NAVAL RESEARCH REVIEWS

JANUARY 1960

A new instrument that permits a dentist to view any part of a patient's mouth, highly magnified on a TV screen, has been successfully demonstrated at the U. S. Naval Dental School, Bethesda, Maryland. (See story on page 22 .)

ANIP

ANIP—the Army-Navy Instrument Program for fixed-wing and rotary-wing-VTOL (vertical takeoff and landing) aircraft—is one of three related research programs devoted to the combination of man and machine to achieve maximum efficiency in controlling military vehicles. The others are SUBIC*, integrated control applied to submarines, and SURIC for surface craft.

The ANIP ball started rolling April 9, 1953, when the Air Branch of the Office of Naval Research and the Systems Presentation Branch of the Bureau of Aeronautics (now BuWeps) announced to the aircraft and instrumentation industries a unified research and development program for the integrated presentation of flight information for fixed-wing aircraft. In 1954 the Army joined in extending this program to rotary-wing aircraft.

A basic objective of this program was, and is, to provide the instrumentation, display, and control capabilities required to achieve maximum effectiveness of the operator or pilot-vehicle combination under all environmental conditions. The basic philosophy is to design the total system to match the requirements of the man rather than insert the pilot into a collection of preconceived black boxes and instruments.

The long-range objectives seek the basic knowledge required to relieve the human pilot of tasks which prevent him from utilizing his full capabilities in carrying out the mission of the man-machine system. Interim results achieved are integrated into the current vehicle developments of the participating agencies. ANIP is directed by an ONR, BuWeps, and Army Signal Corps Joint Steering Committee. The program operates with two mutually complementary teams of industrial organizations as subcontractors to either Douglas Aircraft Co., Inc., the fixed-wing coordinator (prime contractor), or Bell Helicopter Corp., the rotary-wing-VTOL coordinator (prime contractor).

To date ANIP has yielded a number of significant results which are being applied to production aircraft as specific instruments. More highly integrated display and control systems are undergoing flight-test phases. A significant contribution has been the contact analog display which provides a pilot with as much information electronically in bad weather as he can acquire visually in good weather. The transparent cathode-ray tube display surface is another product of ANIP research.

The world's first helicopter flight-simulator dynamic platform and instrument systems, making possible safe, all-weather, helicopter flight, were shown as typical of ANIP's research progress during the three-day ANIP Symposium held at Dallas, Tex., August 31 through September 3, 1959. The symposium was sponsored by the U. S. Army Signal Corps with Bell as host.

Bell and The Franklin Institute of Philadelphia developed the dynamic platform. Designed to carry a full-sized helicopter cockpit

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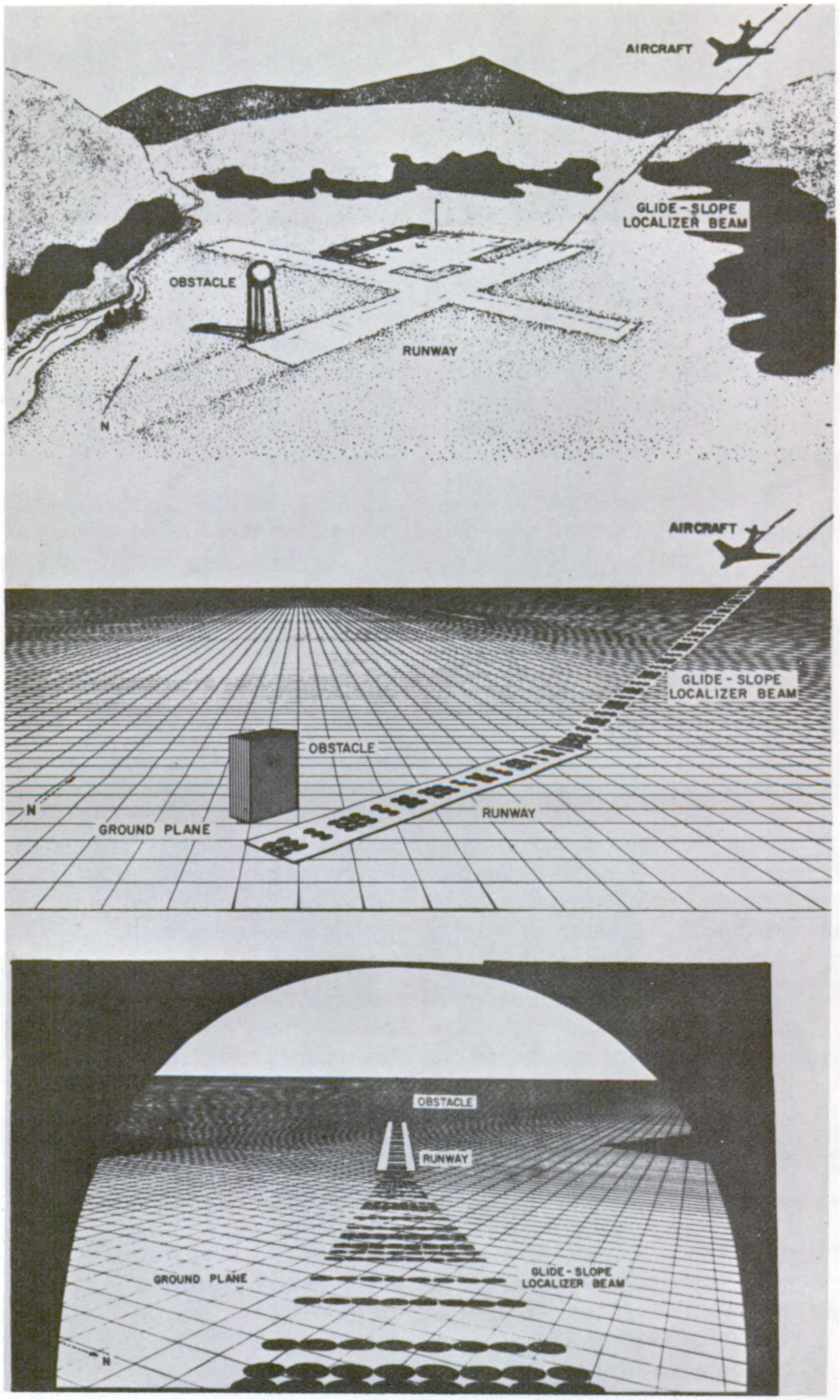
*NavResRev, Aug. 1959.

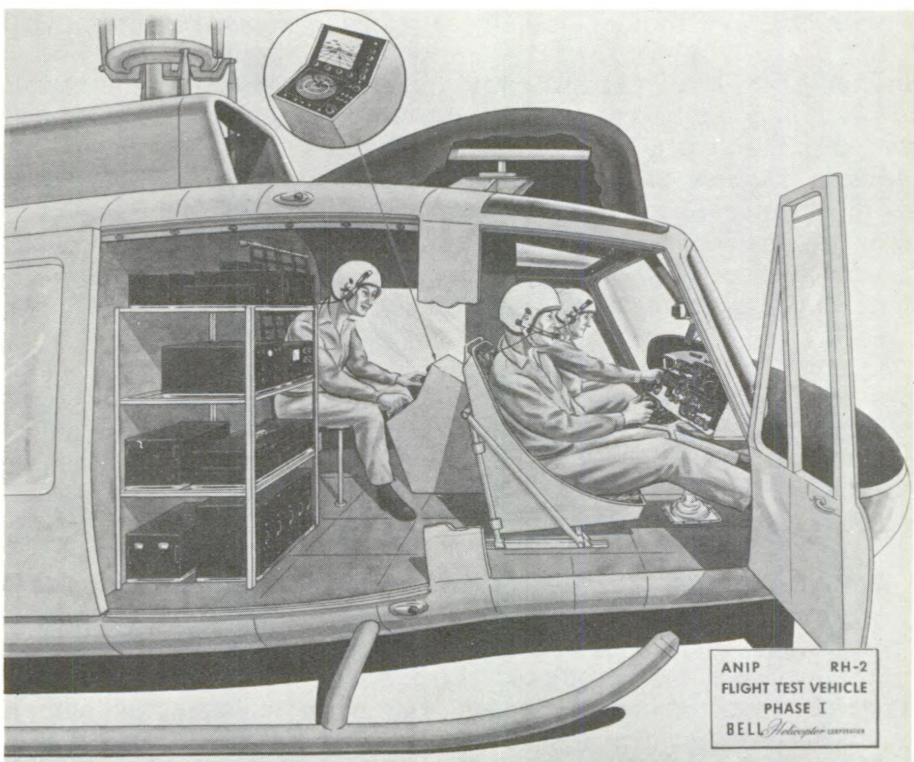


"Highway in the sky" provided by GE's contact analog computer. Top picture shows what the pilot would see in clear-weather, daylight, "contact" approach to airstrip. Center picture shows electronic rendition of top picture. Bottom picture is what pilot sees on his contact analog display when making the same landing approach.

weighing 1000 pounds with two men and instruments, the dynamic platform is capable of giving a "pilot-subject" a realistic feel of flight by reproducing with perfect safety the accelerations to which a helicopter is subjected in the air, thus enabling Bell psychologists to study the effect of motion and vibration on the ability of the pilot to control his craft.

The platform proper is supported by steel gimbals, links, beams, and columns which are actuated by hydraulic cylinders to enable it to move in what engineers know as six degrees of motion. Besides being able to pitch, roll, and yaw—which are rotations about the three main axes—the platform can rise eight feet, and move sideways and fore-and-aft as well. An almost unlimited number of maneuvers can be simulated with the big laboratory tool, by suitably combining these motions through the electronic system—also designed and built by Franklin.

Bell also displayed its RH-1 helicopter version of the Bell-built Navy HTL-7 trainer. The RH-1 demonstrates the realism that can be obtained when a pilot is given synthetic information on a contact analog display to replace information lost by flying at night or in thick weather. A 16-inch square transparent glass screen in front of the pilot contains a moving picture. The changing image resembles ground patterns similar to those seen by a person looking through an airplane window aloft. The image is generated by an optomechanical system developed by Bell electronics engineers and is changed automatically to compensate for helicopter motions of altitude, ground speed, and attitude.



