber gloves.

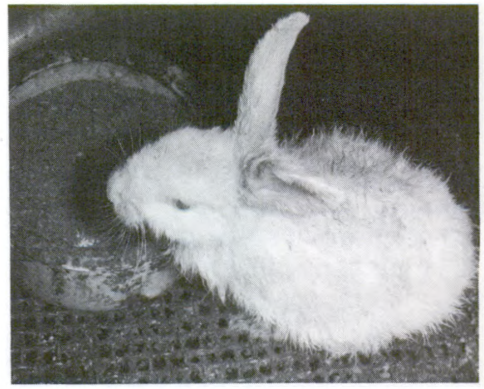
While the procedure for handling germfree animals was being developed, LOBUND itself was growing. In 1936, plans were approved for a new biology building, the entire first floor being set aside for LOBUND. In 1939, the first grant from a private source, the W. K. Kellogg Company of Battle Creek, Michigan, was received and used for the study of problems of nutrition of germfree animals. During the following year, LOBUND embarked on its first joint venture by undertaking, in conjunction with the Zoller Memorial Dental Clinic of the University of Chicago, a study of the causes of tooth decay. Later, the Cradle, the famous foundling home in Evanston, Illinois, cooperated with LOBUND in the study of the prevention of cross infection among infants in hospital nurseries.

It was not until after World War II that sufficient funds for a large expansion of facilities became available. By this time, information about the project had been rather widely disseminated, and other research groups had expressed interest in the technique. LOBUND was then receiving many requests for germfree animals to be used in the investigation of tumor growth, infections by viruses and other microorganisms, the development of antibodies, and of immunity and resistance. As LOBUND was unable to meet these needs, the University, in 1946, proposed to the newly established Office of Naval Research a project for expanding the program, thereby making germfree animals available to other research organizations for their own studies. The project was established, and ONR funds were used to design and construct a prototype for the plastic-jacket isolators, which, as mentioned previously, are large enough to house an entire colony of germfree animals for a number of generations. At the same time, the University decided to construct three new buildings–a Germfree Life Building, a machine shop, and an animal-colony house. Upon their dedication in June 1950, the President of Notre Dame formally announced the establishment of LOBUND as the Institute for Research in Life Sciences. Since that time, the Institute has been maintained through continued support by ONR and other governmental and private agencies.

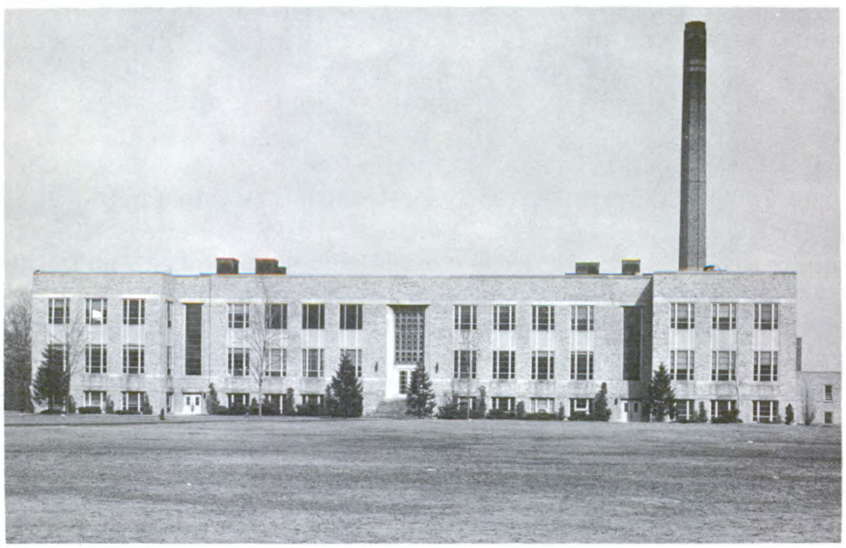
Much has been accomplished through LOBUND Institute's experiments with germfree animals–both in basic and applied research.

