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RESEARCH REVIEWS

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: The Naval Research Laboratory on its thirtieth birthday. For a picture of NRL in 1923, when it began, see page 17. Since July of that year the Laboratory has been carrying out its mission...to perform applied research, development, and evaluation work to meet the immediate requirements of the Naval Forces and to perform basic research in anticipation of future needs for national defense. In working toward these ends, NRL has been a pioneer in hundreds of developments. "NRL Looks Back" by Mr. A. T. Drury, pages 14 to 24, tells about some of these.

Research Reviews endeavers to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C.

Approved by Bureau of the Budget, 14 February 1952

In This Issue

Some of the FAST team alongside a commo trench on the main line of resistance. Left to right are: 1st LT E. R. Kolovos, Army Medical Research Laboratory; LT John H. Kilbuck, ONRU-1; and LTJG Elaine G. Walker, ONRU-1.

Front-line Studies of Combat Stress

Nello Pace

...Associate Professor of Physiology at the University of California, Berkeley, is also Project Director of ONR Unit One, whose first mission he reports here.

Office of Naval Research Unit 1, established at the University of California, Berkeley in July 1951 as part of ONR's San Francisco Branch Office, has successfully completed its first field mission. The fifteen members of ONRU-1 were drawn from Volunteer Naval Reserve Research Company 12-2 and placed on active duty when ONR needed a complement of scientists to initiate a research program for the Navy. Five of the group returned last winter from a four-month operation in Korea and Japan studying the effects of acute combat stress on infantrymen. Sponsored by the Operations Research Office, an agency of Johns Hopkins University under contract with the Army, Project FAST, as it was called, was headed by LCDR Nello Pace, who is Officer-in-Charge of ONRU-1. Dr. Pace here tells the story of Project FAST.

What actually happens inside an infantryman when he is subjected to the stress of combat? What happens to his glands, his nervous system, his mental processes? Seeking an answer to these questions, ONR Unit One joined the Army and the Operations Research Office in a front-line study of infantrymen in Korea—the first of its kind to be made on men in actual combat.

Ultimately we hope to find enough answers to be able to counteract the adverse effects of fatigue and stress—not only of the infantryman but of anyone under severe stress. Because the body's reaction to stress is the same, regardless of the stimulus. In fact, we might not be able to distinguish, by physiological and psychological examination, between a Wall Street banker fatigued by business worries and an infantryman just returned from active combat. Thus, although the Navy (the Bureau of Medicine and Surgery) has the responsibility for the care of Marine Corps personnel and, therefore, a special interest in the combat soldier, our results should be universal in application.

While a great many experiments have been carried out in laboratories where different forms of stress have been simulated by various means, there has always been a question as to the extent of this artificial stress. Consequently, a study of the reactions of

The 8063 Mobile Auxiliary Surgical Hospital (MASH) Unit, north of Seoul, in October 1952. Headquarters of the FAST team, whose laboratory building is shown opposite.

individuals exposed to a truly severe situation, where every element of stress was unquestionably present, should yield valuable results.

A team of 13 included five civilians from the Operations Research Office, two representatives of the Surgeon General of the Army, one from the Naval Medical Research Institute, and five ONRU-1 members—LCDR Nello Pace, physiologist; LT F. L. Schaffer, biochemist; LT J. H. Kilbuck, food technologist; LTJG Elaine L. Walker, physiologist; and LTJG Muriel E. Johnston, physiologist.* We left the west coast by air on August 28 and went directly to Tokyo. In order to try out our test procedures under conditions similar to those we would be working under in Korea, to make sure we had all the necessary equipment, and also to get some control data on infantrymen who were not under combat stress, we set up for operation in Tokyo. Our tent was located in a motor pool parking lot within a block of the palace grounds in the heart of downtown Tokyo. We ran our tests on a group of 23 soldiers located in a camp about an hour's drive away from the tent. This was to simulate the situation in Korea where we expected to have our laboratory about an hour's drive from the various places on the main line of resistance.