Artist's sketch of Bell's RH-2 helicopter, serving as a flying "test bed" for ANIP-developed theories and apparatus. Insert circle shows an ANIP display console.

Bell also had on display another flight system, built into the RH-2 helicopter (a version of the Army's turbine-powered HU-1). The RH-2 is being used to test high-resolution radar which enables a pilot to see obstacles ahead of the helicopter. It also contains a ground map presentation on a separate cathode-ray tube.

A third flight system demonstrated was the Interim Integrated Aircraft Instrumentation and Letdown System (IIAILS) which in its present form enables experienced pilots to operate helicopters in remote areas under zero-zero visibility conditions.

As industry coorindator for the fixed-wing-VTOL portion of ANIP, under the direction of the Office of Naval Research, Bell has awarded 35 contracts to companies in the instrumentation and electronics field. Contracts cover work in sensors, central control computers, display generators, display media, mechanism amplifiers, controls, and human factors. The company's ANIP effort is directed by Owen G. Niehau, chief of the company's electronics department and a pioneer helicopter pilot. He is assisted by Hubert Upton, ANIP project manager for Bell, and Dr. W. G. Matheny, chief of Bell's human factors group.

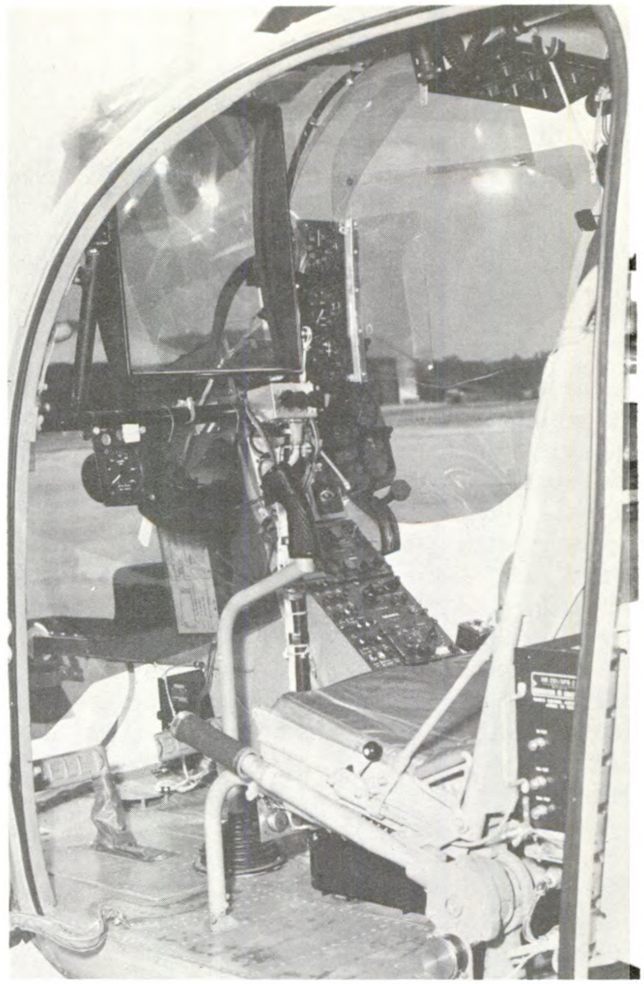
A new concept in "knowledge classification," for the purpose of predicting the performance limits of sensors in advance of costly experimentation, was shown by Motorola, Inc. The novel classification method was conceived during the course of a continuing study of fundamental sensors at the Riverside (Calif.) Systems Research Laboratory, Motorola's Military Electronics Division under subcontract with Bell.

Allen B. Du Mont Laboratories, Inc., displayed two essential systems to enable pilots to correctly orient themselves and their aircraft in relation to the ground to intervening obstacles despite the weather or time of day. The new all-electric systems developed by Du Mont reflect the major advances made by aircraft manufactures and electronic companies in solving problems leading toward the ideal man-machine combination for night and bad-weather flying. The two Du Mont systems are a ground plane generator and a radar data converter.

Among the Douglas displays at the three-day symposium were cockpits of the past, present, and future—demonstrating the novel components made to Douglas specifications for ANIP use. As the prime contractor for the fixed-wing portion of the program, Douglas has monitored the work of over 600 interested firms; some 30 firms have made direct contractural contributions to ANIP.

While demonstrating a series of advance cockpits to members of the symposium, A. M. Mayo, chief equipment and safety research engineer at Douglas' El Segundo, Calif., division, spoke of ANIP progress in control systems. He predicted that improved versions of simplified controls, instruments, navigation systems, computers, and numerous other electronic advancements made possible by ANIP will ultimately be found aboard America's pioneer space vehicles. He also praised the foresight of initiating ANIP more than six years ago. Progress in the program, he emphasized, has already provided the Defense Department with major production efforts in new electronic equipment.

Unique contact analog display installed in the cockpit of a Bell RH-1. Flight information is projected on the "tri-chroic" mirror during instrument-flying conditions.



The General Electric Company displayed its contact analog computer developed for Douglas by engineers at the GE Light Military Electronics Department's Advanced Electronics Center at Cornell University. As mentioned earlier, the instrument shows the pilot an electronic picture of the earth below; it provides a "highway in the sky" by giving the pilot much the same information he would get by looking through the plane's windshield on a clear day. The ground image looks like a huge checkerboard. A clear course to a runway appears before the pilot's eyes as a series of short parallel lines, like railroad ties without the rails. Flying-in is as simple as driving down a straight road.

Participants in the symposium were able to "fly" the display by manipulating the controls in a mockup. They were able to change the direction and speed of a simulated aircraft, using a control stick and throttle, as they saw the results of the display.

The newest working models of the Kaiser-Aiken thin cathode-ray tube were exhibited by the Kaiser Aircraft and Electronics Division, under subcontract to Douglas; this transparent television tube will be coupled to a system for displaying an artificial picture of the real world for jet aircraft pilots.

The microcircuitry concept initiated by Varo, funded in 1955 as a research and development program by ONR as part of its ANIP program, has advanced to a working technology for the design and fabrication of electronic circuits. Within ANIP, Varo has developed the microcircuitry requirements for materials synthesis research and system design, and its efforts have been coordinated with other ANIP team members to advance the microcircuitry technology to a state-of-the-art compatible with the immediate needs for electronic circuit design and fabrication for the ANIP man-machine system.

The displays or instruments presented a striking similarity to those of the SUBIC program. The SUBIC scientists are attempting to create a balanced man-machine partnership that will utilize electronic sensing and data-processing equipment in submarines, which will up-to-the-minute tracking of contacts and provide information necessary for precise navigation and weapons firing. A television-type visual display of information will enable the submarine commander to make prompt decisions. In effect, the skipper will have an "electronic port-hole" to "see" his subsurface environment, similar to a pilot looking through an aircraft windshield. These features, originally developed for the aircraft instrumentation program, are logically adaptable to the latest atomic subs which feature one-man airplane-type control. The single-stick submarine system was recently tested in the high-speed A-sub SKIPJACK which General Dynamics delivered to the Navy on April 15.

Although ANIP has not advanced as far as SUBIC, current applications indicate that ANIP will fill the gap with sensors, computation, display amplification, mechanism amplification, display media, controls, environment and escape, power, and circuitry. It is this composite approach that will give the ultimate solution to the problem of operating future aerial vehicles by day or night, under all conditions of visibility.

Navy's Rocket Catapult Escape System

RAPEC, the Navy's new rocket catapult escape system that is expected to assure a major increase in pilot survivability, is now ready for the fleet. Under development for two years at the Naval Ordnance Test Station, the new system is one of the Navy's answers to the fatality factor for aircraft accidents below 2000 feet. Most jet crashes occur as a result of flameout on takeoff or landing.

RAPEC (rocket-assisted-personnel-ejection-catapult) escape system, the result of a joint effort by the Navy and Douglas Aircraft Company, is a solid propellant rocket fastened to the pilot's seat, operating as a piston inside another tube attached to the aircraft. It will be capable of saving a pilot's life in "bail-out" from ground level to high altitude. RAPEC will work in four stages: propellant gases push the seat out of the aircraft; rocket propels pilot and seat 200 feet above his aircraft; mechanical device separates pilot from seat; parachute opens, lowering pilot safely. The Navy is presently installing RAPEC in its Douglas A4D attack bomber. It will eventually replace all existing systems in the Skyhawk and will be standard equipment in all new Skyhawk aircraft.

Impregnation of Sole Leather

J. M. Cassel
National Bureau of Standards

Leather, an extremely useful material in peacetime, assumes a much more critical position during war emergency periods. During World War II, military and civilian shoe requirements were so great that the tanning industry had difficulty in expanding operations sufficiently to meet the increased demand. Of chief concern were the acute shortage of hides and the uncertainty of the natural tannin supply. Recognizing the need for conservation, the Office of the Quartermaster General sponsored a research program at the National Bureau of Standards, the goal of which was to improve the wear resistance and serviceability of leather. An additional purpose was to improve low-grade hide areas so that a higher fraction of the hide could be used for production of shoe soles. Ultimately, both objectives were attained by development of a method for impregnating leather with polymers. The early, background research, was carried out under the Army's wartime contract. The applied research, leading to pilot plant production of impregnated leather, was completed more recently under contract with the U. S. Navy Bureau of Supplies and Accounts.

The wear properties of impregnated leather are so excellent that all of the armed services are now specifying this type of leather for the military shoe sole. Because of its wear potential there is also considerable demand for impregnated sole leather in construction of certain types of men's sport and work shoes and in boys' shoes.