Some of the more important basic information gained concerns, first, the relationship between bacteria and nutrition. For example, the studies have shown that bacteria play an important role in the rate and amount of absorption of food elements from the digestive system. Second, the studies have shown that antibody production occurs much more

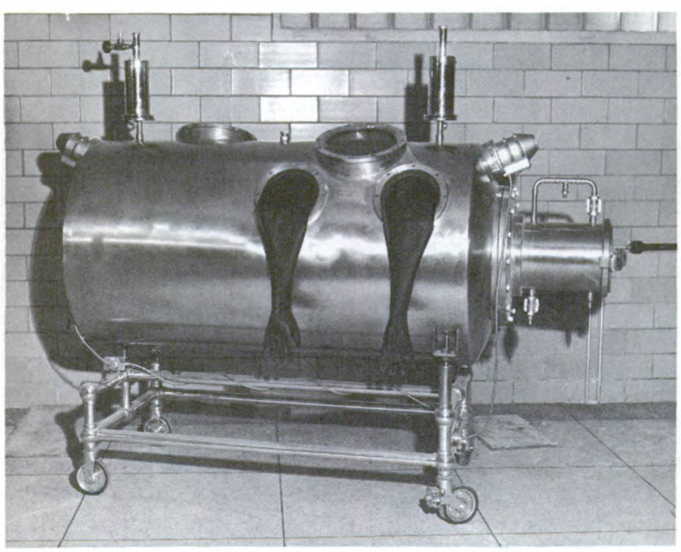




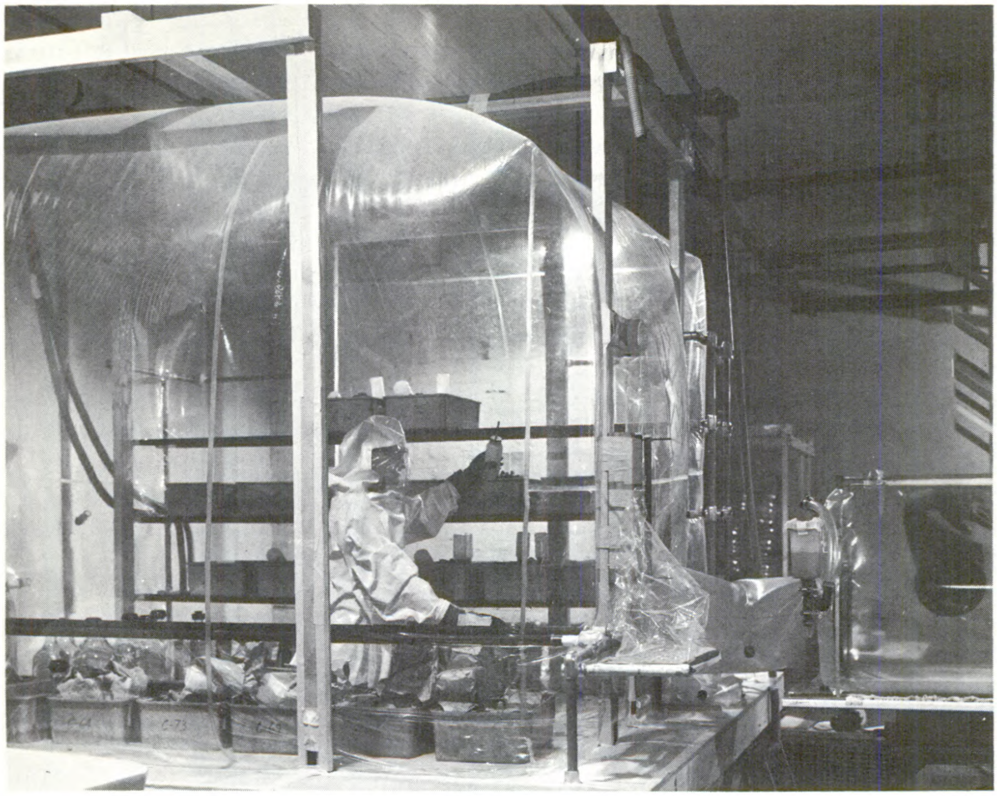
Left, germfree rats. Cages segregate sexes to control breeding. Right, a germfree rabbit.



Kirsch-Wenninger Biology Building. LOBUND laboratories occupy entire ground floor.



Stainless-steel steam-sterilized isolator with Pyrex portholes for viewing.



Plastic jacket isolator capable of maintaining 180 mice; germfree offspring from this number of breeding females will exceed 4,000 per year.

Chemically sterilized plastic isolator. Visibility and flexibility of the plastic greatly facilitates handling of animals by means of sealed-in rubber gloves.

slowly in germfree animals than in conventional animals. This is because the latter have had to produce antibodies constantly since birth and thus have developed the capacity to produce them in the quantities needed; the germfree animal, on the other hand, has not needed antibodies, and so has never developed the capacity to produce them rapidly enough to survive in the "outside" world. When germs are introduced into these animals, antibody production occurs, but at a very slow rate. A third difference between germfree and conventional animals is revealed through a comparison of certain tissues. For example, the germfree animal has larger large intestines and smaller small intestines; and as might be expected, his lymph nodes and spleen, where antibodies are normally produced, are smaller.

