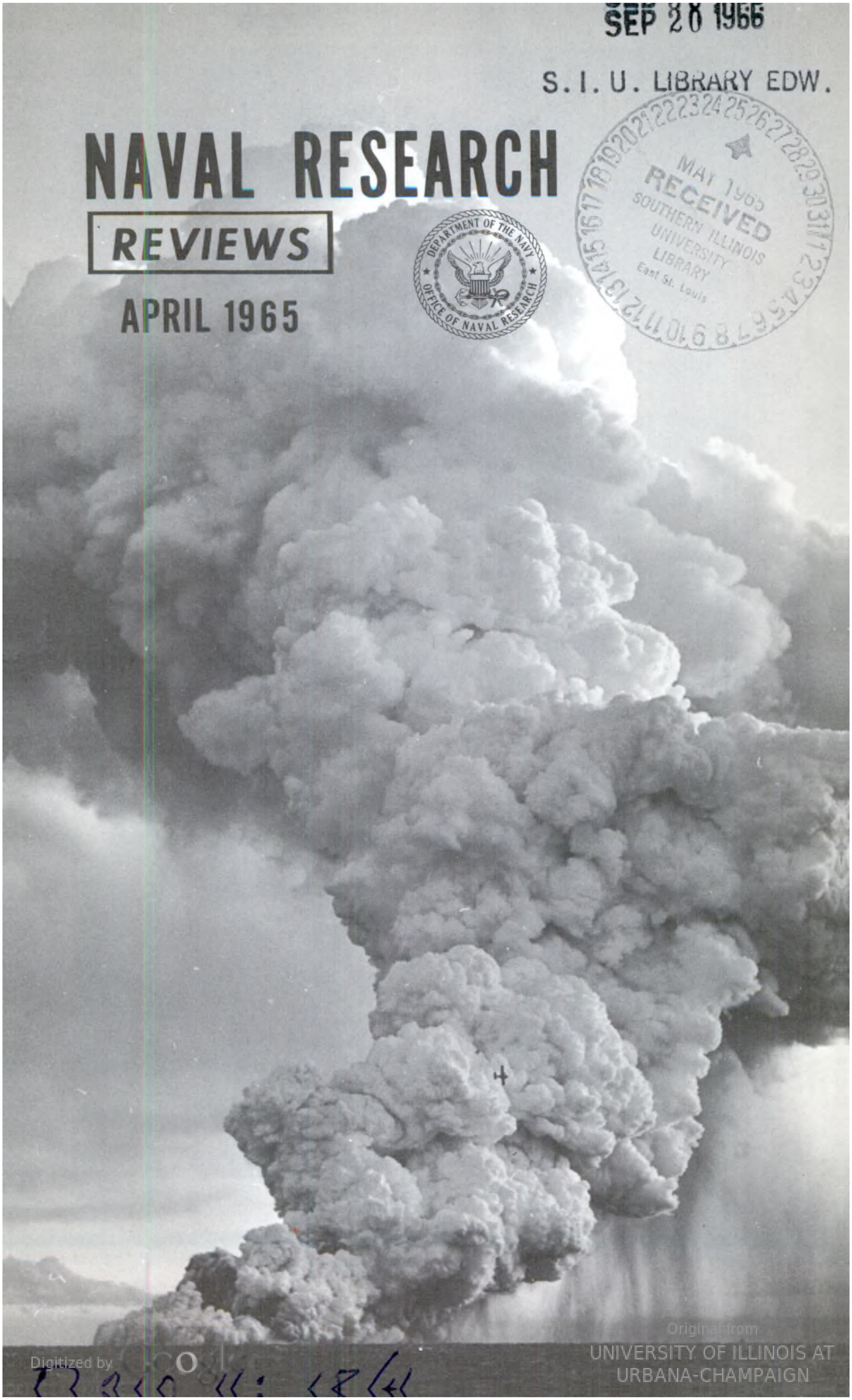
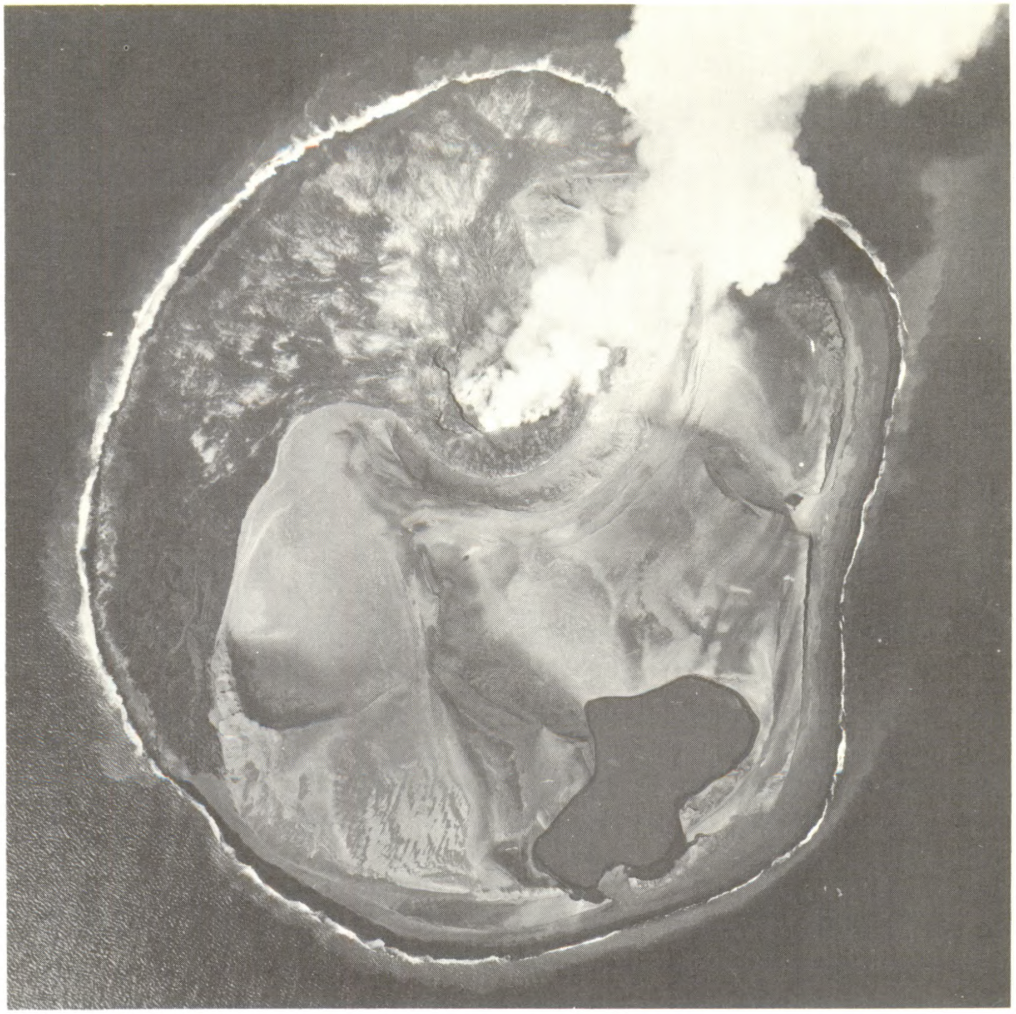
NAVAL RESEARCH REVIEWS

APRIL 1965

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH



Photograph by Timmin.



Many individuals and groups are contributing to the investigation of Surtsey. Prominent among them is the U.S. Navy, which early in the history of the island recognized the uniqueness of the emergence and the opportunities that were afforded to gain an understanding of the meteorological and biological activity associated with it. In accordance with this interest, the Geophysics Branch of the Office of Naval Research, the Naval Research Laboratory, and A. D. Little and Co., Inc. (an ONR contractor), dispatched investigators to the scene only a few months after the volcanic activity began in order to observe the electrical phenomena, waterspouts, and tornadoes generated by the eruption. Through ONR's Biology Branch, support was given to Duke University to study the ecological succession on the island (in other words, ONR and Duke were interested in learning what forms of life established themselves first, second, third, and so on, and they wanted to determine the effects of the residence of one form upon that of another.

The following article, which is reprinted with permission from GEO-MARINE TECHNOLOGY, *Vol. 1, No. 3, concerns the island's formation and the interest that has been taken in it by the scientific communities of several nations.*

Surtsey

World's Youngest Island

CAPT Paul S. Bauer, USNR (Ret.)
Adjunct Professor, Earth Sciences, American University
Member, Surtsey Research Committee

At left is the youngest island in the world—less than a year and a half old. Eighteen months ago, the sea floor from which it rose was 136 meters deep. Then, on the early morning of November 14, 1963, at longitude 20°36.5′ west, latitude 63°18′ north, sulfurous fumes spread over the sea; the water warmed to 11°C (compared to a norm of 7°-to-8°C); and the waters became disturbed. The Icelandic fishing vessel Iseifur II, close by, reported later that it was as though she had been caught in a whirlpool and that she began to roll more than the sea state warranted. And smoke began to billow from the water. Seismographs ashore on nearby Iceland registered no unusual activity in the area. Nevertheless, this was a volcano rising from the sea, the birth of Surtsey—after the Icelandic god of the volcanoes, Surter.