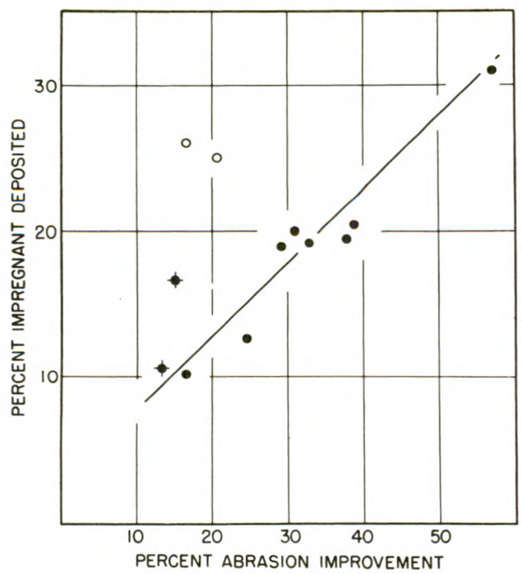
The tightly woven condition of the natural leather fibers results in extremely small pores, and therefore tends to limit the materials with which the leather may be impregnated. Thus, the Bureau's early attempts to use various solutions of commercial high molecular weight polymers — such as polyacrylates — for impregnants were not successful, and research was for a time directed toward impregnating the leather with monomers that would polymerize after soaking into the leather. Subsequently, electron-microscope examination of the macropore-size distribution of unfilled leather (crust leather) revealed that the pores were, on the average, larger than was first believed. In the range of pore radii 250 to 20,000 angstroms, only 14 percent of the void volume was associated with pores having radii less than 1000 angstroms. This information encouraged further research on impregnation from polymer solutions in which polymer molecular weight was an important factor. It soon became apparent that leather could be impregnated by soaking crust leather in polymer solutions prepared or selected on the basis of molecular weight. On the basis of these findings a method of treatment was developed.

Laboratory tests indicated that the treatment increased resistance to abrasion considerably and that it reduced water absorption by about half. Because unfinished sole leather containing a minimum amount of uncombined tannings may be used, considerable saving in tanning materials was indicated. Furthermore, indications were that by the impregnation treatment the wear of belly and shoulder leather could be made equal to that of high-quality sole leather prepared from the bend area (a side minus head, shoulder, belly and shank areas) of the hide.

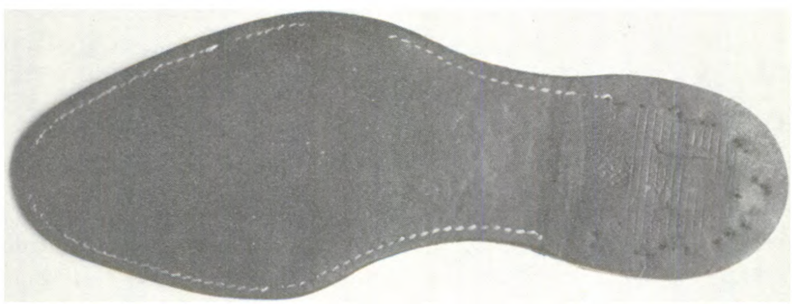
An early laboratory experiment showed that wear of sole leather (as judged by a laboratory leather-abrasion device) could be greatly improved by sufficient deposition of degraded rubber from solutions of benzene or toluene. Preparation of the rubber impregnant, however, involved extended cold milling, followed by catalytic oxidation with mercaptobenzothiazole at 100°C for about 16 hours to give a viscosity of the rubber solutions which would permit penetration into the leather matrix. This laborious task was eliminated when it was shown that similar improvement could be achieved by impregnation with a commercially available rubber-like polymer such as Vistanex (a polyisobutylene).

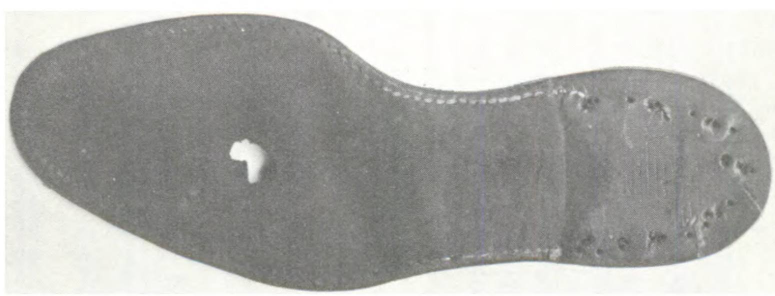
Recognizing the importance of these laboratory-impregnation results, and in order to bridge the gap between laboratory investigation and large-scale industrial application, the Navy Bureau of Supplies and Accounts sponsored a pilot plant study as well as continued laboratory

Equipment used to impregnate leather with polymers in the National Bureau of Standards pilot plant. The large galvanized-iron vat contains the impregnation solution. During impregnation the bend of leather is mechanically raised and lowered in the vat to simulate the motion of tannery rockers. Infrared lamps (lower left) heat the contents of the vat. The NBS pilot-plant study has provided methods for obtaining an improved product at lower cost.



Percent laboratory abrasion improvement in sole leather versus percent impregnant deposited.





Soles, cut from the same location on opposite sides of a hide, (one side of which is finished as commercial sole leather), are attached to shoes and worn until a small hole appears in one sole. The relative wear is calculated from the original thickness. The pair of soles pictured is typical of such a test. The sole on the bottom was cut from a commercial sole leather tannage; the one on the top was cut from a side of leather lightly tanned and impregnated with rubber.

research on impregnation techniques at the National Bureau of Standards significant improvements resulted. By proper selection of polymer impregnant, NBS was able to produce leather with highly improved wear qualities having various degrees of waterproofness, flexibility, and water-vapor transmission.

The pilot-plant investigation involved the impregnation of leather with polyisobutylene and various polymer blends. For impregnation with polyisobutylene, the treatment consisted of soaking the leather at 40°C (104°F) for 3 hours in a 35 to 40 percent solution of polyisobutylene dissolved in mineral spirits. The amount of polyisobutylene deposited was found to be a linear function of the concentration of the polymer in the impregnation solution. By blending certain hard, low-molecular-weight resins and other polymerized rosins with a polyisobutylene-type elastomer in the impregnant, leather of almost any desired flexibility could be produced. Waterproofness and flexibility could be varied in this way.

Although pilot-plant-prepared polyisobutylene or Butyl-rubber-impregnated sole leather was of excellent quality, the ease of carrying out this impregnation process on a commercial scale was of serious concern. Use of high molecular weight polyisobutylene as impregnant on a commercial scale seemed to pose particular problems in ease of handling. The problem became less critical, however, when polymer deposition rather than polymer molecular weight was shown to be the prime factor in improving wear quality. This knowledge immediately permitted use of much more easily handled low-molecular-weight polybutenes (1500 to 10,000 molecular weight) which became available commercially. Leather impregnated with 20 to 25 percent low-molecular-weight polybutene-resin blends could be expected to give a 50 percent improvement in wear and a 25 percent reduction in water absorption. Commercial practice is currently employing a 2:3 ratio of elastomer (polybutene) to resin in the blend.

One serious drawback to pilot-plant-impregnated sole leather was its tendency to spread laterally under compression. In commercial production the heavier rolling of the impregnated leathers minimized the tendency of the impregnated leathers to spread laterally.

Many times a good product cannot be made better, or it may not be economically sound to achieve the improvement. This was the reaction of many leather people to proposals that sole leather impregnation was a sound project. Today the leather industry is well aware that because it is now able to display a leather of improved wearing quality, as well as decreased water absorption without any loss in comfort, the position of leather in the footwear market is considerably improved.

A Navy medical research unit in Taipei, Taiwan, working with Chinese doctors, has developed a vaccine which may play a significant role in halting the spread of trachoma, an infectious eye disease affecting more than 400 million people.

Dr. Thomas J. Grayston, a 35-year old member of the research team, in announcing the results of a year's work, was reluctant to make any predictions as to the ultimate success of the vaccine. He did admit, however, that tests conducted to date were encouraging and that the vaccine has tremendous potential as a preventative, and possible cure, of the illness which often results in total blindness.

Façade, State University of Moscow.

Nuclear Journey to the Soviet Union

M. M. Shapiro* and W. E. Wright†

If the thaw in the cold war continues, American scientists will be traveling in increasing numbers to conferences in the Soviet Union. What are the conditions they can expect to find there? How easy is it to travel about? How good are the living arrangements? Is the environment of a Russian Conference conducive to the cross-pollination of ideas? Some of the answers, plus a few side observations, are contained in the following article—a series of excerpts from the separate trip reports of two Navy scientists who went to Russia last summer.

Dr. Wright and Dr. Shapiro were among the 26 American physicists invited to attend the International Cosmic Ray Conference, sponsored by the International Union of Pure and Applied Physics. The meeting was held in Moscow from Monday through Saturday, July 6-11, 1959. Among the American delegates were James Van Allen of the State University of Iowa, Bruno Rossi of M.I.T., and George Kolstad of the AEC. At one of the plenary sessions of the Conference, Dr. Shapiro presented two papers reporting cosmic ray research at NRL: "Intensity of Primary Helium at Geomagnetic Latitude 3°N" (B. Hildebrand, F. W. O'Dell, M. M. Shapiro, and B. Stiller) and "The Ratio of Lithium, Beryllium, and Boron to Heavier Primary Nuclei Near the Top of the Atmosphere" (F. W. O'Dell, M. M. Shapiro, and B. Stiller.)

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GENERAL IMPRESSIONS

Dr. Wright: There were several other American, French, and South American scientists on the same plane, also bound for the Conference. On Saturday, July 4, we were met at the Moscow airport by a group of English-speaking physicists from the Lebedev Institute to help us through customs. This was a nice gesture, even though it backfired to some extent. I was helped through customs so rapidly that I had no properly stamped declaration form to show on my way out of the country two weeks later. Because of this, the officials wanted to keep all my money before letting me go. However, repeated showings of invitations, delegate cards, and statements of the word "delegate" solved this problem, and I was permitted to keep my few dollars and francs. Great care should be taken in going through customs to make sure that all requirements are complied with, despite the language difficulty. One American family was less fortunate and returned to Paris on the same plane, having left considerable money behind, impounded because of some misunderstanding about entry. One has the impression that currency control is strictly enforced at the border but that opportunities to black market dollars or American goods are abundant in Moscow.

Dr. Shapiro: Upon arrival at the airport we were greeted by some Russian physicists we had met before—Dr. Chudakoff, a leading investigator of space radiation with satellites, Dr. Alla Massevich, an astrophysicist, and several other scientists. Our hosts tried to clear us through the customs office in a hurry, but they were not successful. Apparently, bureaucracy has some characteristics that are universal.