The studies have also shown that germfree animals can tolerate higher doses of radiation than conventional animals. Interesting, too, is the fact that germfree animals not only react violently to disease-producing bacteria, but also to many bacteria that ordinarly are nonpathogenic.

In applied research, techniques for the study of problems relating to both human and veterinary medicine have been developed. As previously mentioned, considerable research has been done relating to the microbes causing tooth decay. ONR has supported much of this work, which has indicated that certain species of bacteria must be present in the mouth of rats in order for dental caries to occur. Utilizing this information, investigators are now attempting to immunize rats against these bacteria. If successful, the technique may be applied to human beings; in other words, a vaccine may be developed which will prevent tooth decay in man. Studies have also been made of lymphomatosis (a disease in chickens resembling cancer in man), radiation sickness, and protein metabolism. Certain phases of three other vital medical problems–cancer, heart disease, and virus infections–have been explored. For this work, germfree mice and rats have been propagated through 19 successive generations. Enough of the experimental animals are now available to permit their use in a number of new programs for which they are particularly suited in addition to the programs now underway.

One of the most important applications of germfree animals to medicine is in the study of the "teamplay" which exists between microorganisms in causing certain diseases. An important example from the Navy's point of view is dysentery. By introducing specific microorganisms into animals under the controlled conditions which exist in the germfree environment, investigators can learn their precise effects–alone and in conjunction with other specific germs–and thus can pinpoint the groupings harmful to man.

In the future, the Institute's activities will be directed at the continued study of physiology, biochemistry, and nutrition of germfree animals. The role of PPLO (pleuropneumonia-like organisms) in disease will be investigated. Further programs are being initiated on the study of radiation disease, intestinal parasitism of protozoa and bacteria, cancer-inducing chemicals and viruses, the origin of the antibody, and, as has already been pointed out, immunization against dental caries.

Research Notes

Reverse GEM

As most readers know by now, a GEM (ground effect machine) is a vehicle that rides on a cushion of air (Naval Research Reviews, September 1962). The air cushion under the vehicle, created by fans or compressors, is entrapped by a circular or elliptical curtain of air surrounding the cushion.

Now, an Office of Naval Research contract investigator–A. P. Kelley of AiResearch in Phoenix, Arizona–has invented a kind of suction cup that uses the same principle in reverse. An upward-blowing fan, located in an opening in the top of a bell-shaped body, provides the suction. Another dome, enclosing this bell-shaped body, forces a recirculation of the fan discharge and creates the GEM-type air curtain around the edge of the low-pressure area below the body. The resulting machine is a large "suction cup" that does not touch the ground.

A 5-foot-diameter model has been built and tested to demonstrate the principle.

A suggested application of the device is to reduce the heavy counterweights on the crash cranes used on aircraft carrier flight decks–where heavy counterweights are most undesirable. Another application may be in the reduction of the weight of tow tractors operated on carrier flight decks. Kelley has been provided with a deck tow tractor by the Fleet in San Diego, and he is now in the process of modifying the tractor to embody the new principle.

Mr. Kelley calls his device a MEG, which is GEM spelled backwards.

–B. J. Cagle, ONR Regional Office, Pasadena

Medical Reactor Begins Operation

The Free World's family of nuclear reactors for medical use added an important new member when the $5 million DASA-TRIGA reactor went "critical" recently at the Armed Forces Radiobiology Research Institute, on the grounds of the National Naval Medical Center in Bethesda, Maryland (Naval Research Reviews, February 1961). The reactor was designed and built by the General Atomic Division of the General Dynamics Corporation under the sponsorship of the Defense Atomic Support Agency, from which it derives part of its name. The other part of the name stands for several of the reactor's functions: Training, Research, Isotope production, General Atomic.

The reactor will be used by biomedical scientists of the medical services of all the armed forces to determine the effects of various types of radiations on animal tissue and detectors. It also will be available to other government research agencies and private institutions. The reactor fills an important gap in biomedical research, because until now, scientists of the Department of Defense have had no controlled source of radiation of the types given off by nuclear weapons. They have had to rely, therefore, on field tests or on reactors not specifically designed for their research requirements.

The reactor is inherently safe because of the properties of its uranium-zirconium hydride fuel elements, which provide a prompt negative temperature coefficient. The effect is an automatic reduction of the power level whenever the temperature rises. As a consequence of this feature, the reactor is able to "pulse" for a split second to a power level as high as 1,200 megawatts–roughly equivalent to the level required to supply electricity to the entire District of Columbia. However, the reactor cannot sustain this power level for more than a few millionths of a second.