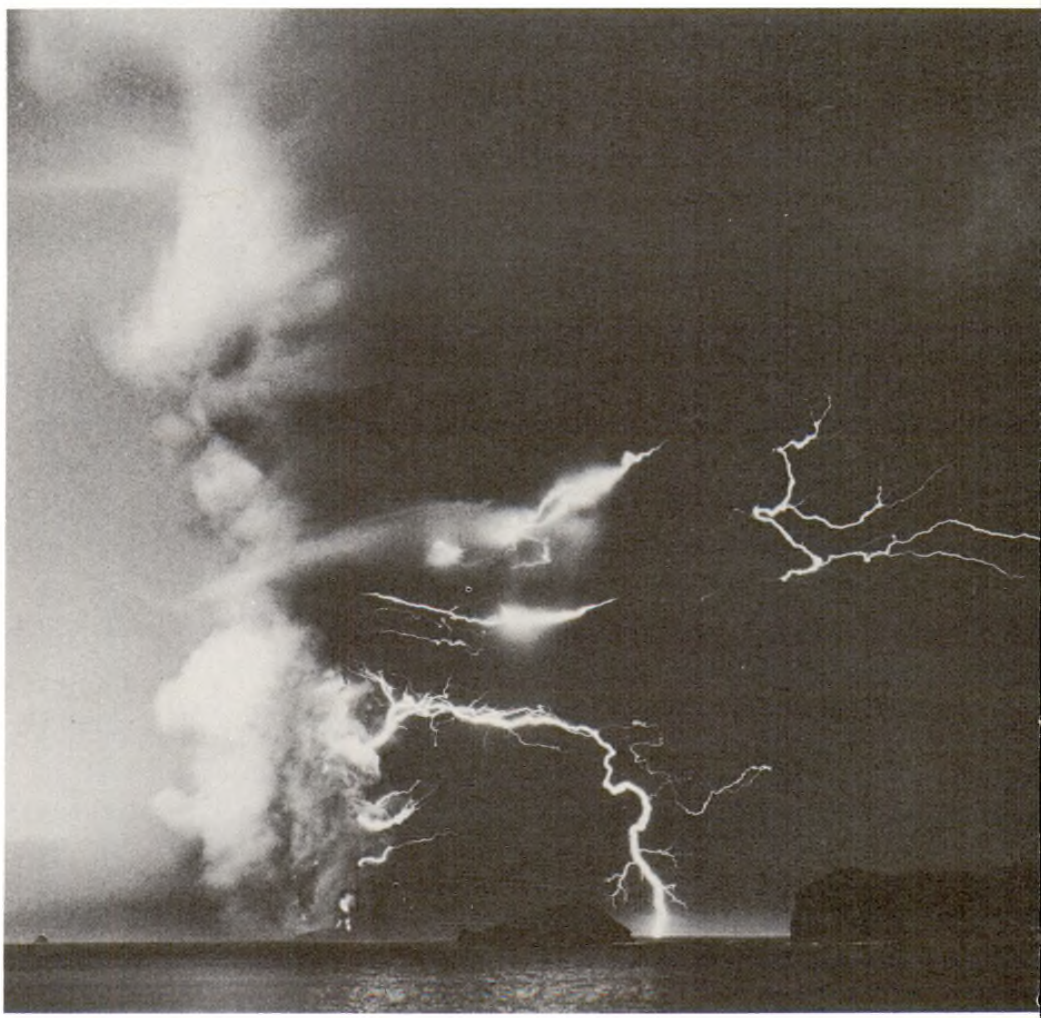
Surtsey Grew Rapidly

The cover picture shows this event later in the day. By three o'clock in the afternoon the action of the sea around the cloud base made it obvious that solid land had pushed very close to the surface. Scientists estimated the eruption fissure to be 500 meters in length. By the next day, Surtsey was 10 meters high; by the 16th, 40 m. high and 550 m. in length; and by the 17th, 60 m. high and 600 m. long. Today, under the still-continuing force of build up and tear down, Surtsey is nearly circular in shape, with its broadest diameter exceeding 1,700 m. The highest permanent structure is a cone and lava lake at 122 m. Towering above this to over 170 m. is a tephra hill, which the wind and rain work to tear down.

If Surtsey's early growth was rapid, it was also violent. Activity in this period was typical of undersea volcanoes. Water either overflowed into its vent or seeped through its scoria walls, producing closely-spaced but intermittant explosions. If these occurred deep within the vent, columns of steam and tephra were hurled straight up—sometimes as high as 500 m. When they occurred close to the vent's broader lip, lava bombs led tephra tails in great arcing fans over the island and up to one km. out to sea. When the sea didn't penetrate, Surtsey roared almost continuously, sending columns of tephra as much as two km. high.

With relatively few lulls, Surtsey's explosive activity continued for the better part of four-and-a-half months. Then, on April 4 Surtsey started an effusive eruption, causing the vent to fill with lava—a glowing lake 120 m. across—which overflowed the rim. If the early phase was the age of grandeur, this was the age of beauty, for Surtsey now put on an ever-changing display of glowing fountains, columns, rivers, rivulets, and fiery deltas—and the inevitable columns of steam as the hot lava hit the sea. This would provide Surtsey with the hard outer shell needed to protect it while it consolidated its "place in the sun," for tephra—before it becomes tuff—is light, almost fluffy, and fine, like sand. If Surtsey had not managed to protect itself with lava—which now covers half its surface and extends protecting arms around 280° of its perimeter—wind and wave would soon have destroyed it.

The tremendous amount of thermal energy poured into the volcanic clouds during Surtsey's explosive phase generated fantastic lightning displays. Photograph by S. Jonasson.



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Test Tube Version Of Birth of Land

But, Surtsey is more than a spectacular display and an entry into the periodical notices to mariners. In its way, it is a test tube version of the origin of land on our planet. When Surtsey rose from the ocean floor it boiled the sea around it, and, as very young land, it, too, in the beginning was sterile. It provides science with a unique opportunity to study at first hand everything from oceanic volcanology, the composition of the earth's inner structure, and the beach mechanisms of new, consolidated land, to the migration and establishment of life on the island, the effect on life in the nearby sea, and the meteorological phenomena associated with tornadoes.

Few really authoritative technical papers have yet been published on Surtsey, but a number of phenomena and parameters have been measured and/or estimated, and a comprehensive research program has been developed. It is the beginning of a program that could extend for many years and from which we should learn much. Sigurdur Thorarinsson, writing in the beautifully illustrated book, "Surtsey—A New Island in the North Atlantic," estimates that during the first few months of activity Surtsey poured heat into the atmosphere at a rate of about 10^{18} ergs per second—equivalent to burning 80,000 barrels of petroleum an hour. He also figures the production of tephra in the first four-and-a-half months at 400 to 500 million cubic m.—an average of 40 cubic m. per second. Icelandic physicist T. Sigurgeirsson measured the lava temperature as high as 1,130°C. Both the lava and the tephra have been analyzed as olivine basalt.

Lava Produces High Electrical Field Charge

Where the lava reached the sea, explosions frequently occurred, and dense steam clouds billowed up. Icelandic scientist Sveinbjorn Bjornsson calculated the charge density in the steam clouds at the lava-sea contact at 10,000,000 elementary positive charges per cubic centimeter—about 100,000 times the atmosphere's normal space charge. This may, in part, explain the strong electrical disturbances and spectacular lightning displays associated with Surtsey's early days. For several hundred meters out to sea (to depths of 50 to 100 centimeters) surface water beyond these points of collision between lava and ocean were at a considerably higher-than-normal temperature. Contrary to early fears, Surtsey and its sometimes violent activity didn't appear to disturb the local fish population—one of the world's densest.

Tornadoes or water spouts under the tephra cloud were a common occurrance—as were hail stones—during Surtsey's explosive phase.

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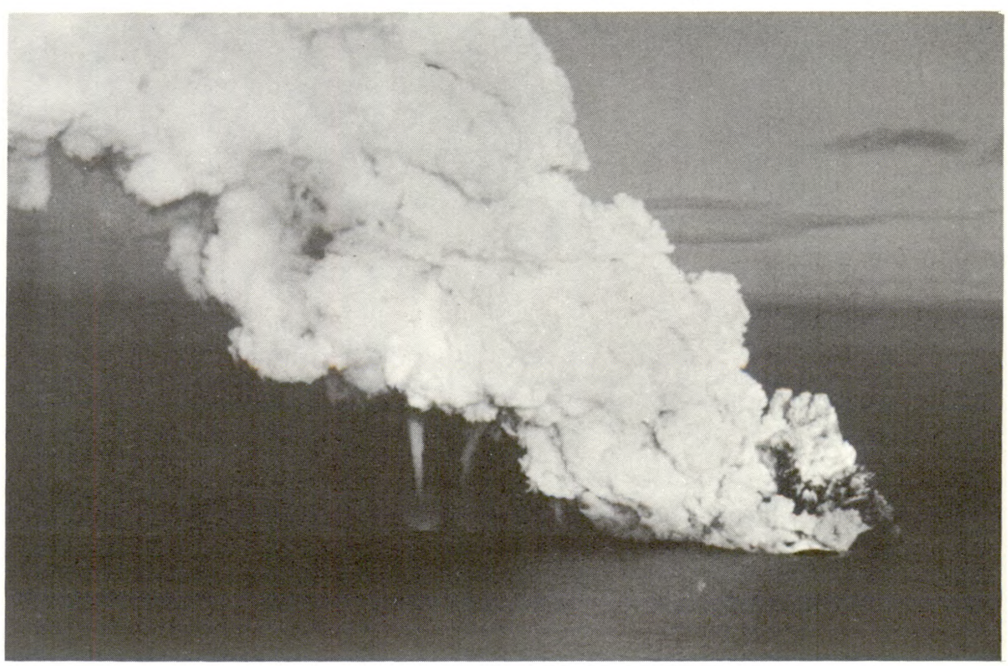
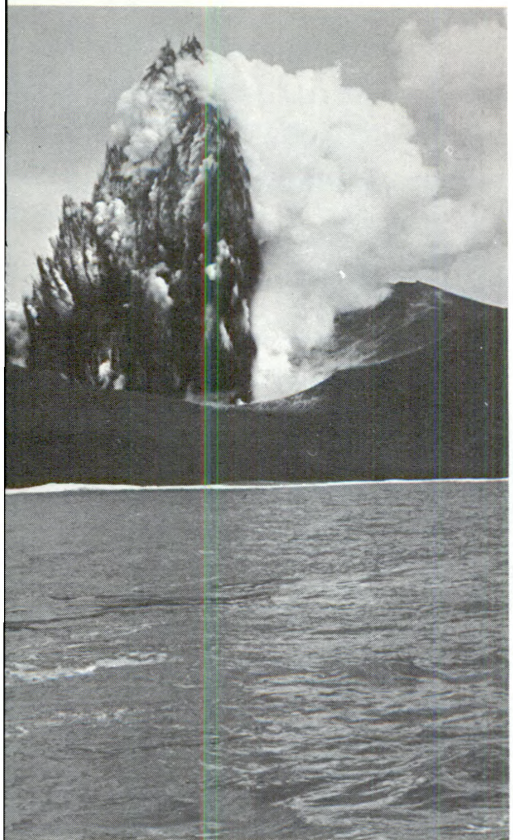
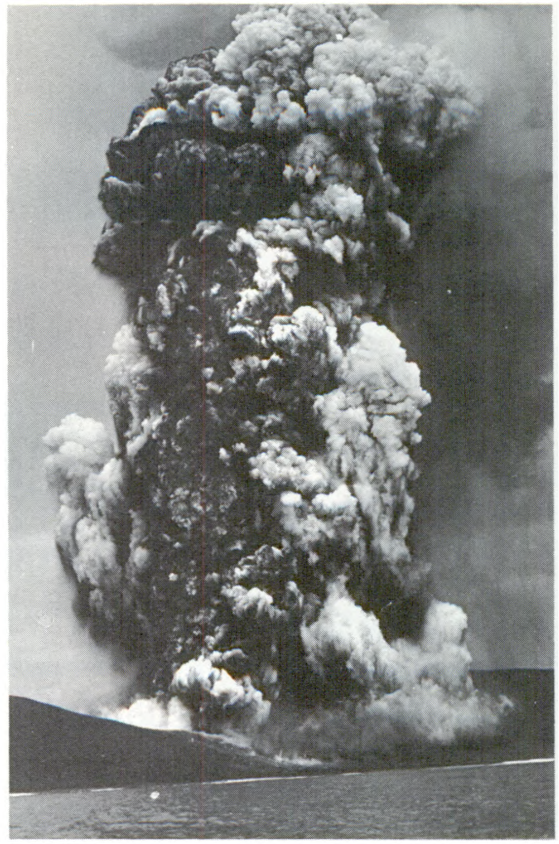
The series of four pictures presented above was taken within a period of 30 seconds. It show
Surtsey during its explosive phase, when material was hurled violently into the atmosphe

The large amount of thermal energy poured into the volcanic cloud caused the formation of many waterspouts.







an average of once every half minute. otographs by Timmin.