Dr. Wright: The meetings were held in two auditoria in the main building on the new campus of the Moscow State University. The schedule was 10:00 to 2:00 and 4:30 to 6:30, with no second session on Wednesday and Saturday. The meeting rooms were excellent, and good arrangement had been made for simultaneous translations into English and Russian.

Dr. Shapiro: There was no serious problem of communication at the Conference. The official languages were Russian and English, and simultaneous translation was furnished in the other languages. With a knowledge of English or German one could communicate privately with a large proportion of the Soviet scientists. Judging from my own experience and those of some friends, there was free exchange of scientific information on both sides. I detected no withholding of information. Of course, the cosmic radiation is an unclassified area of research in the USSR as well as in the West. Soviet scientists in this field are aware that they have much to gain from give-and-take with their western colleagues.

Dr. Wright: Some of the arrangements for the conference were rather poor. As far as I know, we were the first group who had gone to the Soviet Union to attend scientific meetings, and had at the same time made their own travel arrangements, as tourists, through Intourist. The two are nearly mutually exclusive. For example, in order to use our Intourist coupons for the mid-day meal we had to return from the University to our hotel—a half hour bus ride each way. Since the

University has plenty of cafeteria space, this seemed a totally unnecessary waste of time and energy and precluded any informal discussion at lunch with our Soviet colleagues. It also scarcely left time to eat a meal before catching the bus to return to the University. The service in the dining room of the Hotel Moscow (and in most Intourist dining room which I visited) was almost unbelievably slow. I once spent nearly two hours at breakfast, and four hours for dinner was roughly the rule. Many of us adopted the pattern of only two meals a day, plus a late snack just prior to the closing of the dining room at midnight, in order to have some spare time left.

Although the Conference meetings started on Monday, no attendance list was available until Thursday. It omitted the names of the Soviet scientists. Following a protest on that score, a list of Soviet scientists was put out on Friday. It was not correct and it did not give the laboratory affiliation of the men listed. No social-mixing function was held until Saturday, after the close of the conference—and it was easy to have the impression that it had not been planned in advance but put in as an afterthought. It was never publicly announced, and you only heard of it if you rode back to the hotel after the Saturday session on the Intourist bus where cards were handed out. By that time many of us had made other plans for Saturday evening. One could go on, but suffice it to say that if the purposes of the conference included the promotion of informal exchange of ideas between and broader acquintance among scientists, the arrangements were lacking in these aspects.

THE CONFERENCE

Dr. Shapiro: The main subjects discussed at the Conference were the following: nuclear interactions at high energies; extensive air showers; origin of cosmic rays; primary radiation; experiments carried out by means of balloons, rockets, and satellites. Finally, a day was devoted to cosmic ray intensity variations. All sessions of the meeting were held in the skyscraper building of the University of Moscow.

Dr. Wright: Complete coverage was impossible since there were two sessions in the afternoon. Also, starting on Wednesday, a parallel session was arranged after the break each morning to permit some informal discussion. The program was so full that almost no discussion was possible otherwise.

Dr. Shapiro: Invited to the Moscow Conference were 26 American physicists, 60 from other countries throughout the world, and about 175 Soviet scientists. Many of the Soviet invitees are not active in cosmic-ray investigation per se, but in related fields, such as astrophysics and geophysics. The Soviets tend to be inclusive in encouraging a large number of their own scientists to participate in international meetings when these are held inside the USSR. One effect is that the proportion of younger research workers and graduate students seen at such conferences is rather larger than at similar meetings in the West.

The Chairman of the Soviet committee for the Conference was Professor D. V. Skobeltzyn, Director of the Lebedev Physical Institute in Moscow, member of the Academy of Sciences of the USSR, and Russia's pioneer cosmic-ray worker. He is a member of the Supreme Soviet and Chairman of the Lenin Prize Committee.

The Soviet bloc countries were fairly well represented, but there were few well-known cosmic-ray specialists from those countries. An exception was Professor L. Janossy of Budapest, Hungary. Another leading figure was Professor M. Danysz of Warsaw, Poland, who discovered the phenomenon of hyperfragments—a very highly excited state of nuclei. Danysz has just completed a two-year term of office as one of the two deputy directors of the Joint Institute for Nuclear Research in Dubna.

To me it appeared that some of the highlights of the Conference were these: progress in the theory of cosmic ray origin by V. L. Ginsburg and his collaborators; a report by James Van Allen summarizing our present knowledge of the giant zones of radiation surrounding the earth; a report by S. L. Dolginov describing an investigation of the magnetic field of the earth carried out over distances of many earth radii by means of one of the Soviet lunar rockets.

One of the most worthwhile experiences of the Conference for me was my participation in a private conference on the origin of cosmic radiation with [Soviet] Professor V. L. Ginsburg and two of his colleagues, A. A. Korchak and S. I. Syrovatskii. Also present were B. Peters of Copenhagen and P. Morrison of Cornell University. Professor Ginsburg is an exceptionally versatile theoretical physicist, who has made notable contributions in such diverse fields as microwave theory, low-temperature physics, and various aspects of astrophysics. He is remarkably fluent and articulate in English as well as in Russian. Although apparently not yet 40 years of age, he is a corresponding member of the Russian Academy of Sciences.

Dr. Wright: I personally had conversations with only two Soviet scientists to such an extent that I have any real impressions of them as individuals: Yu G. Shafer (Yakutsk) and A. I. Nikishof (Lebedev Institute). I imagine Shafer made an impression on all the visitors. He is a rugged-looking individual with great energy and aggressiveness and seemed quite clearly to be a man of some stature. The story is that he is of German extraction (his father having been at one time in the U. S.) and was a pilot in the Red Army during World War II. He was shown considerable deference around the conference and appeared at the "reception" with a row of ribbons on his civilian jacket. It was during the session that he chaired that I first noted any effort to get discussion from the floor in a form such that it could be included in the proceedings. His wife (who is also a physicist) and daughter were with him in Moscow during part of the meetings. He speaks broken English and German, he commented that at home his wife spoke much better English than he did, but that she couldn't speak it at all away from home. He has a Stalin prize for his ionization chamber, the major cosmic ray instrument at NIZMIR. He was far and away the most aggressive mixer among the Soviets (almost the only one), frequently coming to the hotel for the mid-day meal or dinner. One night he stayed quite late talking to a group (which included George Clarke of M.I.T., who mentioned it to me) in the lobby of the Moscow Hotel about the evils of inheritance, etc. At the reception he assumed many of the chores of a host, helping people select wines, urging that they try this or that, etc.

Dr. Shapiro: Shafer is a remarkable man. When he moved from the Moscow region to remote Yakutsk, his salary was tripled—a privilege not enjoyed by the local scientists in that region. Dr. Shafer and his wife, who is also a physicist, found the salary differential embarrassing, and petitioned the Academy of Sciences to reduce their salaries.

Dr. Wright: Two technical matters made a particular impression on me during the course of the conference. First, in a paper on "Measurements of Cosmic Ray Variations in the Stratosphere," Charakhchian reported on a series of 900 balloon flights during the course of the IGY with simultaneous launchings from 3 latitudes: 41° South and 51° and 64° North. It appears that the Soviets use only rubber balloons, usually singly though sometimes in clusters, hydrogen filled. Nevertheless, this is a substantial operation and evoked admiring comment from Neher.

Second, in parallel papers regarding "Radiations in Cosmic Space," Van Allen and Chudakov were in clear disagreement on the interpretation of the data regarding the trapped radiation in the inner zone. Van Allen concludes the major component is electrons, Chudakov holds for protons. Data are sparse and none of the experiments are extremely elegant. However, Van Allen's use of both shielded and unshielded counters does have real appeal as a fundamental way of investigating an unknown radiation. This sharp difference of interpretation evoked surprisingly little discussion, so little in fact, that I worried that I might have misunderstood the presentations. A subsequent dinner conversation with Van Allen confirmed that indeed this difference did exist.

Dr. Shapiro: Dr. E. E. Chudakov, probably the outstanding of the younger investigators exploring the cosmic radiation with the help of satellites and rockets, made a gracious acknowledgement in his scientific report. He implicitly credited James Van Allen with discovery of the radiation belt. (Although it is common knowledge in the West, Soviet publications had not always acknowledged this priority.) I had met Dr. Chudakov two years ago, and he was at the Moscow airport to greet several colleagues and me upon our arrival.

VISITS TO SOVIET LABORATORIES

Dr. Wright: No arrangements had been made in advance [by the Conference committee] for visits to Soviet laboratories. Indeed, the first reaction to our requests for such visits was that they would be impossible. Later, however, some people were able to visit some laboratories—although at one point some of us were told that even to visit the laboratory on campus of the University was "too difficult." Despite these difficulties, I did visit our laboratories in and around Moscow and one in Leningrad. These were: Cosmic Ray Laboratory at Moscow State University, NIZMIR, Veksler Accelerator Institute, Joint Institute for Nuclear Research at Dubna, and the Emulsion Laboratory of the [Leningrad] Polytechnical Institute.

[Dr. Shapiro visited the same laboratories, plus several others in his longer tour, including the Ukranian Academy of Sciences in Kiev. Because space is limited, only one visit is noted here: the excursion to Dubna.]