The power-producing core of the reactor resides in a tank almost 20 feet deep which is filled with demineralized water. Other shielding consists of high-density concrete, in some places as thick as 12 feet. Among the special features of the facility are two exposure rooms which are equipped with massive rolling concrete "plug" doors weighing more than 40 tons each. One of these rooms is lined with wood 1 foot thick to prevent the concrete from being activated.

Hydrogen on Saturn

Office of Naval Research contractor Dr. Guido Munch of Mount Wilson and Palomar observatories and Dr. Hyron Spinard of California Institute of Technology's Jet Propulsion Laboratory have obtained the first evidence that the atmosphere of Saturn contains molecular hydrogen, probably in large quantities. This evidence was discovered in the spectra of Saturn obtained by Dr. Munch. The two investigators conclude that the atmosphere of Saturn consists primarily of hydrogen and helium; previously, only traces of methane and ammonia had been detected on Saturn. Another determination made concerning Saturn is that very high winds, with velocities of hundreds of miles per hour, exist in the atmosphere of the planet. These winds may sweep the gases and particulate matter in the atmosphere into the three bands which are observed to parallel the planet's equator. The bands are estimated to be about 10 miles high. The studies were not involved in Dr. Munch's ONR contract.

–A. R. Laufer, ONR Regional Office, Pasadena

Bottle 1456, Where Were You?

A drift bottle, used for measuring surface currents, was returned to the Woods Hole Oceanographic Institution recently, 40 years after it was dropped into the Atlantic Ocean about 120 miles east of the entrance to Delaware Bay. The bottle–Number 1456–had been set out from the

U.S. Bureau of Fisheries vessel HALCYON on July 12, 1922, by Dr. Henry B. Bigelow, later named the first director of WHOI. Number 1456 was found on the beach at Oregon Inlet on Cape Hatteras, North Carolina, last February 20.

In order to obtain information about the release of the bottle, several old logs and record books had to be resurrected. This "leg work" was done by Dean F. Bumpus of WHOI. After much searching, he found the original notations, which revealed that the bottle had been dropped over the side of the HALCYON in the company of several other bottles. As the other "drifters" were recovered within three or four months, the chances are fairly good that Number 1456 lay buried in the shifting sands of the cape for all but a few months of the 40 years it had been missing.

A card in Number 1456 promised a reward for the return of the bottle. Although 25 cents was the amount promised, the going rate–50 cents–was paid to the finder–Mr. James I. Gray of Avon, North Carolina.

–Max C. McLean, ONR Scientific Liaison Officer, WHOI

Intercontinental Clock Synchronization by Telstar

The use of Telstar to send highly precise time signals between the United Kingdom and the United States was demonstrated during recent passes of the satellite over the Atlantic Ocean. The purpose of the transmissions was to determine if Telstar could be used to synchronize the master clocks of the Naval Observatory in Washington, D.C., and the Royal Greenwich Observatory at Herstmonceux.

Although this first use of a satellite to bring clocks on two continents into near perfect accord was experimental, it has indicated the capability which exists for keeping the clocks in synchronization through satellite time-checks at intervals–the accuracy of the measurement being 10 microseconds, or twelve millionths of a second.

The experiments were carried out at transmitting and receiving stations at Goonhilly Downs, England, and at Andover, Maine, by representatives of the National Physical Laboratory, Teddington, England, and the Naval Observatory in Washington. Further transmissions are planned to test equipment of improved accuracy and reliability. Subsequently, experiments will be made with the Centre National d'Etudes des Telecommunications in France.

Lightweight Deep-Water Core Sampler Developed

Undisturbed samples of hard ocean bottoms in deep water can now be obtained without employing large conventional drill rigs, owing to a new, relatively lightweight, pneumatic core sampler developed at the Naval Ordnance Laboratory, White Oak, Maryland. The 700-pound rig will be used to sample ocean bottoms of coral and sand where underwater ordnance is to be tested. Analysis of the undisturbed cores reveals the strength of the sampled areas for holding mine anchors which are explosively driven into the bottom.

During recent tests off Fort Lauderdale, Florida, a prototype of the new sampler successfully obtained a core of sand and coral 4 feet long by 3 inches in diameter in 90 feet of water.

The rig consists of a four-legged pyramidal frame about 8 feet high, a pneumatic hammer and associated air supply and exhaust hosing, 400 pounds of lead weight, an anvil, and a 4-foot long aluminum barrel with a driving head for cutting through coral. To obtain a sample, the assembly is lowered by cable from a ship until its legs touch bottom and place it squarely into position for drilling. Air under pressure is hosed from the ship to dirve the pneumatic hammer, the force of which is applied to the anvil, which in turn drives the aluminum barrel into the ocean bottom. Rebound of the barrel is prevented by the lead weight. After the entire rig has been raised to the surface, the bottom sample is removed from the aluminum barrel for analysis.