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ouds of steam rise above Surtsey's shore as a pours into the sea. Photograph by Timmin.

rtsey's lava lake as it appeared in August 1964. Photograph by Timmin.

In broad terms, these result from Surtsey's high energy release rate. Thorarinsson and Bernard Vonnegut (the latter is an ONR contractor with Arthur D. Little, Inc.) estimate the wind speed in some of these vortices to be on the order of 90 m. per second.* Another phenomenon of note: None of Surtsey's volcanic activity has been picked up by Icelandic seismographs. This location, incidentally, is at the intersection of the Red Sea Tectonic Arc and the Mid-Atlantic Ridge.

Life On Surtsey

Life came to Surtsey early—if not to stay, at least for brief visits between eruptions. Seagulls were seen on the island when it was only two weeks old. Subsequently, quite a variety of birds have been seen along with seals, flies, and butterflies. In addition, various bacteria have been found, along with the seeds of a number of coastal plants. As of December 1964, however, except for bacteria, nothing was known to have taken up permanent residence.

Surtsey Research Program

In the fall of 1964, the Surtsey Research Committee, under the chairmanship of Steingrimur Hermannsson (National Research Council, Reykjavik), agreed on a comprehensive and orderly program of study of the island, the atmosphere above it, and the sea around it. By and large, those now conducting Surtsey research welcome the cooperative participation of others. Iceland's scientific research budget does not permit "American-style" funding, and there is a need for certain types of gear. A program outline follows.

Topography and Geological Mapping: 1. Map of Surtsey. 2. Map of bottom of sea around Surtsey. 3. Map of the spreading of ash and pumice.

The following to be done every two weeks in summer; once a month in winter:

Chemical & Physical Oceanography: (a) Temperature and other hydrographic measurements; (b) collection of samples for chemical studies of dissolved material from ash and lava; and (c) special studies of trace elements dissolved in the sea from flowing lava (in collaboration with NIO, U.K.).

*S. Thorarinsson & B. Vonnegut. Whirlwinds Produced by the Eruption of Surtsey Volcano. *Bulletin of the American Meteorological Society,* Vol. 45, No. 8, August 1964.

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Marine Biological Research: (a) Coastline studies; (b) bottom samples; (c) plankton samples for larvae of bottom animals.

Terrestrial Biological Research: (a) Fauna: (1) systematical search for terrestrial invertebrates, their collection and identification, and the evaluation of their means of arrival; (2) colonization by birds and their role in facilitating transport of invertebrates to the island; (3) utilization of island by seals. (b) Flora: vascular plants, mosses, fungi, lichens, algae, bacteria; dispersal of plants to the island, their ecology and biology.

Geochemistry: (a) Collection of steam and gases for chemical and isotopic analysis and radioactivity measurements; (b) chemical reactions between ash and sea, tuff formation.

Geological studies: (a) Erosion and sedimentation caused by the sea (surf, reefs, ridges, surf cliffs, etc.); (b) erosion and sedimentation (caused by running water, avalanches, etc.); (c) collection of xenoliths in volcanic products; (d) structural geology.

Geophysical research: (a) Physical characteristics of the magma, including temperature, viscosity, vesicularity, electrical conductivity, and seismicwave velocity; (b) studies of upper crustal structure in vicinity of Surtsey by seismic refraction at sea (equipment needed); (c) study and recording of earthquakes and tremors in Surtsey (portable seismograph needed); (d) gravity measurements; (e) magnetic measurements, such as of changes in geomagnetic field which may occur when magma solidifies, measurements at crater, on lava, and on ash deposit; (f) atmospheric electricity.

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20th Anniversary of Underwater Sound Reference Laboratory

The 20th anniversary of the Underwater Sound Reference Laboratory, Orlando, Florida, as a Navy laboratory was observed on March 1, 1965, by the presentation of 20-year-service certificates to four persons who have been employees of the laboratory for the entire period—O. M. Owsley, who left the Sound Division of the Naval Research Laboratory to become head of the USRL on March 1, 1945; Miss Helen Gordy, secretary to the Director; Mrs. Eva Raybun, physicist in the Acoustics Calibration Division; and R. J. Keiser, Head of the Engineering Branch, Transducer Division.

The USRL has been in existence since May 1, 1941, when it was established by the Bell Telephone Laboratories for the National Defense Research Committee. Columbia University's Division of War Research operated it from May 1, 1942, to March 1, 1945, at which time it became a field station of the Naval Research Laboratory. It came under the management control of the Office of Naval Research on October 6, 1946.

Inertial Guidance Sensors

CDR M. Gussow, USN
Air Programs
Office of Naval Research

The purpose of a Navy missile system is to deliver a warhead to a predetermined point at a given time. Ideally, the missile system should be highly reliable, simple in operation, capable of firing rapidly, and be reasonably priced. To achieve these ends, the simplest guidance techniques consistent with the required accuracy of delivery must be used. The guidance system may include, singly or in combination, radio, radar, infrared, electro-optical, or inertial techniques. This article concerns investigations of inertial guidance, particularly of inertial sensors, conducted by Air Programs, Office of Naval Research, for applications in Naval tactical missiles.

Inertial guidance is a self-contained technique for measuring the movements of a vehicle between its starting point and its positions in space by sensing changes in acceleration. These measurements are used to maneuver the vehicle to its destination. An inertial system looks at no lighthouses, gazes at no stars, relies on no earthly or celestial aids, refers to no compass, listens to no radio signals, and senses no radar pulses; hence it cannot be misled or jammed by an enemy. It also functions independently of weather and visibility.

The first known application of an inertial guidance system was made in the German V-2 rocket during World War II. Outstanding U.S. pioneering work in this field was done by the Massachusetts Institute of Technology's Instrumentation Laboratory under Dr. C. S. Draper. The early theoretical and design work of this laboratory led to the development of two inertial guidance systems that are operational currently in the Navy: that of the Polaris ballistic missile and the Ships Inertial Navigation System (SINS). In the past decade, the problem of achieving satisfactory performance has been predominant, while that of cost has been secondary. Now that excellent accuracy is being obtained, low cost consistent with high reliability is the Navy's paramount interest. When low-cost equipment becomes available, inertial techniques will be used in short-range tactical missiles.

Inertial Guidance Concept

Inertial guidance seeks to answer two simple questions: (1) Where am I, and (2) which way am I going? The basic system components are accelerometers, gyroscopes, and integrators.

Accelerometers and gyroscopes are the basic sensing elements in all inertial guidance systems. An inertial sensor is one whose basic intelligence is provided by the inertial properties of mass. Linear motion is detected by the accelerometers, angular motion by the gyroscopes. Accelerometers operate on the principle that the acceleration of a mass is proportional to the applied force. Gyroscopes operate on the principle that a spinning-mass system will maintain a fixed position in inertial space in the absence of any external forces. When a force is applied, the gyro spin axis will precess, and the angle of precession will be a measure of the force.

Integrators perform the mathematical operation of integrating twice the accelerometer output to compute the distance the vehicle travels. Since this computation provides a measure of change in distance, the initial velocity and initial position must be inserted to determine the final position (Where am I?) and heading (Which way am I going?) accurately.

Figure 1 illustrates how a simple inertial guidance system works. Three accelerometers can measure acceleration in three directions that are perpendicular to each other, such as north-south (x), east-west (y), and vertical (z). To do so accurately, the sensitive axis of each accelerometer (x,y, or z) must remain parallel to the direction of measure-

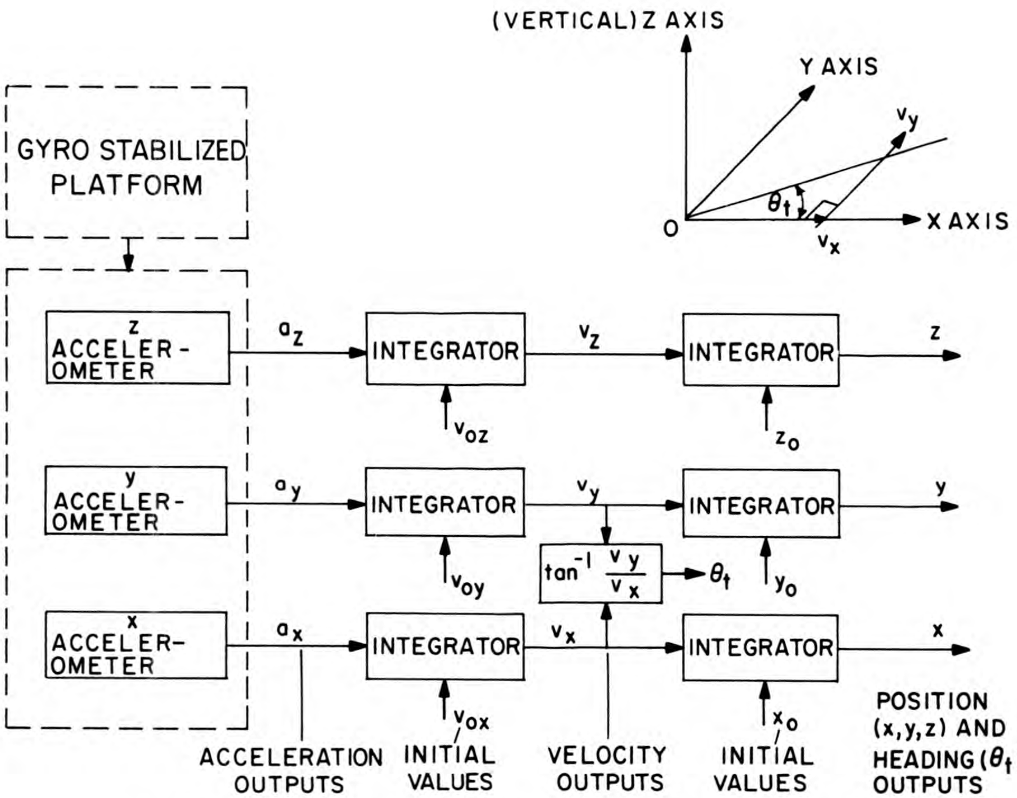

Figure 1 – Block diagram of a simple inertial guidance system that provides position and heading outputs.