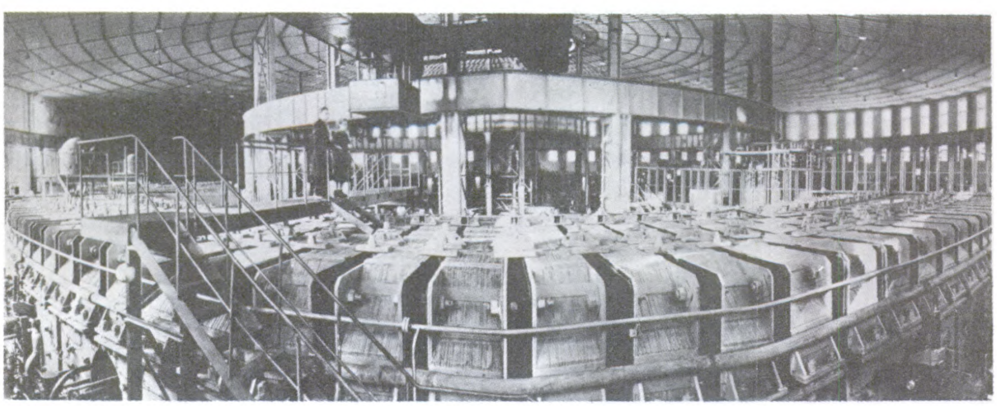
The visit to Dubna was quite well conducted, except that the number who could go was arbitrarily limited. Of those who remained after the conference, at least Otting and Amaldi were left behind in Moscow. The structure of Dubna has been described in a booklet available last year at Geneva. The program has the following major parts and instrumentation: (a) nuclear problems—650 Mev synchrocyclotron, (b) high-energy problems—10 Bev accelerator, (c) theoretical physics—Computer, (d) nuclear reactions—heavy ion accelerator, and (e) neutron physics—reactor under construction. We saw (a) and (b).

At the end of our visit we were given a nice meal in a lodge off the site, in the nearby town, complete with vice director and some people I assumed to be party heads of workers groups. On the way back to the city we stopped to go swimming in a large man-made lake, the Moscow Sea. The swim was a very welcome break in a hot bus ride.

Dr. Shapiro: This large laboratory-complex [Dubna], founded in 1956, is a sort of Soviet answer to the CERN laboratory in Geneva. The latter was set up three years earlier by a dozen western European nations for the purpose of carrying on nuclear research in areas that require apparatus too costly for any single nation to undertake by itself. Similarly, the USSR invited the Soviet bloc countries to collaborate in founding a joint institute for nuclear research. Normally the director of the Institute is a Soviet citizen, and the two deputy directors are selected from among the other Soviet bloc states. The two principal accelerators of the Joint Institute were donated by the USSR to the Laboratory. They are the 680 Mev synchro-cyclotron and the 10 Bev proton-synchrotron, which the Russians call a "synchro-phasotron."

During the tour I obtained the following information about the Institute: Altogether there are approximately 2700 employees at Dubna, of whom more than 300 are scientific workers. (Presumably technicians are not included in this number.) About 40 percent come from foreign countries and the remainder from various parts of the Soviet Union. The annual budget of the Institute is approximately 200 million rubles, which includes new construction.

My net impression of the 10 Bev phasotron, which for a couple of years has at least the nominal distinction of being the highest energy machine in the world, is that it will turn out to have been something of a white elephant—both economically and scientifically. If a beam of adequate intensity had been achieved one or two years ago, the Soviet workers in high-energy physics could have "scooped" the West on many



The electromagnet of the synchrophasotron of the high-energy laboratory at Dubna. (Note the size of the two people on the bridge.)

important discoveries and would have been in the forefront of research in "strange-particle" physics. Actually, nothing of the kind has happened. If the Dubna workers do succeed in raising the intensity significantly, the machine will then become more useful and productive. However, it will have at most a few months of unique capabilities above the 6 Bev region, and then the higher energy CERN machine will probably go into operation.*

CONCLUSION

Attending a conference in the Soviet Union is not all work and no play. Dr. Wright and the Shapiros—Mrs. Shapiro went along—managed to do some shopping, theater-going, and just plain sightseeing. Everywhere they went, in theaters and restaurants, on the street or in the subway, they were repeatedly approached by friendly strangers who wanted to talk to Americans. The frustrating tie-ups and restrictions imposed by bureaucrats and civil employees were more than offset by the graciousness and genuine interest displayed by Russians at the personal level.

The three came away with the common impression that today's Russians are fascinated with education, ardently nationalistic, and dedicated to the purpose of catching up with the Americans.

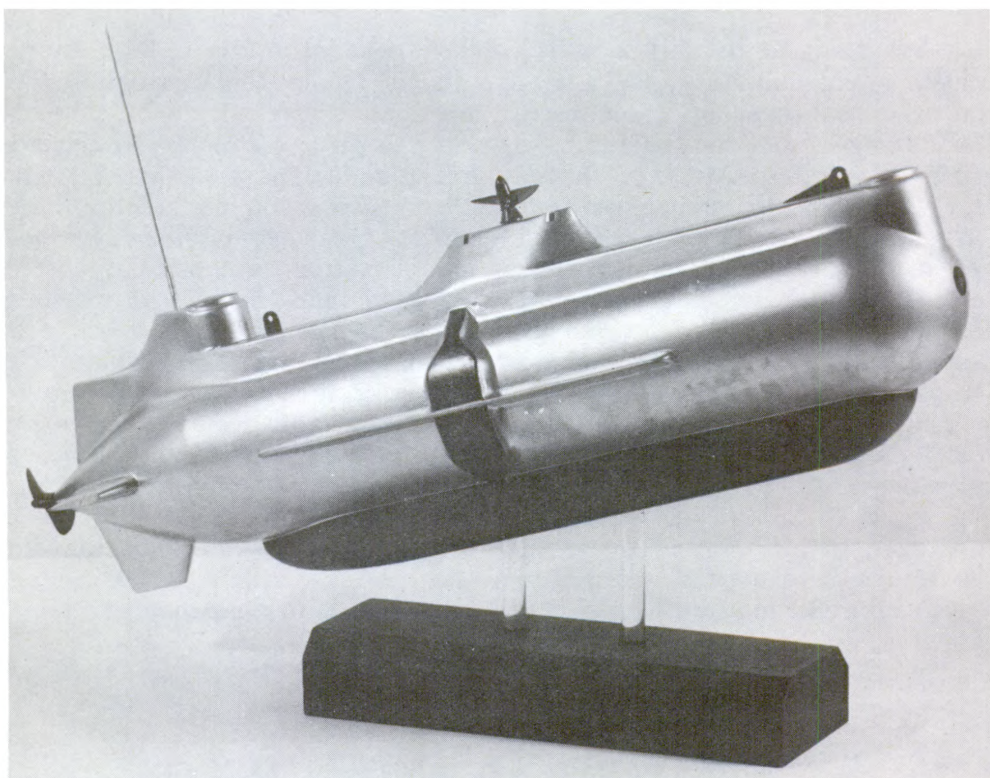
Dr. Shapiro: In the fields with which I am most familiar, high-energy physics and cosmic rays, I believe that physicists in Western Europe and the U. S. are still generating more of the significant discoveries than their Soviet colleagues. However, these are among the areas in which the USSR is determined to overtake and surpass the West. Massive resources of manpower and equipment are being poured into these fields. Moreover, students of science receive every encouragement when they select these areas of specialization. Accordingly, great strides have been made in the past decade, and the rate of growth of Soviet strength in these disciplines has been greater than our own. Along with the substantial encouragement of research and higher education in these areas of modern physics, it is noteworthy that Soviet scientists enjoy a measure of freedom considerably greater than that of the typical citizen (though by our standards it still leaves much to be desired). This freedom is apparently recognized as an essential precondition to success in basic research. If this freedom should not be abridged in the coming years, and if the present rate of Soviet physics continues to exceed the rate of growth in the West for a decade or two, then the USSR may well forge ahead of the West in fundamental nuclear physics, as it has done in rocket technology.

*Dr. Shapiro wrote these observations in September, 1959. Two months later, on November 24, 1959, the CERN accelerator in Geneva did reach its design energy of 28 Bev. It is now the highest-energy atom smasher in the world.

The Aluminaut

In the not-too-distant future, American oceanographers will be exploring the ocean floor in an aluminum research-type submarine, appropriately named "Aluminaut." In both purpose and concept it will be similar to the Piccard "Trieste," but it will be far roomier (because the observers will be inside the hull, rather than in a ball-like gondola) and will have much greater underwater cruising radius: nearly 100 miles as opposed to Trieste's 1/4 mile. The submersible will be able to dive to 15,000 feet, which is equal to or greater than the known depth of 60 percent of the world's oceans.

Building the Aluminaut is a private undertaking of the Reynolds Metals Company, of Richmond, Va. The completed vessel will probably be leased to oceanographic institutions for specific research projects. The Navy is closely involved because it is one of the chief sponsors of oceanic research in this country; it will probably act as sponsor for Aluminaut's use at various institutions. For that reason the ONR Undersea Programs Branch has been consulted continuously since the inception of the project at Reynolds. Other consultants have been the Southwest Research Institute, National Academy of Sciences, Woods Hole Oceanographic Institute, and Scripps Institution of Oceanography.



Model of "Aluminaut" (courtesy Reynolds Metals Co.).

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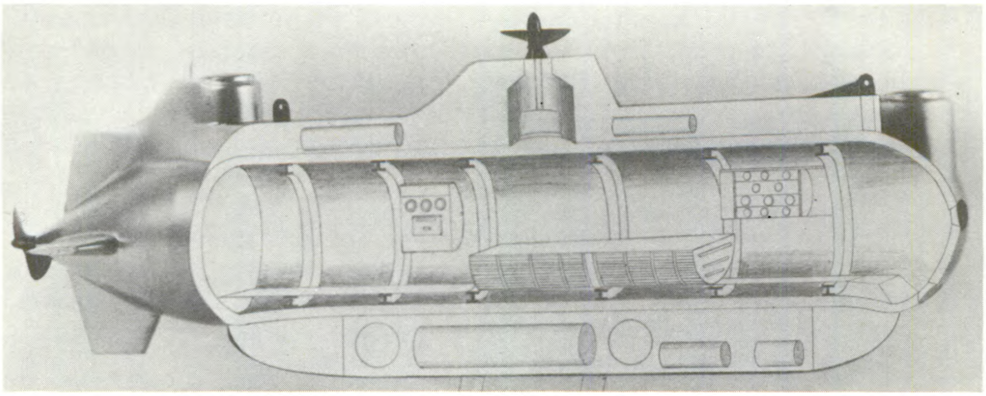
*Adapted from a series of articles in Reynolds Review.