Design improvements being made on the rig are expected to extend the maximum operating depth as well as increase the length of the samples obtained.

Research Fleet is Expanding

The expanding research fleet of the United States has been joined this year by a number of new or converted ships. Among them are the five vessels described here, which will be put into service by prominent Navy or Navy-supported research groups.

The USS ROBERT D. CONRAD (AGOR-3), launched earlier this year, has been equipped in Jacksonville, Florida, for use by the Lamont Geological Observatory. A scientific shakedown of the 209-foot ship is planned for November, with Dr. Maurice Ewing of Lamont supervising the training of the new crew and overseeing the technical operations. The ship will sail to its home port in New York, then in January will embark on a second scientific cruise. Shortly thereafter the CONRAD will sail for the Indian Ocean to take part in the international expedition already underway in that region (Naval Research Reviews, August 1962).

The new ship was named for CAPT Robert Dexter Conrad, first head of the Planning Division, Office of Naval Research, and the chief architect of the Navy's basic research program.

A sister ship of the CONRAD, the USS CHARLES H. DAVIS (AGOR-5) was also launched this summer. She will be operated by the Military Sea Transportation Service, but will be under technical control of the Naval Oceanographic Office (formerly Navy Hydrographic Office). This office will use the ship to conduct studies of underwater acoustics and to collect meteorological data for the Navy Underwater Sound Laboratory. The DAVIS, which, like its sister ship CONRAD, is 209 feet in length, was named for two famous oceanographers–RADM Charles H. Davis, USN, and his son, RADM Charles H. Davis II, USN, both now deceased. Each of the two scientists served as superintendent of the Naval Observatory.

A third research ship put in service is the GOSNOLD, a 99-foot former Army cargo vessel built in 1941. She has been purchased by the Woods Hole Oceanographic Institution to replace the Institution's research ship BEAR. For the past 10 years the ship has been in storage in Miami. The GOSNOLD will be used primarily for cruising in local waters and along the continental shelf. Extensive modifications are being made on the ship this fall, after which she will be ready for service as a full-fledged research vessel. She displaces about 304 tons, has a 21-foot beam and a cruising range of about 2,500 miles.

The ship is named for Bartholomew Gosnold, the renowned English navigator and commander of the GODSPEED, which carried the first settlers to Virginia.

An eighth ship was added to the fleet of the Scripps Institution of Oceanography recently upon the christening of the ALEXANDER AGASSIZ. This 180-foot, 570-ton ex-Army cargo ship, the second largest at Scripps, is capable of operating in all oceans, but probably will be used chiefly in the North Pacific. She will be making numerous voyages to this part of the world because she will be at the disposal primarily of the University of California's Marine Life Research Program, which is undertaking investigations in the northeast Pacific. The studies will be related especially to fisheries problems.

The former cargo ship has been named in honor of the famous American naturalist of the 19th century.

Launched only last month was the R. V. ATLANTIS II, being built for the Woods Hole Oceanographic Institution. The ship was designed for all-weather oceanographic research from sub-artic to tropical waters. When completed she will incorporate many special features.

ATLANTIS II, which is 210 feet long, will carry a complement of 25 scientists and 28 officers and crewmen. The ship is equipped with an underwater observation chamber, a special bow-maneuvering device, anti-rolling tanks, a stern ramp, and a center well to permit protected oceanographic experiments in adverse weather. Included also will be four fully equipped scientific laboratories.

Current Research in Mathematics to be Reviewed

The Navy is bringing to Washington, D.C., some of the world's outstanding mathematical scholars for a series of open lectures on current progress in mathematical research. In sequence, at monthly intervals, these men will present 15 lectures, each concerning the specific field of interest of the lecturer. The first lecture was delivered earlier this month by Professor Paul R. Halmos of the University of Michigan; his subject was Hilbert space. The series is being arranged by George Washington University and sponsored by the Office of Naval Research.

The purpose of the lecture series is to provide rapid and efficient dissemination of information concerning the current status and principal directions of mathematical research. The Navy is engaging in the project because it considers such research a prime requisite for major advances in military technology. Therefore, the primary audiences will be scientists on the staffs of Navy laboratories and other naval activities in the Washington area. However, the lectures will be open also to non-Navy scholars interested in mathematical research.

In addition to Professor Halmos, mathematicians who have been scheduled to speak are Professor Samuel Eilenberg of Columbia University, who will lecture on the subject of algebraic topology; Dr. Alston Scott Householder, senior mathematician at Oak Ridge National Laboratory since 1946, who will discuss numerical analysis; Professor Irving Kaplansky of the University of Chicago, who will talk on Lie algebra; and Professor Richard Brauer of Harvard, whose subject will be algebraic group theory. Professor Laurent Schwartz of the University of Paris will also speak.