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ment. To maintain this parallelism, a three-axis gyro-stabilized platform is attached to the vehicle through a gimbal system, which permits the platform to take any orientation with respect to the vehicle. Three gyros are mounted on the platform, with their input, or sensitive, axes oriented in the x,y, and z directions. If the vehicle rotates about any of its three axes, the platform also rotates. The gyros sense this rotation rate and provide an electrical signal proportional to it. This signal is amplified and used to drive a platform servo, which causes the platform to rotate an equal amount in the opposite direction, thus keeping the platform space-stabilized. In this way, the orientation of the platform is preserved independently of the vehicle's rotation. See Figure 2.

The accuracy of each sensor depends to a large extent on the refinement of its construction. This refinement involves primarily the development of low-friction supports or suspensions of the inertial mass. A large area of research is devoted to the development of mass-suspension schemes which have the potential of providing satisfactory performance and reliability at *low* cost.

Three inertial sensors under investigation by Air Programs, Office of Naval Research, will be discussed: (1) a dynamic film accelerometer,

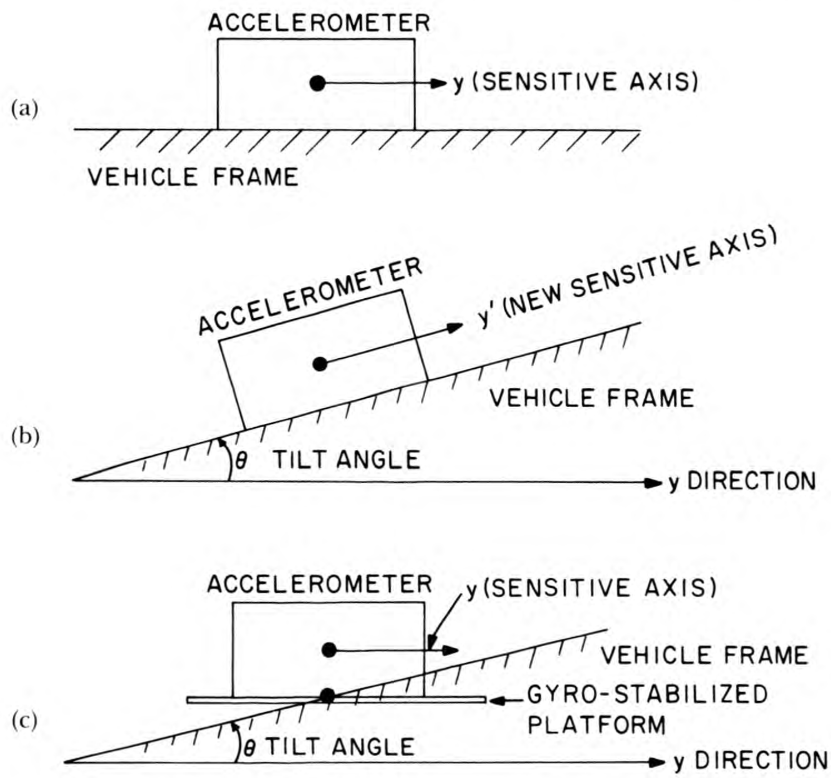


Figure 2 – The effect of tilt angle on accelerometer outputs. (a) Vehicle acceleration in y direction produces output along y axis. (b) When vehicle is tilted by an angle θ, acceleration in y′ direction produces a false output along y direction. (c) A gyro-stabilized platform in the vehicle isolates the vehicle tilt angle from the accelerometer so that the sensitive axis remains in the same y direction.

(2) a bouncing ball type accelerometer, and (3) a dynamically tuned free rotor gyro. The Bureau of Naval Weapons is participating in these projects.

Dynamic Film Accelerometer

In order to improve the performance and ruggedness of certain accelerometers while at the same time lowering production costs, research is now being directed to a unique film suspension for these accelerometers. The main components of the suspension system are a gas (ambient dry air at one atmosphere pressure) and a piezoelectric ceramic tube. The gas, which surrounds the accelerometer proper, is caused to vibrate at a high frequency as the result of the minute oscillatory motion of the piezoelectric tube. This action, called "squeeze film" action, has been found to be sufficient to generate a firm, noncontracting air cushion. Although this concept has been known in general for a number of years, it has not yet been reduced to practice in accelerometers.

The accelerometer on which this film suspension is being tried out detects accelerations by means of vibrating strings; hence it is called the "Vibrating String Accelerometer (VSA)." It was selected for this application by Instrument Division, Lear-Siegler, Inc., primarily because it provides a digital output, which is advantageous in digital computing systems because of its accuracy and the fact that a conversion is not required.

Figure 3 shows a schematic of a VSA supported by a dynamic gas film. At rest, the inertial mass is centered so that the tension in each string is equal, resulting in equal frequency for each string and, therefore, no acceleration measurement. If the inertial mass is accelerated along the string axis, the frequency of one string increases, while that of the other string decreases—the frequency difference being proportional to the

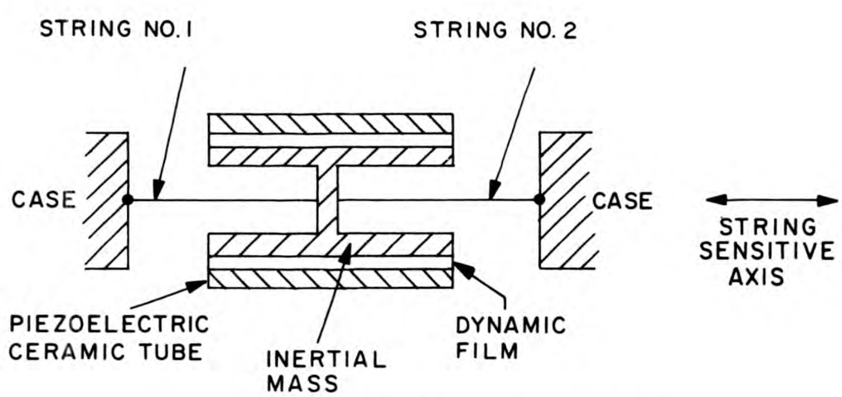


Figure 3 — Simplified representation of the vibrating string accelerometer.

acceleration. By converting the string oscillations to voltages of the same frequency and feeding these voltages to a frequency-difference counter, a determination can be made of the acceleration. In the VSA, each cycle of frequency difference represents an incremental velocity change of 0.4 feet per second.

Beryllium ribbon tape appears to be a satisfactory material for the vibrating string because it produces high frequencies with reasonable string length and combines high tensile strength with low mass per unit length.

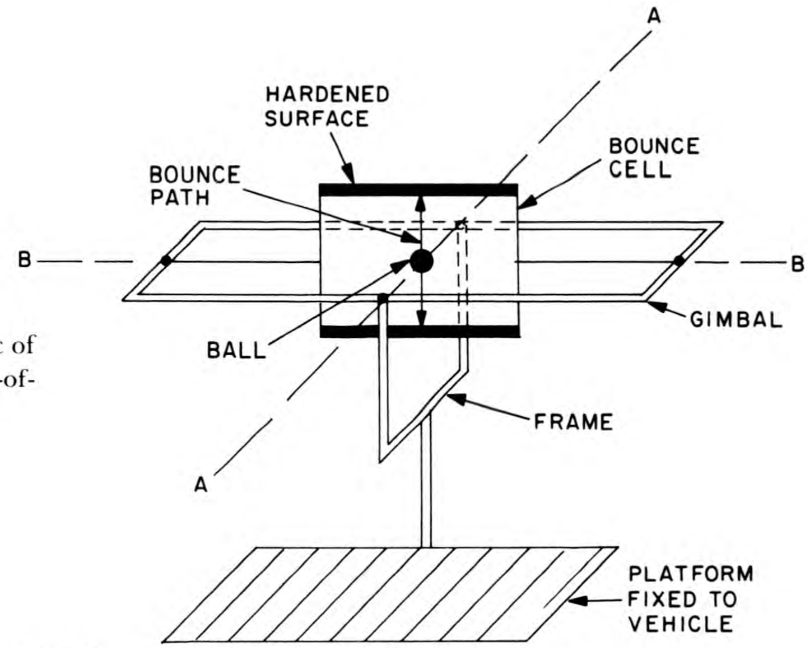
The problem to which ONR has directed its attention is that of restraining the mass against acceleration forces acting normal to the string axis. Such forces cause unwanted disturbances of the inertial mass and set up high stresses in the mass supports. As a consequence of these stresses, measurements may be in error and supports may be broken or weakened. The dynamic film support method overcomes these limitations by providing stiffer support and higher natural frequencies. The higher frequencies are desirable because they render the mass insensitive to common low-frequency disturbances.

The piezoelectric ceramic tube is energized by a solid-state oscillator which squeezes the supporting film between the tube and the mass. A suspension of film in the order of 150 millionths of an inch thickness is sufficient to support the mass against 30 g's of cross-axis acceleration forces. The tube vibrates radially at a frequency of about 68,000 cycles per second.

Bouncing Ball Type Accelerometer

The bouncing ball type accelerometer is a completely new concept for inertial guidance. It has the potential of sensing accelerations by measuring the deviations of a linearly moving mass from its prescribed path. Some basic components are shown schematically in Figure 4. The inertial mass—a ball—bounces in a cell between hardened parallel surfaces when the cell is vibrated. The vibrations are induced by a piezoelectric ceramic driver energized by an oscillator circuit. The bounce cell and driver are mounted in a frame suspended in a gimbal assembly. The frame may be rotated with respect to a reference platform fixed in a space vehicle.

Acceleration is measured in terms of the motion of the ball relative to the reference platform. Figure 5a shows the "at-rest" position of the bounce cell; in other words, when there is no acceleration the bounce path is at right angles to the bounce cell surfaces. Figure 5b shows the tilt of the bounce cell under acceleration forces to the right. The bounce path now makes an angle with respect to the right-angle path, the angle being a measure of the acceleration.



igure 4 – Schematic of ouncing ball two-degree-of-reedom accelerometer.