The Aluminaut will be about 48 feet long, with a 30-foot cylindrical pressure hull made of 6-inch aluminum plate. Its 7-foot inside diameter will accommodate a pilot and two scientific observers, together with more than 3400 pounds of scientific instruments. In addition to a stern propeller the vessel also has a vertical propeller which will permit hovering and staying in place for special observations. The vertical propeller also will help to control rate of descent and ascent. The main propulsion motor and control system power units will be mounted within a completely isolated stern capsule, filled with oil for pressure equalization.



Artist's drawing of the interior of the Reynolds Aluminaut. Three men, with 3400 pounds of scientific instruments, can be carried within its 7-foot-diameter hull. (Courtesy Reynolds Metals Co.)

The Reynolds Company has programmed the submarine development project in five phases:

- Feasibility studies to determine merits and practicability of construction with high strength aluminum alloys, and to establish general dimensions and specifications.

- Preliminary design and structural model tests.

- Final design with complete engineering and equipment specifications.

- Fabrication of the submarine and proof testing of structural components.

- Proof testing with unmanned dives to 17,000 feet, sea trials, surface and submergence tests, and final readiness for manned deep dives to 15,000 feet.

The first-phase feasibility research was completed in January 1959, after nearly a year of experimenting and testing by a Reynolds-sponsored team of submarine experts. RADM D. H. Day, USN Ret., now a Reynolds executive, is its project director. The studies indicate that the Aluminaut would be capable of exploring at 15,000 feet depth for 36 hours, with another 36 hours emergency allowance. It could travel nearly 100 miles through the depths or along the ocean's floor before returning either to a tending ship or to harbor. For operations far offshore, the boat can be towed at considerable speed even in rough waters.

The feasibility studies included pressure testing of several aluminum alloys of varying thicknesses. The 6-inch plate finally selected will solve the primary problem confronting submarine designers—that of providing sufficient strength to withstand the pressure of extreme depth, without the need of a material so heavy as to defeat its buoyancy.

The work with aluminum alloys revealed an unusual phenomenon. Since the 6-inch-thick aluminum hull is less compressible than water, the boat will descend from the surface when it carries an excess of weight over buoyancy, but it will not fall all the way to the bottom unless water ballast is added. Thus the Aluminaut could descend to a selected intermediate depth and remain suspended where weight and buoyancy are in equilibrium.

The second phase of the Project—design and model testing—was recently completed at the Southwest Research Institute in San Antonio, Texas, under the leadership of Dr. Edward Wenk, Jr. Prototype scale models were built, and were tested in pressure tanks which simulated depths to 21,000 feet.

Aluminaut will be bolted together and the seams will be caulked and bonded with a special adhesive that is now used in bonding the aluminum skins of some jet airplanes. Three built-in ballast systems—shot tanks midships, submergence water tanks in the keel, and solid keel ballast which is detachable for emergency surfacing—are provided in the preliminary designs. (The shot tanks contain steel balls which are held magnetically so that they can be quickly jettisoned to increase buoyancy.)

Aluminaut represents the first member of a new generation of research submersibles. Succeeding members could be equipped with robot arm mechanisms for collecting material from the sea bottom and depositing it in exterior bins. Master-and-slave mechanical hands, such as have been developed for remote handling of radioactive substances, could operate mining equipment, make borings, collect samples, and perform other useful tasks. These operations would be conducted from within the hull. Although Aluminaut's present design specifies two small, thick viewing ports in the bow, final design may include powerful TV cameras, which would telecast the view onto screens within the hull.

The first Aluminaut, however, is designed primarily for scientific study of the physical and chemical properties of the ocean depths and floor, acoustic measurements, geophysical and geological exploration, and biological discovery of benthonic forms of life previously beyond the depth of direct observation.

The entrance of the Reynolds Company into the field of submarine designs was not just a routine business venture. The Company's executive vice-president, J. Louis Reynolds, has had a life-long interest in the mysterious world beneath the surface of the sea. He was a friend and business associate of the famous submarine inventor, Simon Lake; he took to the Maritime Commission, during World War II, a design for a cargo-carrying submarine that would have had a 7500-ton capacity yet could be built at low cost; after the War, he retained Lake as a consultant for the design of an oil-drilling submarine; meanwhile, he became one of the first Americans to investigate the aqualung, and was a pioneer in the sport of skin diving.

In talking about Aluminaut, Mr. Reynolds has said, "Three-fourths of the earth's surface is covered with water. It's reasonable to assume that our greatest reserves of minerals are probably to be found in this area. Many of the mountain ranges which are now producing minerals were once under water. There is geological evidence to prove this, and we know how much oil has been found in the shallow off-shore waters of Lake Maracaibo and in the Gulf of Mexico.

"If we could get down to a depth of 18,000 feet, 90 percent of the underwater world would be accessible for exploration. If we can get down that deep to explore we can develop means to exist at that depth to mine the minerals or to drill for oil. The possibilities are enormous. The problem to overcome, of course, is the tremendous pressures to be encountered at such depths. At 18,000 feet, for example, a tiny hatch two by three feet in size must be able to withstand 3888 tons!"

Mr. Reynolds is the first to admit that the Aluminaut is but a first step in the exploration of the vast ocean floor. "This vessel will be able to make studies and take some samples and photographs," he said. "But primarily its purpose is to prove that man can operate safety at such depths."

M. Lee Lewis Memorial Fund

A memorial fund to help provide for the education of the children of the late M. Lee Lewis, killed while preparing a ballon for flight, was established by three companies engaged in the fabrication and flying of high-altitude research balloons: General Mills, Inc., Minneapolis; Raven Industries, Sioux Falls, S.D.; and the G. T. Schjeldahl Co., Northfield, Minn.

CDR Malcom D. Ross, who accompanied Mr. Lewis on the first plastic balloon flight, will serve as trustee of the fund. The companies contributed $1000 each, to be paid over several years.

"Lee Lewis was one of the world's most important pioneers. His flights to the edge of space have yielded important scientific data that will endure forever," CDR Ross stated.

Research Notes

TV Optical System for Dental-Medical Use

A new optical fiber probe and closed-circuit TV system (see inside front cover) that will permit viewing of the inside of the patient's mouth, highly magnified, on a TV screen has been successfully demonstrated at the U. S. Naval Dental School, Bethesda, Md. The device eventually can be adapted for medical probes to explore inside the human body. It has been developed under a feasibility study sponsored by the Office of Naval Research and carried out by Avco Corporation at Wilmington, Mass.

RADM Bartholomew W. Hogan, Surgeon General of the Navy, stated: "The Navy supported this program because we desired to find out whether this promising new principle would actually work in practice. The research done so far has demonstrated that television can be very useful in dental procedures and offers the promise of significant improvement in dental training. Also, with further development, this technique may permit us to review the inside of other body cavities, highly magnified and in color, with the picture accessible to many persons—perhaps doctors, nurses, and students—simultaneously."

TV cameras are now used in limited dental application, but are impractical. They can view only part of the mouth, present a difficult lighting problem, and cause discomfort to both patient and dentist because of their size.

The optical probe system being developed at Avco consists of a bundle of optical fibers wound together in a small whip-like cable with a fingertip-size lens arrangement at the probing end, coupled to a closed-circuit TV camera at the other end. A bundle contains up to 10,000 of the hair-like fibers. Each tiny fiber picks up light from a microscopic section of the surface in front of it, and transmits the speck of light to the other end. With thousands of the fibers bound tightly into a cable, a picture made up of the thousands of light segments can be sent from the lens inside the patient's mouth to the TV camera and from there to the screen where the tooth, or a portion of it, is seen magnified up to 35 times its actual size.

This permits the dentist to display selected portions of the mouth or individual teeth during actual operative procedures for simultaneous inspection by other dentists or students. From a training standpoint, it would permit large classes of students to watch the procedures of an experienced practitioner.

Successful use of the new system in "endoscopes" would be a great step forward over any current technique. The flexible probe could reach and illuminate areas not now accessible. It could display these areas for inspection by several specialists for immediate consultation and diagnosis. It would render surgical operations highly visible to students, who now must rely almost entirely on the surgeon's running commentary for an understanding of the operation.

Since the fibers can transmit light in both directions, they could also be used to bring in light from a remote source without electrical wires. This means that body cavities could be illuminated for inspection or treatment without the hazard of electrical sparks in the presence of an explosive anesthetic.

The use of fiber optics for transmitting light has been under exploration at various places in the United States and Europe for many years, and their application to medical probes has also been previously investigated. The Navy-supported Avco feasibility study, however, is the first to couple the fibers, lenses, and a TV camera to obtain a system permitting great magnification and simultaneous viewing. The work has been the responsibility of H. P. Hovnanian, head of medical science technology at Avco's Research and Advanced Development Division. Technical assistance and advice on the project have been provided by the U. S. Naval Dental School, National Naval Medical Center. Experimental optic fiber bundles were obtained from the American Optical Company. (Navy Medical News Letter)

"Land" Beneath the Gulf

A new "land"—starting beneath the bottom of the Gulf of California and reaching thousands of feet down—has been explored for the first time by a geophysicist at the University of California, Los Angeles.

Underneath the smooth layers of sand and mud covering the Gulf floor are large valleys and ridges, says Dr. John C. Harrison, a 30-year-old scientist at the UCLA Institute of Geophysics. To map these rock formations, Dr. Harrison and Dr. Michael Caputo, of the University of Trieste, in Italy, took a two-month scientific voyage aboard the USS HORIZON, the 505-ton research vessel of the Scripps Institution of Oceanography, LaJolla, Calif. Criss-crossing the Gulf between Baja California and the Mexican mainland, they measured the pull of gravity of the invisible rock formations with changes in the pull indicating variations in the height and composition of the ridges. Their measuring tool was a gravity meter, an apparatus so sensitive that it can detect changes in gravity of one in a million.

"This is one of the first large-scale gravity surveys made from a surface ship," says Dr. Harrison. "Until now, most measurements were taken by submarines which could dive under the waves and float in still water."

The survey, supported by the Office of Naval Research, is part of the "Vermilion Sea Expedition," a wide-ranging study of the Gulf by Scripps.

In addition to its importance to oceanographers and the Navy, the gravity study may ultimately lead to oil explorations beneath the ocean floor. (ONR-Pasadena)

The Mohole

As a result of previous ONR-supported research in Oceanography, scientists can predict what discoveries can be expected from Project Mohole. When the deepest hole on earth—the Mohole—is drilled through the floor of the Pacific to the earth's mantle, the scientific puzzle of "the missing sediments should be solved."