Research on Explosion Forming of Metal

In the past four or five years metal fabricaters have made increasing use of explosion techniques to form metal. Because only a female die is needed, plus a controllable explosive of some sort, the method is both rapid and economical. It is often the preferred way to accomplish the final forming of many metallic containers, thin-skin machine parts, and the like. A relatively large effort has been expended in this country and abroad in the development of explosive forming methods and in the metallographic examination of explosively loaded metal specimens. However, little has been published on the mechanical properties of the explosively formed sections.

A program of investigation was initiated by NRL metallurgists to provide this information. One of the advantages confirmed was the unusual characteristic of explosive forming that it apparently eliminates spring-back in the formed specimen. This signifies that such forming is accomplished without residual macrostresses in the work piece. Another finding was that the yield strength of the work piece can be increased by as much as 100 percent by the explosive forming process. Of particular significance was the discovery that material that has been thus greatly increased in strength still retains a satisfactory degree of ductility.

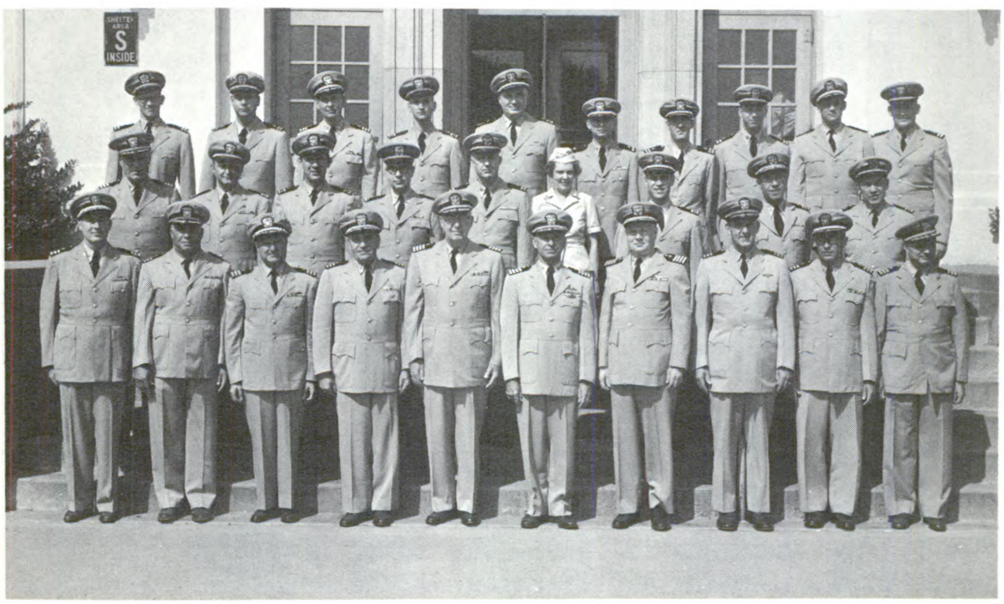
These new findings indicate that the explosive forming process may now have a wider application than was previously anticipated. As a sidelight a great deal has also been learned about the durability and re-usability of metal structures that have been subjected to uncontrolled explosions, such as near-miss bombs or accidental discharges.

On the Naval Research Reserve

Annual Seminar Held at NRL

The Tenth Annual Naval Research Reserve Seminar was conducted at the Naval Research Laboratory, Washington, D.C., from August 19 to September 2. Twenty-six Reserve officers on active duty for training were welcomed to the Laboratory by CAPT A. E. Krapf, the Director. He introduced the Chief of Naval Research, RADM L. D. Coates, who gave a brief review of current research being conducted by the Navy.

A luncheon sponsored by Naval Reserve Research Company 5-9, headquartered at NRL, was arranged for the opening day. CDR H. D. Cubbage, USNR, the Commanding Officer of NRRC 5-9, introduced the guest speaker, CAPT J. W. Jockusch, Special Assistant, Research Reserve, Office of Naval Research, who spoke about the present status of the Reserve and legislation affecting the Naval Reserve.