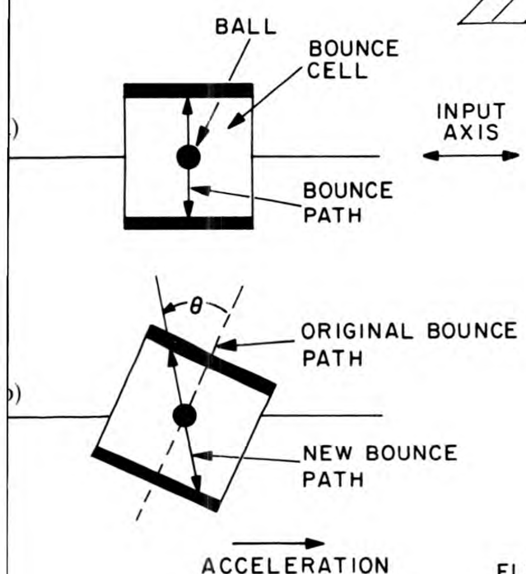
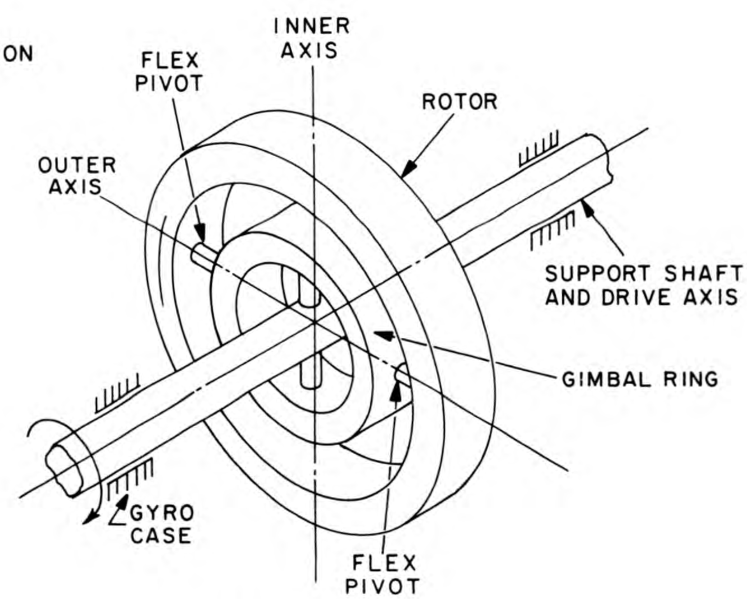


Figure 5 – Bounce paths of ball when bounce cell is in "at rest" position and when it is influenced by an acceleration force.



igure 6 – Free rotor gyro suspension.

Deviations in the bounce path may be detected by an optical system. Voltage outputs from a photovoltaic detector represent angular errors. These signal errors are proportional to the angle and are fed into a feedback loop which includes a servo loop that rotates the bounce cell to maintain the right-angle bounce condition.

The main potential attractions of this new inertial system are simplicity and, therefore, low cost. It was studied originally by the Rand Development Corporation, Cleveland, Ohio, and is now being investigated by General Technical Services, Inc., Cleveland, Ohio.

Dynamically Tuned Free Rotor Gyro

The classical concept of the perfect gyro is described as one which has an inertial spinning mass with no restraining or coupling forces associated with its support to cause drift (unintentional deviations of a gyro's spin axis). The dynamically tuned free rotor gyro is an all-mechanical gyro suspension which, at one particular spin velocity, ideally decouples the rotor from the spin motor shaft, thus minimizing drift errors. (See Figure 6.)

The heart of this system is two pairs of flexing spring pivots, placed at right angles to each other, that connect the drive axis to the gimbal ring and the gimbal ring to the rotor, as shown in Figure 6. By placing the rotor outside of the gimbal ring, it is possible to attach the spin motor to the case and to drive the rotor through the support shaft and the spring pivots. Thus the motor is eliminated as a critical balancing problem within the suspension system, and no electrical leads, which might introduce disturbing torques, need be carried across the gimbaling system.

It can be seen from Figure 6 that as the rotor rotates, the gimbal ring also rotates. When the gyro case is rotated due to turning movements of a vehicle, the rotor spin axis will tend to remain fixed in space. What results is an offset angle between rotor spin axis and drive axis (case), causing the rotating gimbal ring to oscillate. Thus, a gimbal inertial torque is set up, which is found to act in a direction opposite to that of a real spring torque. In order to cancel the gimbal torque, flexural springs are introduced into the suspension. The net result is that the gyro is influenced by both torques, which at a particular spin velocity cancel each other out. At this spin velocity, the rotor is essentially decoupled from the spin motor shaft, which means that it is "free" from inherent disturbing torques that cause drift. In other words, the gyro is dynamically tuned, since at the critical spin rate the frequency-sensitive gyro experiences no net coupling torques. In gyro parlance, the concept of a "free rotor" gyro is approached.

– Continued on page 24.

Gaku

A Computer System that Learns to Solve Problems by Experience

A computer system that can learn to handle increasingly complex tasks by using its own past expereince plus human guidance is being developed by Mrs. Aiko Hormann of the System Development Corporation, Santa Monica, California. The system is called "Gaku," which is a Japanese name denoting learning. The Office of Naval Research is providing part of the support required for the continuation of Mrs. Hormann's research.

Gaku is not a machine but a new partnership formed between a digital computer and man. In the conventional method of using a computer, fully detailed instructions must be programmed into the machine, specifying the exact steps needed to arrive at the solution to a given problem. This method is inadequate if the data are incomplete and the solution procedure is not known precisely in advance. Furthermore, it is not feasible to store in the computer's memory all of the specific procedures required to solve all problems, some of which may not even be conceived at the time the system is designed.

Gaku overcomes this basic difficulty by utilizing instructions and procedures of a more general nature. This information consists of general rules for decision making and data handling that the system can apply to a wide variety of problems. When given a specific problem, Gaku uses these general procedures to work out an appropriate course of search and experimentation leading toward the desired solution.

Gaku has four major components or mechanisms.

- The first one is a programming mechanism for manipulating basic operations and prestructured programs, similar to the function performed normally by a programmer outside of the computer.
- The second and key component is the problem-oriented mechanism, which is responsible for determining the overt behavior of the system. This mechanism both constructs and carries out the required sequence of actions leading to the solution of a given problem. It contains the procedural rules, mentioned previously, according to which actions are chosen more efficiently than they are by random trial-and-error search. These rules are of a step-by-step nature, causing the mechanism to attack problems in piecemeal fashion. Because of the "near-sightedness" of the problem-oriented mechanism, a third component is required.
- The third part of the system takes a larger view, often at an abstract level, of a given task. This component, called the planning mechanism, is capable of analyzing the structure of a given problem and placing

guideposts on the road to the solution. After surveying the task as a whole, this mechanism divides the task into a hierarchy of subtasks, each of which is supposed to be easier to perform than the original task. This hierarchy of subtasks constitutes a rough sketch of a possible course of action that guides the problem-oriented mechanism.

- To make efficient use of Gaku's expereince, the problem-oriented mechanism is influenced also by a fourth component, called the induction mechanism, which takes a still larger view of a given task. The induction mechanism can survey the system's past experience with various problems and apply relevant experience to new problems.

Although it may be noted that many of the features of Gaku are based on what is known about human intelligence and learning, the system is not intended to be a deliberate imitation of human processes. Gaku works in partnership with man, who is its teacher in the early stages of the search for the solution to a problem. Gradually, as the system works with its human colleague, its capability increases. The human partner assists by giving Gaku (1) samples of other problems solved previously relating to the subject, (2) general information which might be in the form of a lecture, and (3) suggestions on how the task might be done.

In order to evaluate Gaku's performance and detect its limitations, Mrs. Hormann has used as a testing vehicle a sequence of increasingly difficult problems taken from the Tower of Hanoi puzzle. This puzzle involves a tower or stack of disks of increasing size from the top to the bottom. The problem is to transfer the disks from the peg on which they rest to either of two empty pegs in the fewest possible moves—moving only one disk at a time and never placing a larger disk on top of a smaller one. Humans sometimes take hours to solve this puzzle, and sometimes they give up completely.

Experiments with Gaku started with the relatively simple three-disk puzzle. After the system solved this problem, it used its experience to find the solution moves for progressively more difficult problems involving a larger number of disks. Finally, it found a general solution pattern through the induction mechanism.

Currently, the system is in a rudimentary stage and thus is not yet able to handle a wide variety of complex tasks. Many problems of both a technical and conceptual nature must be solved before the desired generality and versatility can be achieved.

In her continuing research, Mrs. Hormann will look for new ways to make the system more efficient and capable of wider application. One of the principal areas to be covered in the next phase of research, which is being sponsored by ONR, it to improve communications between the human tutor or experimenter and Gaku. The objective is to find ways in which the tutor can define problems and give suggestions to Gaku in a manner that is both flexible and broad, similar to the approach taken by a teacher to a human student.

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Some Trends in Oceanography

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The studies described in the following article have been singled out to demonstrate how the emphasis in oceanographic research may change over relatively short periods of time. The discussion is based on selected portions of the oceanographic program of the Geophysics Branch of the Office of Naval Research and thus does not encompass all of the research supported by that branch; nor does it cover the work of the other branches of ONR which support oceanographic research, namely, Geography, Biology, and Undersea Programs.

The experiences of the Navy during World War II demonstrate clearly the important relationship that exists between the conduct of all forms of Naval operations and the level of our understanding of the ocean environment. For this reason, the Office of Naval Research began supporting a program in oceanographic research shortly after the Office was established in 1946. This work was carried out at universities and other private institutions under contract to ONR, as well as at ONR's own Naval Research Laboratory. Although considerable emphasis was given to applied research—as, for example, to the development of underwater detection systems—the bulk of the effort was devoted to basic research.

Most oceanographers agree that modern oceanography started with the unprecendented round-the-world cruise of HMS CHALLENGER during the years 1872 to 1876. This expedition also ushered in the era of oceanic exploration in which oceanographic ships were fitted out by governments, sent on long cruises, and dismantled upon their return, whereupon the scientists' attentions were devoted to the task of working up the research results of the cruises.

The oceanographic voyages of this era, which continued until World War II, were made primarily for exploratory purposes. The techniques used for sampling and measuring the constituents of sea water changed very little during the entire period. The only major advance that was made concerned the use of acoustic signals to determine water depth.

Since World War II, the great increase in financial support given to oceanographic research by the Navy and other government agencies has enabled government and private institutions to conduct research on a continuing basis and to concentrate on specific problems. As a consequence, the researcher has been able to evaluate theories at sea through series of shorter, more specialized cruises.

During the 19 years since ONR was started, this approach has led to significant changes in both the types of research problems under investigation and the techniques used to solve them. These changes are reflected in the following comparisons of some of the oceanographic programs supported by ONR in 1946 and at the present time.

Physical oceanography was concerned with investigations of the one-dimensional (nondirectional) energy spectra of surface waves having periods of 3-15 seconds (wind waves and swell); the prediction of tidal heights and currents in bays and estuaries; determinations of various features of ocean currents and of other forms of circulation on the basis of (1) geostrophic calculations utilizing data collected at Nansen-bottle stations; (2) direct measurements made by means of propeller-driven current meters; (3) the establishment of temperature-salinity relationships of various water masses; and (4) calculations of diffusion and mixing based on indirect measurements.