Careful study of the rates of the deposit of sediments on the deep-sea floor tells oceanographers that there should be a layer of sediment about two miles thick between the waters and the underlying rock. Equally careful measurements of the actual thickness of the sediments indicate that they average about 1500 feet in the deep Atlantic and about 1000 feet in the deep Pacific. That is about a tenth as much sediment as might be expected.

Russel Raitt, professor of geophysics at the University of California's Scripps Institution of Oceanography, has spent the past decade mapping the sea floor and the rocks beneath it by seismic methods. His technique is to set off an explosion and to record the time it takes the resultant earthquake waves to travel through the various layers in the crust of the earth. By this method Raitt has measured the thickness of the sediments and the three layers of rock above the earth's mantle.

Raitt says there are three possible solutions to the mystery of the missing sediments:

- The Pacific Ocean simply might not be as old as is believed. If the rate of sedimentation has always remained the same, and if all the sediments remain unconsolidated on the sea floor, then the Pacific is no more than 100 million years old.

- Sediment accumulation might have been much slower in the past than at present. At present it is less than a quarter of an inch in a thousand years. Perhaps in the past, a thousand years might have passed with the deposition of sediments no more than the thickness of a sheet of paper.

- Old sediments may have turned to rock or they may be hidden by lava flows known to exist on the ocean floor.

Raitt and other scientists believe when the National Academy of Sciences drills the Mohole within the next few years, this question may at last be answered. (ONR-Pasadena)

Hazards of Electromagnetic Radiation

Several scientists and engineers at the U. S. Naval Ordnance Laboratory, White Oak, Md., are participating in a research program, RAD HAZ—for RADiation HAZards—now being actively pursued by all military services and also private industry. The "probelm in search of a solution" is that of radio-frequency energy from radio and radar transmitters which has caused a number of accidental rocket firings; high-intensity in ship structures and carrier aircraft; and burns suffered by personnel.

NOL is engaged in studying one aspect of the problem under the HERO project—Hazards of Electromagnetic Radiation to Ordnance. This aspect of the problem is complicated by the many different types of weapons and electrically initiated explosive components placed in operation. In addition to laboratory research at NOL, White Oak, representatives of NOL have taken part in field tests at the Naval Ordnance Test Station, China Lake, Calif., and on board aircraft carriers.

NOL research is presently centered on establishing the sensitivities of various initiating devices to radio-frequency energy. The primary vulnerability of a weapon to radio-frequency initiation is usually found in the electroexplosive device, the normal means of initiating the weapon. Since World War II, radio and radar transmitting equipment have become progressively more powerful. During the same period, electroexplosive devices have been designed for ever greater sensitivity to ensure reliable performance. The work at NOL is essentially part of a long-range program which will eventually result in the establishment of radio-frequency tolerance limits for all weapons and components. Present work of the HERO project at NOL is devoted largely to determining the sensitivities of various electroexplosive devices to electromagnetic radiation.

The earliest experiences with radio-frequency hazards to explosives were in private industry. A report published in 1953 by the Institute of Makers of Explosives stated: "When they are in operation, all transmitters of radio and related radio-frequency services, such as television and radar, create a field of electrical energy in the air surrounding their antennas. It has been found that . . . electrical blasting caps may pick up enough of this energy to cause them to explode." Tables included in this report covered minimum safe distances from transmitters for electric blasting operations and operating characteristics for most types of radio-frequency transmitters.

In the over-all HERO test program, involving every branch of the military and naval services as well as private industry, all types of ordnance have been exposed to all sorts of electromagnetic radiations. Each weapon or component poses an individual problem. An early finding was that rockets in certain types of launchers were highly susceptible to accidental premature ignition from radio-frequency energy emanating from deck-edge whip antennas. As a result, restrictions were placed on the use of these particular launchers until they could be modified to eliminate the hazard.

The Bureau of Ships has over-all responsibility for coordinating the RAD HAZ program for the military services. Contributing to the program are HERO, undertaken by BuOrd and BuAer, and SPARKS, related to hazards to fuels and other volatile materials, under BuShips. A third aspect, under the Office of Naval Research, is BIO, related to personnel and health hazards encountered from radio-frequency energy.

U.S. Navy-New Zealand Joint Dental Investigation

CAPT F. L. Losee, DC, USN, is currently representing the Naval Medical Institute on an extended field assignment, undertaken at the request of the New Zealand government, to take part in an investigation entitled "New Zealand Dental Caries and Soil Relationship." Associated with CAPT Losee as coprincipal investigator is Dr. G. N. Davies of the University of Otago Dental School, Dunedin, New Zealand.

Extensive preliminary clinical surveys of the incidence of dental caries in children of certain communities indicated a strong influence by regional soil types. This research was designed to determine the relationship between the trace elements in soil, pasture, food, and water of selected areas to trace elements in urine, bones, and teeth of sheep; and in urine and extracted teeth of children living in those areas. Resultant findings will be related subsequently to the clinical-dental condition of children living in the areas. The first year of selection led to selection of two pairs of communities where caries incidence is lower, and in which trace element contents of locally grown vegetables appear elevated in molybdenum, aluminum, and titanium, and lower in copper, manganese, barium, and strontium.

The Prime Minister of New Zealand, the Right Honorable Walter Nash, expressed his government's appreciation to the U. S. Navy Dental Corps for the part it is taking in the program.

Project TRADEWINDS

A recent experimental program conducted jointly by the U. S. Navy and the U. S. Air Force has proved conclusively the existence of an elevated transoceanic atmospheric duct capable of trapping and propagating radio waves at low loss over the considerable distance in the South Atlantic tradewinds area between the coasts of South America and Africa. Previous meteorological studies conducted by the U. S. Air Force Cambridge Research Center, the U. S. Naval Research Laboratory, and the Electromagnetic Research Corporation predicted the existence of the elevated duct due principally to the atmospheric temperature inversion layer characteristic of the tradewind regions.

This duct has a thickness of approximately 500 feet and is centered at a height of approximately 5000 feet and extends from West Africa to the coast of Brazil. Ascension Island, the last island outpost on the U. S. Atlantic Missile Test Range with launching sites at Cape Canaveral, Florida, is strategically located in this region.

The airborne radio experiment was conducted by the Naval Research Laboratory between two aircraft, a WV-2 from the Naval Research Laboratory and a P2V from the Naval Air Development Unit, operating between Recife, Brazil, and Ascension Island for a four-week period in November and December. Radio equipment operating at a frequency of 229 Mc (slightly above the VHF TV band) was used to measure radio signal characteristics as a function of both distance and elevation heights varying from sea level up through the elevated duct. With a transmitter power of only 100 watts, signals were detected all the way from Brazil to a point over 1430 miles away (the turn-around point of the receiving aircraft). This represents a technological advance in transoceanic communications possibilities.

Meteorological characteristics of the duct indicate a stable mechanism is present all year around with a small variation in height with season. A similar mechanism is predicted for the other three tradewinds areas—North Atlantic and North and South Pacific.

Future joint programs under consideration include a ground-to-air study of the ducting conditions between the Coast of California to Hawaii, a ground-to-ground experimental program between Ascension Island and Brazil to determine methods of coupling radio energy into and out of the elevated duct by ground-based transmitters and receivers, and a preliminary meteorological study in the North Atlantic tradewind region.

Needed: Research As Old As Seafaring

The "Ancient Mariner" summed up a problem in a manner that will probably never be surpassed. The problem: "Water, water everywhere, nor any drop to drink."

A shortage of fresh water has plagued the Navy since its beginning. Salt water is fine, especially for floating a ship, but until someone discovers an easy and cheap way to remove its saline content, salt water is somewhat less than desirable for drinking. Many approaches have been made to the problem. Chemical tablets have saved lives in emergencies. Fresh water can be carried in containers, but weight limitations and faulty containers have limited this approach, especially for emergency use.

During World War II, some patrol aircraft were issued small five gallon stills that used various fuels to produce potable water. A problem here lay in the fact that these stills just as readily distilled liquids other than water and frequently were used for that purpose.

Solar stills have been used, but generally depend upon a warm climate. This is a fabric container that is inflated into the shape of a sphere. Sea water poured into the top and sunlight causes it to evaporate and condense into a container.

Rainwater still continues to be collected, but any aerologist can testify to the unreliability of weather. Since a man requires at least one pint per day – water, that is – to sustain life, rain squalls might be too few and far between.

Somewhere, someday, one of the men now working on this problem will come up with a solution and the world will be his for the asking. It may be so simple that everyone else will say, "Now why didn't I think of that?" It's food for thought – or, perhaps, water for thought.

On the Naval Research Reserve

Research Reserve Companies Win Top District Honors

Research Reserve Companies in the Eighth and Thirteenth Naval Districts placed first in Specialist Program competition in those districts.

NRRC 8-13

The First-Place Award in Eighth Naval District Specialist Program competition was made to NRRC 8-13, Stillwater, Oklahoma. Out of a total of 82 Specialist Units competing (1881 officers and 104 enlisted), NRRC 8-13 was the highest score in district competition for fiscal year 1959. The award ceremony took place at a dinner meeting on 19 November 1959 and coincided with the 10th anniversary celebration of the company.

CDR L. P. Hoskins, USNR, of the ONR Branch Office, Chicago, presented to CDR Dariel E. Howell, Commanding Officer of NRRC 8-13 during fiscal year 1959, the Commandant's Plaque for excellence. After the presentation, CDR Hoskins spoke about leadership problems in the Pacific Fleet. LT C. S. Lardis, also of the ONR Branch Office, Chicago, discussed training opportunities in the light mobilization plans for Research Reservists, and then bid farewell to the members of the company due to his forthcoming detachment. CDR J. A. Holley, USNR, Dean of the College of Education at Oklahoma State University, represented the Commandant, Eighth Naval District, and discussed the leadership program. In attendance were the 14 members of the company and LCDR W. D. McClary, USN, Commanding Officer of the Naval Reserve Training Center, Stillwater.