Participants in 10th Annual Naval Research Reserve Seminar

FIRST ROW:	SECOND ROW:	THIRD ROW:
CDR R. M. Hodges	CDR J. H. Hickey	LT W. A. Sanders
CDR F. D'Italia	LCDR E. F. Corcoran	LT J. D. Baker
CDR B. J. Jaskoski	LCDR B. G. Barr	CDR E. B. Freyfogle
CDR R. N. Jennings	LTJG D. W. Irvine	LCDR R. A. Levy
CAPT S. B. Sudduth	LT K. P. Jones	LCDR P. J. Boylan
CAPT A. E. Krapf	LCDR M. J. Binger	ENS C. E. Holland, Jr.
CAPT J. W. Jockusch	LCDR S. R. Oleinick	LT K. W. Lundstrom
CDR J. Hartlein, Jr.	CDR W. C. Hodgson	LT R. W. Kenney
CDR S. N. Hall	LCDR E. J. I. Paulson	CDR M. J. Roebuck
CDR R. T. Messer		LT H. D. Thompson

The remainder of the two-week period was filled with visits to each of the scientific divisions at NRL. The officers heard talks on such current subjects as microelectronics, lasers, plasma physics, thermonuclear research, new radar techniques, and many other technological developments. Tours were conducted through the Hot Cell facility, the 5 Mv Van de Graaff, and the NRL Reactor facility. In addition, the Engineering Services Division presented a review of the services it renders. One day was spent at NRL's field station, Chesapeake Bay Annex, 40 miles below Washington on the Chesapeake Bay. A side trip to the Bureau of Naval Personnel afforded the reservists a chance to review their service records.

New ONR Reserve Assistants

◀CDR Adami

CDR Hughes▶

● CDR W. S. ADAMI, USN–CDR Adami reported to the Office of Naval Research Branch Office, Boston, for duty as executive officer and assistant for Research Reserve on August 2. Prior to reporting to Boston, CDR Adami, completed a tour of duty as operations officer at the Naval Auxiliary Air Station, Kingsville, Texas.

A native of Indiana, Pennsylvania, CDR Adami attended Indiana State College, where he majored in general science. He enlisted in the Navy in March 1941, and was appointed an Aviation Cadet in May of that year. He received his wings and was commissioned an ensign in December 1941.

Noteworthy in CDR Adami's career is the fact that during the war he served in Scouting Squadron 72 aboard the USS WASP (CV-7), being a survivor in the sinking off Guadalcanal in September 1942. For a brief interval, he served also aboard the USS HORNET (CV-3). In 1943-44 he was in the USS BUNKER HILL (CV-16) in Bombing Squadron 17.

CDR Adami has been an operational flight instructor, an aircraft carrier and task force CIC officer, a staff member of Commander Operational Development Force, officer-in-charge of two aircraft training squadrons, commanding officer of a fleet aircraft service squadron, air operations and operations officer of an aircraft carrier, and the operations officer of an all-jet air station.

Of special interest to the Research Reserve are the naval development and evaluation problems and projects with which CDR Adami has been actively associated. In 1948 he was shipboard project officer for carrier controlled approach (CCA) trials, assisting in establishing criteria for CCA systems organization and equipment. From 1951 through 1953 he worked in evaluating Mark X SIF, SPS-6 series radars, a submarine air surveillance radar, helicopter dipping sonar search pattern control, an airship air surveillance radar, an electronic data display system, an airborne early warning system against low flying aircraft, and many other projects.

● CDR ORVAL D. HUGHES, USNR–CDR Hughes reported to the Office of Naval Research Branch Office, Chicago, on September 14 for duty as Research Reserve program officer. CDR Hughes will be assisted by ENS Eugene F. Bartell, USNR, who reported for duty as assistant program officer in June 1962.

CDR Hughes received his B.A. degree in mathematics at Colgate University in 1942. Upon graduation he entered the Navy through the V-7 program, remaining on active duty until February 1946. His World War II experience was aboard destroyers.

Upon release from active duty, CDR Hughes attended Syracuse University earning his M.S. degree in 1947. From September 1947 until June 1951, he taught secondary-school mathematics and science in upstate New York. During these years CDR Hughes participated in the organized Reserve program.

In August 1951 CDR Hughes returned to active duty and was assigned to the Field Command, Armed Forces Special Weapons Project, Sandia Base, Albuquerque, New Mexico. In 1953 and 1954, CDR Hughes served as the officer-in-charge of the Nuclear Training Branch at Sandia.

Sea duty was his next assignment. From 1955 to 1957 he served aboard the USS LOS ANGELES (CA-135) and the USS HIGBEE (DDR-806). In the USS HIGBEE he served as executive officer and navigator.

In September 1957, he reported as Executive Officer, NROTC Unit, Purdue University. Prior to reporting to the ONR Branch Office, CDR Hughes served as operations officer in the USS VALLEY FORGE (LPH-8).