Air-sea interactions. Information on this subject was sought through calculations of energy-and-mass balance made from indirect evidence.

Chemical oceanography involved research in the distribution and cycling of plant nutrients and the concentrations and distribution of the major elements in sea water.

Marine geology encompassed research on bottom topography and efforts to classify different oceanic areas on the basis of bottom contours; the age-dating of sediments on the basis of fossil materials; the transport of sand and other sediments along coasts and in bays and estuaries; and the classification of sediments according to mineral composition.

It terms of scope, these portions of ONR's oceanographic program have changed little since they were first begun. However, in each discipline, the emphasis has shifted gradually, and a number of new areas of interest have been explored. The following enumeration of these changes gives some idea of the directions oceanographic research has been taking since World War II and provides a basis for speculation on the course of that research in the future.

Physical oceanography. In surface-wave research, waves having periods of from 3-15 seconds are still being investigated, but the emphasis now is on the two-dimensional (directional) spectra rather than the one-dimensional spectra. Also, the growth of these waves under various wind conditions is being studied. In addition, we are now investigating (1) capillary waves (wavelength of less than 2 cm.), (2) low-amplitude, long-period (20-40 second) waves, which are forerunners of storm-produced waves, and (3) the 15-60 minute tsunami waves (those generated by earthquakes) as they approach the coast and run up on the land.

In tide research, the emphasis has shifted from tidal currents in shallow inshore waters to those in deep-ocean waters and to the prediction of tidal heights both in isolated harbors and across the deep ocean. In addition, tidal theory has been developed to supplant empirical techniques. In the studies of ocean currents and circulation, all of the classical methods are still being applied, but now more effectively, as the result of improvements in theory and instrumentation. The emphasis on the direct measurement of currents has changed from data collection at individual points as a function of time to synoptic measurements at a large number of points.

In studies of diffusion and mixing of ocean waters, indirect measurements have been supplanted largely by direct measurements made by methods devised recently by the research scientists. These methods include the tracing of special dyes, conductivity sensing, and the tracing of artificially introduced fission products.

Air-sea interactions. Of chief interest in this field at the present time is the direct measurement of the transfer of energy, mass, and momentum on a local basis. The objective is to understand the transfer mechanisms by which the exchanges of those properties take place. Studies of such transfers on a regional basis, which also are important in these considerations, are continuing.

Chemical oceanography. Here, the emphasis has shifted from analyses of nutrients, such as phosphates and nitrates, and of the major chemical elements in ocean waters to the measurement of the concentrations of trace elements, including radio-isotopes. These new studies have been made possible by the advent of neutron-activation techniques and improvements in various spectroscopic techniques; they are being pursued in an effort to increase our knowledge of physical mixing and oceanic circulation. In addition, the concentrations of organic compounds are now being used as water-mass tracers.

Marine geology. The classical methods of studying sediments to learn their ages, types, rates, and processes of deposition and transportation, and to increase our knowledge of bottom topography are still in use; however, the techniques and instruments used in these studies have been improved and augmented. Also, the emphasis has shifted from general cataloguing to the determination of the ways in which bottom features and properties affect sound propagation (absorption, reflection, scattering, and reverberation), bearing strength with respect to the placement of man-made structures on the ocean floor, ocean currents and circulation, and tides.

Marine geophysics. Since the many studies outlined above were initiated at ONR, the entire field of marine geophysics has evolved and now constitutes about one-fourth of ONR's total effort in oceanography. Included in this research are seismic reflection and refraction studies, from which we are learning about the shape of the earth's crust beneath the oceans and gaining insight into the mechanisms which produced the ocean basins. Newly developed sub-bottom reflecting techniques are being used on a large scale to measure the thicknesses and acoustic properties of sediments; such charting of the sub-bottom structure adds a powerful new parameter to geophysical navigation. Gravity and magnetic measurement techniques, which were developed initially under the ONR research program, are now being used routinely by a number of research institutions, both for making determinations of crustal structure and for geophysical navigation. The flow of heat through the ocean floor is also under investigation, and the results are being applied to theories of continent and ocean-basin formation.

Instrumentation. The development of oceanographic instrumentation, which was negligible when ONR's oceanographic effort began, has now assumed a large role in the total undertaking. Whereas in the early 1940's the Navy's own laboratories produced most of the new instruments, the work is now going forward primarily at private institutions supported by ONR, and many of the products are being adopted by the Navy. Many examples of valuable instruments obtained in this way can be given. Precision depth recorders, shipboard gravity meters, and sub-bottom depth recorders are only a few. At present, the most important instrument being developed is a long-range, general-purpose oceanographic buoy (see *Naval Research Reviews,* October 1964). Even though this buoy is being developed for research purposes, it will undoubtedly be applied to several operational efforts of the various government agencies involved in oceanography. To ensure the buoy's use on an international scale, the oceanographic community has requested exclusive frequency allocations for oceanographic communications.

It is certain that the types of changes which have taken place over the past 20 years not only will continue, but will accelerate in the future. Tools are becoming available which will open up new areas of investigation. For example, deep-diving research vehicles will permit oceanographers to study the deep waters in detail never before possible. Oceanographic buoys will enable truly synoptic measurements to be made for use in large-scale studies of mass transport and global heat and energy balance. Finally, it soon may be possible to study oceanic processes by the use of remote sensors in satellites.

The National Oceanographic Program, Fiscal Year 1966

Many of the studies in oceanography supported by the Office of Naval Research are being conducted as part of a far-reaching national effort called the "National Oceanographic Program." As stated by the Federal Council for Science and Technology, the goal of this program is "to comprehend the world ocean, its boundaries, its properties, and its processes, and to exploit this comprehension in the public interest, in enhancement of our security, our culture, international posture, and our economic growth."

Oceanographic studies not included in the program concern, chiefly, those conducted directly in support of weapons systems. Thus most of the investigations concerning the oceans underway at ONR's own laboratories, such as the Naval Research Laboratory, are not reported in the National Oceanographic Program. Separate funding applies also to a large portion of the oceanographic work undertaken by the Bureau of Ships, Bureau of Weapons, and the Naval Oceanographic Office.

On March 2, President Johnson sent to Congress a 73-page report, entitled "National Oceanographic Program, Fiscal Year 1966," in which he proposed obligations of $141.6 million for the program for that year. Of this amount, 68.1 million was to be utilized by the Department of Defense, primarily by the Navy. Of the Navy's portion, the Office of Naval Research was to assume the largest obligation.

Of the $141.6 million requested for fiscal year 1966, $85.0 million has been earmarked for research, $30.6 for surveys, $13.4 for ship construction, $4.4 for facilities construction, and $8.2 for instrumentation and equipment procurement.

The research budget, broken down according to national goals and problem areas, appears as follows:

FY 1966 Research Budget by National Goal

Strengthening Basic Science	$25,180,000
Improving National Defense	33,376,000
Managing Resources in World Ocean	9,905,000
Managing Resources in Domestic Waters	7,785,000
Protecting Life and Property; Insuring Safety of Operations at Sea	1,785,000
Total	$78,031,000

FY 1966 Research Budget by Problem Areas

Physical Properties and Motion of the Sea	$21,845,000
Ocean-Atmosphere Interrelationships	6,146,000
Biological Properties of the Sea	22,391,000
History and Structure of the Sea Floor	18,745,000
Man's Modification of the Sea	8,904,000
Total	$78,031,000

The report, "National Oceanographic Program, Fiscal Year 1966," was prepared for the President by the Interagency Committee on Oceanography of the Federal Council for Science and Technology. In mapping out the effort for 1966, the ICO was guided by a long-range oceanographic plan (1963-1972), which the Committee prepared several years ago. That plan is described in detail in *Naval Research Reviews,* September 1963.

Radioactive Tracer "Captured" by Huge Water Bag

A new technique for measuring naturally occurring radioactive silicon in the ocean, which is expected to help oceanographers chart the circulation and mixing patterns of the sea's depths, has been developed and tested by Dr. David R. Schink, assistant research professor, University of Rhode Island. By means of the technique, about two ounces of silicon can be removed from more than 40 tons of sea water taken at selected depths. Development of the new method reflects more than four years of work, which was begun by Dr. Schink when he was at the University of California's Scripps Institution of Oceanography. About one more year's work will be required to perfect the process. The Office of Naval Research is supporting the effort.

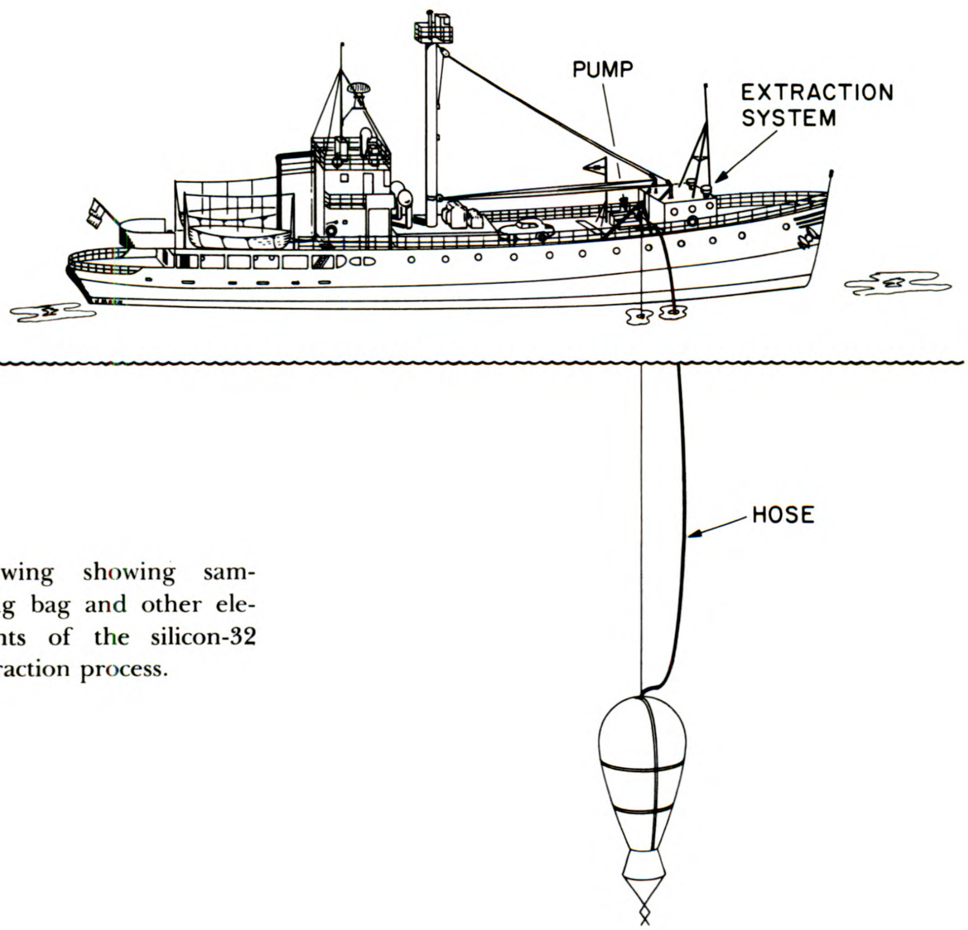
About 10 out of every billion, billion atoms in the water samples taken in a 40-ton sea-water sample are radioactive silicon-32, an isotope of the element which is formed by cosmic rays bombarding the upper atmosphere. Since the rate at which silicon-32 decays is known within broad limits, Dr. Schink's measurements give an indication of the "age" and the movement of ocean waters. Expansion of such measurements is vital not only to our understanding of ocean circulation, but also to our knowledge of the dispersal of radioactive wastes deposited in the oceans.