The first Commanding Officer of the company, CDR O. H. Hamilton (1949-50, 1953-56), was master of ceremonies at the banquet. All of the members of NRRC 8-13 are on the faculty or staff at Oklahoma State University. Three of the members are original "plank holders." They are CDR Hamilton, CDR Howell, and LT D. F. Wadsworth. The present Commanding Officer is CDR Roy W. Jones, USNR.

Presentation of First-Place Award to members of NNRC 8-13.

NRRC 13-2

The Richland, Washington, Research Reserve Company, NRRC 13-2, was named by the Commandant, Thirteenth Naval District, as the outstanding Specialist unit in the naval district. The Richland company was selected best of 41 Specialist companies competing.

The First-Place Permanent Plaque was presented by CDR E. C. Miller, USN, District Program Officer for the Naval Reserve Research companies, to LCDR Roy S. Peterson, USNR, Commanding Officer of NRRC 13-2. Seventeen of the 18 members of the company are employees of Hanford Atomic Products Operation of the General Electric Company.

Presentation of First-Place Permanent Plaque to NNRC 13-2.

Awards Presented in Ninth Naval District

First and second place awards to Research Reserve companies in the Ninth Naval District have recently been presented to NRRC 9-5, Ames, Iowa, and NRRC 9-19, Iowa City, Iowa, respectively.

Presentation to NRRC 9-5

NRRC 9-5, composed of Navy Reservists in the Ames, Iowa, area was recognized as the outstanding Research Reserve company in the Ninth Naval District for the fiscal year 1958-1959 and an award was presented at a dinner 28 October 1959 in Ames, Iowa.

The award was presented by CAPT D. F. Francis, USN, Assistant Chief of Staff for Naval Reserve and Training, Ninth Naval District. Other guests at the dinner were COL R. H. Crockett, USMC, Commanding Officer, NROTC unit, Iowa State University; CDR K. H. Berkley, USN, Executive Officer, NROTC unit, ISU; CDR J. M. Fabre, USNR, Commanding

Officer, U. S. Naval and Marine Corps Training Center, Des Moines; and CDR L. P. Hoskins, USNR, Officer of Naval Research Branch Office, Chicago.

LT Robert K. Larson, USNR, was the Commanding Officer of the unit during the period in which the award was won. LT LeRoy Everson, USNR, is the present Commanding Officer of the unit.

Presentation to NRRC 9-19

Presentation ceremonies for the Commandant, Ninth Naval District, Second-Place Award Plaque were held on 2 October 1959 in Iowa City, Iowa. The recipient of the award was NRRC 9-19, Iowa City, commanded by LT Marvin S. Thostenson, USNR. A cocktail party and dinner preceded the formal ceremonies. Guest speaker was CAPT J. P. Aymond, Special Assistant to the Chief of Naval Research (Research Reserve), ONR, Washington, D. C. CDR L. P. Hoskins, USNR, and LT C. S. Lardis, USN, of ONR, Chicago, were also present for the award ceremonies.

CAPT D. F. Francis, USN, presents the Award Plaque to LT R. K. Larson, USNR.

Submarine and Diving Medicine Seminar to Convene

The next Research Reserve Seminar to be held will be the Submarine and Diving Medicine Seminar at New London, Connecticut. The seminar will convene on 21 March 1960.

This seminar, presented for the first time last year, promises to have an excellent program again. Reservists are eligible for attendance who are concerned with the physiological, psychological, and environmental problems related to submarine and diving operations.

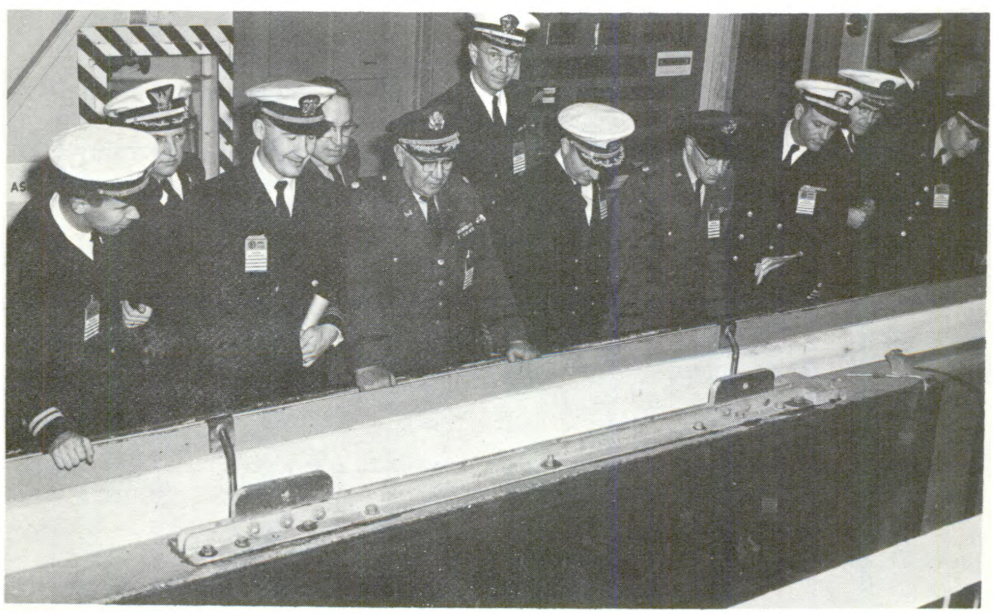
Nuclear Science Seminar at Oak Ridge

The Eleventh Annual Nuclear Science Seminar at Oak Ridge, Tennessee, was held from 29 November to 12 December 1959 with Naval Reserve Research Company 6-3 serving as host. The seminar was sponsored by the Office of Naval Research in conjunction with the Atomic Energy Commission and the Oak Ridge National Laboratory. The 95 participants, including 52 USNR, 28 USAR, 3 USA, 10 USAFR, and 2 USCGR officers, constituted the largest seminar group so far in Oak Ridge. CDR C. O. Smith, USNR, served as Seminar Chairman.

During the two-week seminar, discussions were devoted to various facets of the over-all nuclear research program including some basic theory and applications in the fields of the life sciences, isotope production and use, and nuclear reactors. The presentations of these topics were made by scientists and engineers associated with the Oak Ridge National Laboratory, the Oak Ridge Institute of Nuclear Studies, and the University of Tennessee Agricultural Research Laboratory.

Speakers on topics of specific military interest were: CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research for Research Reserve ("The Research Reserve"); CDR H. F. Slawson, USN, Defense Atomic Support Agency ("Nuclear Weapons"); CDR P. W. Crutchfield, Jr., USN, Nuclear Power Section, OPNAV ("The Navy's Program for Nuclear Propulsion of Ships"); COL J. E. Bicknell, USAF, Aircraft Reactors Branch, USAEC ("Aero-Space Applications of Nuclear Energy"); and CAPT J. Astarita, USA, Army Reactors Branch, USAEC ("The Army Nuclear Power Program"). The closing talk of the seminar was given by Dr. W. G. Pollard, Executive Director of the Oak Ridge Institute of Nuclear Studies on the "Origin of the Universe."

Field trips included tours of the American Museum of Atomic Energy, Fort Loudon Dam (TVA), Kingston Steam Plant (TVA), Abbot Laboratories, the ORINS Industrial Isotopes Laboratory, the UT-AEC Agricultural Research Laboratory, and the Oak Ridge National Laboratory.



Seminar attendees at the "Swimming Pool" Reactor, Oak Ridge National Laboratory.

Seminars Planned for Fiscal Year 1961

Eleven Research Reserve seminars are planned by the Office of Naval Research for fiscal year 1961. Final approval on these seminars must be given by the Bureau of Naval Personnel. Further information will then be promulgated officially in BUPERS Instruction 1571.4 series. This Instruction is expected to be available in May 1960. The titles, places, and dates of the seminars presently planned are as follows:

Research Methods, Columbus, Ohio	10 July 1960
Training Device Center, Port Washington, N. Y.	17 July 1960
Nuclear Science, Idaho Falls, Idaho	24 July 1960
Naval Research Laboratory, Washington, D. C.	14 August 1960
Guided Missile (West Coast), Pasadena, Calif.	14 August 1960
Research Planning & Management, Princeton, N. J.	21 August 1960
Life Sciences, Brookhaven National Laboratory, Upton, L. I., N. Y.	11 September 1960
Nuclear Science, Oak Ridge, Tennessee	27 November 1960
Aviation Medicine, Pensacola, Florida	19 March 1961
Research Reserve Seminar, ONR, Washington, D. C.	4 June 1961
Great Lakes Seminar, Great Lakes, Illinois	11 June 1961

CDR Ross Observes Venus from Navy Research Balloon

CDR Malcolm D. Ross, USNR, who piloted a balloon more than 15 miles above the earth, is a member of Naval Reserve Research Company 5-8, Washington, D. C.

The front-page flight was launched on 28 November 1959 at the Stratobowl near Rapid City, South Dakota. Accompanying CDR Ross on the flight was Charles B. Moore, a scientist on the staff of Arthur D. Little, Incorporated, Cambridge, Massachusetts. Mr. Moore handled the data-taking instruments.

The primary purpose of the flight was to confirm the feasibility of using the Strato-Lab balloon system to conduct astrophysics research while aloft in the stratosphere, a region free of most of the effects of the earth's atmosphere. Venus was selected as the object to be studied during the flight because it was in a favorable position for such observations at that time.

During this flight, a specific study was made of the atmosphere of Venus in order to determine its water vapor content. Other planets and possibly stars beyond the earth's solar system will be studied in subsequent flights.

The flight terminated in a parachute landing, during which the gondola was dragged for a considerable distance and nearly demolished. CDR Ross received a violent shaking up, but escaped serious injury.

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Uniform for looking at Venus. CDR Malcolm D. Ross, USNR, left, and Charles B. Moore, scientist on the staff of Arthur D. Little, Incorporated, Cambridge, Massachusetts, right. (See story on facing page.)

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

Scientific information exchange in Russia. Delegates to the International Conference on Cosmic Rays chatting on the steps of the University of Moscow.