Oak Ridge Seminar Cancelled

The Nuclear Sciences Seminar scheduled to be held at Oak Ridge, Tennessee, on November 25 has been cancelled this year because of the relatively short period of time that has elapsed since the last seminar was held. This short interval exists because, as research reservists will remember, last year's seminar was postponed due to the limitation of training-duty funds. When funds for that seminar became available, the meeting was rescheduled and successfully held from June 3-16, 1962, with a record attendance of 95 officers. It is considered that the time interval between June and the scheduled seminar in November is too short for the presentation of a similar seminar. Therefore, although this popular meeting is cancelled for the current fiscal year, it is anticipated that it will again be scheduled for fiscal year 1964.

Convening Dates Tentatively Set for Selection Boards

Fiscal 1963 selection boards appointed to choose inactive Naval Reserve officers for promotion are tentatively scheduled to convene as follows:

PROMOTION TO	CONVENING DATE (1963)
Flag Rank	January 3
Captain (line)	January 8
Commander (line)	January 15
Captain and Commander (staff)	February 26
Lieutenant Commander (line)	March 5
Lieutenant (line)	April 9
Lieutenant Commander and Lieutenant (staff)	April 23

A forthcoming issue of The Naval Reservist will denote the register number of the Junior officer in each grade eligible for consideration.

Research Reserve Statistics

The following figures were compiled from data submitted in the annual reports forwarded by Research Reserve Companies for fiscal year 1962:

Companies	116
Members	2,543
Ready Reserves (percent)	80
Standby Reserves (percent)	20
Attendance at drill meetings (median percent)	88
Earned satisfactory Federal year	2,164
Selected for promotion	146
Promoted	131
Received active duty for training	1,065
Captains	89
Commanders	319
Lieutenant Commanders	358
Lieutenants	250
Lieutenants (JG) and below	49
Completed correspondence courses	1,550

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Deep-Diving Miniature Research Sub to be Built

The Woods Hole Oceanographic Institution has contracted with General Mills, Inc., for the design and construction of a unique 10-ton two-man submarine, which can be carried aboard and operated from Navy oceanographic research ships. The 20-foot craft, tentatively dubbed "Alvin," will have a maximum speed of six knots, an endurance of 24 hours, and a maximum range of 30 miles. Primarily, it will provide a simple, reliable, and inexpensive means for exploring ocean bottoms at depths of more than a mile. Upon being put in service in the summer of 1963, "Alvin" will be operated by Woods Hole as part of a research program supported by the Office of Naval Research. (An artist's conception of the sub appears on the front cover.)

The two men and 1,200 pounds of scientific instrumentation which "Alvin" will be able to carry will be contained in a spherical cabin, or pressure hull, fabricated of a special high-strength steel not previously used for undersea vehicles. Surrounding the sphere will be a free-flooding cylindrical outside skin and a 5-foot conning tower made of reinforced fiberglas.

The sub's spherical steel pressure hull will be similar to the highly successful hull of the Navy's bathyscaph TRIESTE, designed and built by the late August Piccard. In the General Mills design, the sphere has an outside diameter of 6 feet 10 inches, which is about the same as the outside diameter of the bathyscaph sphere; however, the latter is suspended from a 50-foot buoyancy hull. The walls of the sphere of the new vehicle will be 1-1/4 inches thick, as compared with 4 to 7 inches for the bathyscaph. The TRIESTE can descend to 36,000 feet, but is capable of only limited horizontal movement.

Propulsion will be furnished by the lead-acid storage batteries and electric motors which will drive three fixed-pitch shrouded propellers. A 15-horsepower motor aft provides main propulsion, and two 7-1/2 horsepower motors forward provide vertical control. Steel shot to be used for ballast will be held in hoppers by magnetic means so that if the sub's power fails it will be released, causing the vehicle to rise. Two mercury trim tanks, which are droppable, are also included in the design.

One of the chief objects of study to be undertaken with "Alvin" will be the continental shelf along the eastern seaboard of the United States. Another may well concern the acoustic characteristics of the sea–the vehicle serving as a quiet, deep-riding, mobile station for this work. In addition, several physical oceanographic investigations are being considered–for example, of currents, turbulence, internal waves, and variations in temperature and salinity. The sub may also be used to determine the natural resources of the eastern fishing banks.

CORRECTION: "Certificate of Retirement to be Issued," Naval Research Reviews, September 1962: Certificates of Retirement (DD363N) will be issued automatically to officers and enlisted personnel who retire permanently with pay. No request is required. The only persons who need to request the certificates are those who have already permanently retired with pay.

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Subscription price: $1.50 per year in U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D.C. The issuance of this publication approved by the Secretary of the Navy on 1 March 1961.

Artist's concept of two-man research sub to be used for ONR investigations at ocean depths as great as 6,000 feet. See article on inside back cover.

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