The most widely used method of determining the age of sea water has been carbon-14 analysis, a method which has also enabled scientists to understand better many of the life processes of plants and animals. It is advantageous, however, to have two measuring processes, so that the results of one can be compared with those of the other. If significant differences are noted, an effort can be made to account for them and thereby improve the accuracy of the measurements.

While carbon-14 is very useful as a radioactive tracer of sea-water movement, its rate of decay is too slow (half a given quantity decays in 5700 years) to provide the accuracy of measurement desired. Although the half-life of silicon-32 is not known exactly, it is believed to be about 300 years. This length of time is more appropriate for circulation measurements because sea water is believed to take about 1000 years to complete its cycle into the depths and back again.

The key equipment developed for the silicon-32 study is a water-bag sampler capable of collecting 1000 gallons in one dunking. The bag, made of rubberized nylon, is lowered empty into the depths by means of a large shipboard winch and A-frame. At a pre-set depth, a hydrostatic device opens the nine-foot mouth of the bag. As the bag is raised,

The 10,000-gallon water-sampling bag is hauled aboard ship after being used to collect salt water from which radioactive silicon is extracted.



Drawing showing sampling bag and other elements of the silicon-32 extraction process.

water gushes through a 15-foot neck of funnel into the bag itself, which is nearly 28 feet long. When filled, the bag is turned over to disengage the funnel and is then hoisted to within 50 feet of the ocean's surface. Here, a suction hose and pump run the collected water through an extraction system in which the silicon—in the form of dissolved silica—is removed by means of a specially treated ion-exchange resin.

After processing aboard ship with hydrochloric acid and distilled water, the resin yields some 150 gallons of solution. This substance is stored aboard ship until completion of the voyage, when it is removed to a laboratory. The radioactivity of the minute quantities of material eventually obtained is measured with a Geiger counter (actually, silicon-32 decays to form phosphorous-32, a radioactive "daughter," which can be handled easily and counted).

Originally, silicon-32 is formed on the borders of space when high-energy cosmic rays strike the nucleus of Argon, creating atomic fragments, some of which are silicon-32. Argon is an inert gas which makes up a little less than one percent of the earth's atmosphere. The atmosphere's silicon-32 is carried by rainfall to the sea's surface, where the mixing process begins.

Inertial Guidance—Continued from page 14.

The contractor investigating this concept is Arma Division, American Bosch-Arma Corporation. Advantages appear to be extreme simplicity of design, low gyro coupling, low cost, inherent stability, small size, and low power consumption. A random drift rate as low as about 0.02 degrees per hour has been achieved in the laboratory.

Former ONR Chief Scientist Appointed I.B.M. Chief Scientist

Dr. Emanuel R. Piore, a former chief scientist of the Office of Naval Research, has been appointed vice-president and chief scientist of the International Business Machines Corporation. In the new post, Dr. Piore will direct all phases of I.B.M.'s technological effort.

Dr. Piore is chairman of the Panel on Government Laboratories of the President's Science Advisory Committee, and he is a member of the Naval Research Advisory Committee, the National Science Board, the National Academy of Sciences, and the Defense Industry Advisory Council.

Inventions

Directional Control of the Explosive Force of a Warhead

By the use of radar, infra-red, photoelectric, and acoustic sensing devices, a missile or projectile can be guided very near to an airborne or land target. Because of the high velocities of both the projectile and the target, in the case of an airborne target, direct hits have been very difficult to achieve. For this reason, various schemes have been advanced for scoring the projectile case and causing it to explode in close proximity to the target so that its fragments would disperse in all directions, thereby increasing the chances of making a "kill."

As knowledge of the explosion phenomenon increased—for example, with respect to the changing characteristics of the explosive material from the time it is ignited until the explosion occurs—it became apparent that the direction of the explosive force could be controlled and the "kill" range extended. The "Electrically Controlled Directional Warhead," Patent No. 3,136,251, issued June 9, 1964, to Morris I. Witow of the Naval Ordnance Laboratory, White Oak, Maryland, was designed for this purpose. At the heart of this invention are a plasma produced by a chemical reaction and an electrostatic or electromagnetic field, the direction of which can be controlled to cause the charged particles of the plasma to move in any desired direction.

High-speed studies of explosions have shown that the explosive process goes through two distinct phases: deflagration and detonation. Deflagration is the burning, or flame, phase, in which the extremely high temperatures that are generated cause the production of large numbers of free electrons and positive ions. The time period for this phase is short when compared with conventional time standards, but it is long with relation to the detonation period. During this burning phase, the strong electrical field set up by electrical plates causes a mass migration of the negatively charged free electrons away from a negative plate and toward the positive plates. This migration tends to set up a shock absorbing layer, or cushion, around the inner surface of the explosive container in the vicinity of the positive plates. At the same time, the positive ions migrate *en masse* toward the negative plate.

During the deflagration phase, the pressure within the closed container builds up rapidly; then, with astonishing suddenness, the transition to the explosive phase takes place. During the explosion, the burning rate increases 1000 times or more over that of the deflagration phase, and a violent shock wave is produced which exerts tremendous and almost instantaneous pressures on any object which offers resistance. The section of the container shielded by the cushion of gases tends to absorb the shock wave for one brief instant, which is sufficient time to allow the uncushioned segment of the container—that in which the negative plate is located—to receive most of the hammer-like blow of the shock wave. The blow is so severe that it shatters the material and causes a large portion of the fragments to travel at a very high velocity in the direction of the target.

The invention utilizes four electrodes, each located in a separate quadrant in the warhead of the projectile. Each electrode is electrically connected to a rotary selector switch so that it may be charged either positively or negatively; if it is charged negatively, the other three electrodes are given a positive charge. Of course, the electrode having the negative charge will be situated on the target side of the projectile. Thus, when the explosive is ignited, almost all of the force of the charge in the warhead is directed against the target.

Flame-Out Eliminator

In the high-speed jet aircraft of today, air is fed to the combustion chamber of the jet engine through an air scoop, which is generally mounted in the forward portion of the craft. The air scoop is designed so as to provide the amount of air required at the various speeds and altitudes the plane flies. If any interruption or disturbance of the normal flow of air into the scoop occurs during operation of the aircraft, the flow of air will be decreased below that which is required for combustion purposes, causing extinguishment of the flame in the burner, called "flame-out."

When the guns mounted near the air scoop are fired at a high rate, the gases that are produced are projected from the gun barrel into the critical area of the air scoop. These gases not only interrupt or diminish the flow of air, but those containing carbon dioxide and unburned explosive material are swept into the combustion part of the jet engine. This condition, of course, is extremely hazardous, and in many cases causes the complete extinguishment of the flame in the jet-engine burner.

As a means of diverting the gases, baffles were built into the aircraft near the gun barrel. This arrangement did not prove satisfactory, however, because of the fact that the muzzle of the gun was subject to considerable vibration when firing, giving rise to the danger that one of the projectiles would strike part of the baffle, which could cause considerable damage to both the plane and crew.

To overcome this disadvantage, G. M. Chinn of the Naval Ordnance Laboratory, White Oak, Maryland, invented the "Flame-Out Eliminator," which is attached directly to the muzzle of the gun, much in the same way that a gun silencer is attached. The patent for the invention, No. 3,141,376, was issued July 21, 1964.

The device is a cylindrical tube having an internal threaded portion for engaging the threaded portion of the gun barrel, the bore of the tube being slightly larger than the bore of the gun. Longitudinally spaced along the bore of the tube are a series of circular grooves or chambers which serve as baffles. Each of the circular grooves has a number of radially and rearwardly directed ports through which the gases escape from the tube.

The actual behavior of the high-velocity gases which the eliminator removes is still not entirely understood. It is believed, however, that the following events take place during the operation of the device. The gases which propel the projectile from the barrel are of two types. The first type of gas follows the projectile directly and does the majority of the work; it has an extremely high velocity and tends to travel a great distance beyond the gun barrel. The second type of gas, which trails the first type down the gun barrel, is of lower velocity, but of larger volume; it must be prevented from emerging from the gun barrel in an unburned state to avoid the danger of a secondary explosion, which might interfere with the air flow into the jet engine.

As the base of the projectile moves past the wall of the first groove of the eliminator, the gas immediately behind it expands laterally into the first groove, where most of it is directed outward through the ports. That portion of the gas that is deflected back toward the longitudinal center line of the bore is believed to set up a turbulence and, in effect, create a gas barrier to the remaining oncoming gases. This barrier tends to retard the velocity of the remaining gases so that they may be trapped more readily and directed outside. It is believed that these conditions are repeated at each groove or channel as the gases pass along the interior of the eliminator. Tests of the device have shown that substantially all of the gases are removed by the first two or three grooves or channels, that few gases reach the remaining channels, and that none of the gases proceed as far as the muzzle end of the eliminator.

Instant Accelerometer. Naval aircraft launched by catapult and landing on a carrier deck are subjected to acceleration forces that vary with choice of pilot and motion of the ship.

Forces exerted when the arresting gear is engaged sometimes damage the airframe or landing gear. The magnitude of such forces cannot be evaluated immediately by conventional instrumentation, so delays are encountered in determining the airworthiness of carrier planes before they can be used again.

A mechanical accelerometer, developed recently by the National Bureau of Standards, provides a record of such forces and is easily read as soon as the aircraft is secured on deck. The instrument indicates immediately whether the aircraft has been subjected to excessive forces either when launched by catapult or stopped by arresting gear. It operates without power and attention.

On The Naval Research Reserve

NINTH NAVAL DISTRICT REPORTS

Some Thoughts About the Research Reserve in the Ninth Naval District

The impressions of the Research Reserve Program which I have gathered during my two years as Assistant Chief of Staff for Naval Reserve and Training for the Ninth Naval District are most favorable. I have noted with pleasure the number of worthwhile projects which individual units have undertaken from time to time. I refer to such accomplishments as the Denver Seminar, the pilot leadership evaluation study, the McDonnell Aircraft Symposium, and the GPACDUTRA tours to major Fleet and shore activities. I am pleased to note that several other good Navy efforts sponsored by various Naval Reserve Research companies have been made recently or are in the planning stages within this District—the weekend seminar at Urbana and the St. Louis National Science Fair come to mind.

That the Research Reserve Program is a "live" program and has dedicated membership are most evident. It is one of the largest specialist programs in the District, and its ACDUTRA participation is especially good. I wish there were more Category D funds to support this ACDUTRA, but this is not always possible, particularly near the end of a fiscal year.

I am sure all units in the Research Reserve are suffering recruiting problems, as are other Specialist units. Keeping in mind the mission of the Naval Reserve—namely, to back up the Fleet—it must be accepted that Specialist programs will receive less money and less attention from District levels than will Selected programs. This does not mean a lack of interest, but rather a policy of putting the greater effort on the more important tasks. That the Research Reserve units have been so active, in view of the non-pay aspects of their program, is most commendable. I have had many spirited conversations with CDR Hughes, your Program Officer, and you may be assured he is looking out for your interests at all times. He has kept me well informed of the problems faced by your units.

In the Ninth Naval District we do not have a set policy which requires the deactivation of small units. Considering that the Ninth is the largest Naval District in the country, geographical factors arise which require a somewhat sympathetic attitude to the plight of the smaller units. The isolated unit—the one far removed from a metropolitan area—will be treated differently from the small unit in a large city, where better training is available from other units, particularly NROS.

All in all, I am pleased with the enthusiasm evidenced by all the worthwhile activity, and am most appreciative of the difficult problems you are facing in recruiting young officers.

—CAPT E. J. Alt, USN

Seminar on Defense Department Research

Information on Defense Department research in the Champaign-Urbana, Illinois, area was presented to 60 Reserve officers during a three-day seminar, February 26-28, 1965. This group active-duty-for-training was arranged by Naval Reserve Research Company 9-2, Urbana, under the direction of LCDR R. L. Langenheim, Jr., USNR, Commanding Officer. In attendance were Reserve officers from 15 Research Reserve companies in the Ninth Naval District.

The seminar got off to a good start Friday evening with a most interesting and informative address by Mr. Reginald Eggleton, Research Associate in the Biophysical Research Laboratory, on "Effect of Ultrasonics on Nerve Tissue."

Saturday morning the group visited nearby Chanute Air Force Base, where COL Harry Hawkins, USAF, Deputy Commander, Technical School, welcomed the group. During the morning, the group visited the Maintenance School for the Hound Dog Missile and the Minuteman School. The Hound Dog Missile presentation was supported by the display of a missile with its attached service pylon, the maintenance trainer console, and a mockup of an entire maintenance facility. The tour of the Minuteman School featured motion pictures of the missile in action and visits to a command post trainer, maintenance trainer, missile transporters, and a "silo" mockup.

For the afternoon session, the group returned to the University of Illinois campus. CDR O. D. Hughes, USNR, Assistant for Research Reserve, ONR Branch Office, Chicago, opened the session with a discussion of matters concerning the Naval Reserve and, more specifically, the Research Reserve. Mr. F. X. Finnigan, ONR Resident Representative at Urbana, discussed the scope of Defense Department contract research on the University of Illinois campus. Mr. Finnigan is a former member of NRRC 9-2 and a retired lieutenant commander, USNR. Last on the program for the afternoon was a tour of the Coordinated Science Laboratories, which was ably conducted by Mr. M. E. Van Valkenburg, Professor of Electrical Engineering and Associate Director of the Laboratory. The explanation, display, and demonstration of the Plato Teaching Machine, a device for self teaching by machine, was a high-

Reservists visit the Radio Telescope Facility at Danville. Pictured from left to right are LCDR Langenheim; CDR Hughes; Mr. Schriefer; LCDR J. B. Gartner, a member of NRRC 9-2; and LT COL Joseph Tobias, USAR.

light of this trip, as was the display and explanation of the spherical, electrostatically supported gyroscope.

Sunday morning was devoted to a visit to the Radio Telescope Facility at nearby Danville. Mr. A. Schriefer, civil engineer in the Astronomy Department, explained details of the construction of the facility and physical problems in its operation. Dr. J. R. Dickel, Assistant Professor of Astronomy, explained current understanding of the phenomena of radio astronomy and described the program of charting radio sources, for which the telescope was constructed.

The participants were unanimous in their appreciation for the efforts of members of NRRC 9-2 in presenting this most worthwhile weekend program.

An Exchange of Memories

When CDR Malcolm D. Ross, USNR, a member of Naval Reserve Research Company 9-3, Ann Arbor, Michigan, performed his annual training duty in February at the Office of Naval Research Branch Office, Chicago, he exchanged memories with an old friend, CAPT Raymond C. Gossom, USNR, at Great Lakes, Illinois. Both CDR Ross and CAPT Gossom have participated in Navy space research programs which utilized balloons to gather data on man's reactions to space flight.

CDR Ross and CAPT Gossom.

CDR Ross set the world balloon altitude record of 113,739 feet over the Gulf of Mexico on May 4, 1961. He is now president of the Space Defense Corporation, Birmingham, Michigan. CAPT Gossom was one of the original staff members in 1947 of "Operation Helios," the Navy's stratosphere balloon project for recording upper air scientific data. He is presently assigned to Headquarters, Ninth Naval District, as Deputy Chief of Staff for Naval Reserve.

Colorado Company Tours NOTS

Seventeen members of Naval Reserve Research Company 9-26, Colorado Springs, Colorado, spent the first week end in December on group active-duty-for-training at the Naval Ordnance Test Station, China Lake, California. LCDR A. R. Ormond, USNR, Commanding Officer of the company was in charge. Other units attending the tour included the Military Sea Transportation Service Division 12-3, San Mateo, California; the Fort MacArthur USAR School, San Pedro, California; and the Naval Reserve Intelligence Division 11-1, Long Beach unit, Los Alamitos, California. These three units brought the total attendance at the meeting to 93.

LCDR Howard R. Anderson, USNR, of WEPTU 774, was the officer-in-charge of the training tour. He was instrumental in setting up the extremely interesting and informative sessions, and he also made arrangements for accommodations for the group.

The scientists who did the lecturing were eminently well qualified in their subjects, both in formal training and in experience gained through extensive research in their specialized fields. Included in this highly skilled group were three Naval Reservists who are attached to this NOTS facility. A good portion of the fine program was devoted to the Navy's missile weapons systems. Detailed information on the existing program was presented along with some of the future possibilities in this area. The remaining presentations were concerned with the introduction of the missile equipment to the Fleet, propulsion systems, and other classified programs with which this facility deals.

The participants were enthusiastic in their approval of this excellent opportunity to learn, first hand, more about this special aspect of the Navy, and by so doing to keep up to date on recent developments of concern to Research Reservists.

* * * *

Promotion Selections

Five hundred and ten Naval Reserve line officers have been selected for promotion to captain, and 486, to commander by the Fiscal Year 1965 Reserve Selection Boards. Of these numbers, 23 Research Reservists were selected for captain, and 7, for commander.

FOR CAPTAIN

	NRRC		*NRRC*
Austin, Jere C.	3-9	Nelson, Carlton J.	4-12
Bloom, Ralph, Jr.	4-1	Peterkin, Ernest W.	5-9
Burns, William A.	13-2	Rouse, Roy D.	6-2
Dearing, George B.	4-5	Salyards, Justin M.	6-17
Gilliam, Otis R.	3-5	Sarelas, Nicholas P.	5-10
Hoff, John J.	11-5	Smith, Charles O.	6-3
Holloway, John T.	5-10	Soltes, Aaron S.	1-1
Mathews, Charles W., Jr.	9-26	Stadelman, William J.	9-7
McClung, Norvel M.	6-9	Tatum, Hubert M.	6-17
McGill, John T.	9-21	Young, Edwin H.	9-3
Merenda, Peter F.	1-2	Zumwalt, William T.	6-17
Miller, Maynard M.	9-16		

Statistics based on the records of the Research Reservists selected for promotion are as follows:

Date of Rank		*Designator*		*Year of Birth*	
Earliest	1-1-54	1105:13	1515:3	Earliest	1915
Latest	7-1-60	1355:3	1665:1	Latest	1924
Median	10-1-58	1405:3		Median	1918

U. S. GOVERNMENT PRINTING OFFICE : 1965 O - 771-706

FOR COMMANDER

	NRRC		NRRC
Bohan, Walter A.	9-10	Taft, John R.	1-1
Cochran, Howard E.	6-3	Tassinari, Silvio J.	3-9
Davis, Charles F., Jr.	1-1	Trickey, Earl N.	1-2
Pitt, Donald A.	9-6		

Statistics based on the records of the Research Reservists selected for promotion are as follows:

Date of Rank		*Designator*		*Year of Birth*	
Earliest	1955	1105:4	1515:1	Earliest	1920
Latest	1960	1405:1	1535:1	Latest	1926
Median	1959			Median	1922

Fiftieth Anniversary of U.S. Naval Reserves

Thousands of Naval Reservists throughout the world celebrated their fiftieth anniversary on March 3, 1965.

The Naval Reserve, as a Federal organization, was established during the 63rd Congress, when on March 3, 1915, Public Law 271 was enacted, which states in part: "There is hereby established a United States Naval Reserve...."

Approximately 60 percent of the personnel manning the Navy during World War I were Naval Reservists. More than 80 percent of the personnel manning our Navy in World War II were Reservists, numbering over 3,000,000 personnel. Almost 30 percent of the Navy men on duty during the Korean conflict were Naval Reservists. Thousands of Reservists were on duty for the Berlin crisis of 1961 and for the Cuban confrontation in 1962.

Today there are approximately 500,000 people associated in some way with the Naval Reserve. There are approximately 140,000 who carry orders to report to duty stations within hours in the event of mobilization. There are 50 Naval Reserve training ships which deploy with the Fleet regularly.

Excerpt from a Psychological Sciences Contractor's Report: "Organizational effectiveness has been found to be higher under the following conditions: When there exists a tradition of critical internal evaluation; when there is appropriate sharing of responsibility for developing and modifying problem-solving systems; when there is a knowledge of alternative procedures and experiences, and where there is long range perspective..."

IN THIS ISSUE

VOL. XVIII No. 4

NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington, D.C., 20390. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

EDITOR: Richard D. Olson

A massive cloud of steam billows from a submarine volcano during the emergence of the island Surtsey from the North Atlantic Ocean in late 1963. The formation of the island and the scientific interests that it has evoked are discussed in the article beginning on page 1. Photograph by Timmin.

NAVSO P-510