Leaving Tokyo on September 28 we went directly to the 8068 Mobile Army Surgical Hospital Unit (MASH) which was at that time

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*This is the first time WAVES have been in a combat zone. LTJG Walker and LTJG Johnston were taken along as an integral part of the team because of special technical qualifications. Both of them visited forward installations and LTJG Walker visited the main line of resistance. She had the experience of having an enemy mortar round burst within 25 yards of her.

The FAST laboratory building at the 8063 MASH. Left to right are: LTJG Muriel E. Johnston, ONRU-1; PFC Eddie Harris, jeep driver; LTJG Elaine L. Walker, ONRU-1; and LCDR Nello Pace, ONRU-1.

located in central Korea about as far from the sea as any Navy man could get in Korea. The Army built us a prefab structure with a cement floor known as a tropical shell, 20 by 54 feet, so that our situation there was much better than we had expected. (We had been overly pessimistic in Tokyo, and had made things unnecessarily difficult for ourselves.) Two sinks were improvised from a 50-gallon fuel barrel, cut in half longitudinally. We also had to rig up our own water supply. Power was provided by the generator brought along. We had also

The H13 helicopter with two side litters above the skids at the 8063 MASH. This is the life-saving ambulance of the Korean war.

brought tanks of propane so that we had water, gas, and lights—altogether a quite up-to-date, complete laboratory just 12 miles behind the main line of resistance (the MLR).

As there was very little active combat at the time, our original plan was to use patrol actions as a sharply definable tactical operation—to study the men a few days before they went out on patrol and immeddiately after they returned and then again a few days later. Comparing these data would then give us some idea of the effect of a patrol action on the individuals. We scheduled our first patrol group to be studied for October 7. But on the night of the 6th the Chinese started their limited fall offensive on the White Horse Hill area. This was right next to the 7th Division sector; the action actually overlapped it slightly. Patrol schedules therefore were cancelled. We did take advantage of the increased action, however, and, to get some idea of the physiological changes accompanying psychiatric breakdown, we studied a few men who were psychiatric casualties as a result of the action.

It then developed that the 7th Division had been planning an offensive which turned out to be the Triangle Hill battles, and we were able to make studies on a group of 24 men from Able Company of the 31st regiment which led off the Triangle Hill assault. We tested them the day before they went into combat, again shortly after they were relieved from the active assault area two days later, then four days after their return, and finally again 3 weeks after return. We were also able to study another group of 13 men from George Company of the 17th regiment who had been in the same area a little later on during the Triangle Hill battles. They had been in active combat for five days, and we got them within five hours after they retired from the assault area. We were not able to get prestress tests on these men, but we did measure them again 10 days after their return.

In order to get a little more detailed information on the normal situation for a combat infantryman in Korea, we thought it would be desirable to test another group of men who had not been exposed to acute combat stress for a while. Consequently, we studied a final group of 24 men from the 15th regiment of the 3rd Division. On these men we ran repeat tests four days apart, thus gaining a good retest estimate of the various measures used. All told, some 106 soldiers, including company officers, were examined in the course of the study, and an average of two to three *tests* were performed on each man.

In line with recent developments in the field of stress physiology, we centered our interest largely on investigating the part played by the pituitary-adrenal system in the body's reaction to combat stress. The autonomic nervous system—long known to play an important role in resistance to stress—was also studied, to a lesser degree. An estimate was made of the influence of nutrition. To complement these organic indexes of the effects of stress, we examined behavioral changes of the individual—by quantitative psychological tests primarily to measure higher mental function, and by general and psychiatric interviews.

Able Company, 31st Regiment, survivors after Triangle Hill assault.

The blood was analyzed (for sodium, potassium, chlorine, urea, sugar, uric acid, and creatinine), and the urine extracted for adrenal cortical substances (17 ketosteroids and neutral lipids, largely compound F); these extracts were sent back to the U. S. for analysis. Saliva samples were analyzed for sodium and potassium.

In addition, three special tests were carried out on randomly selected individuals. By injecting red blood cells labeled with extremely small tracer doses of radioactive phosphorus (delivered regularly from Oak Ridge by the AEC), we measured the total blood volume. The second special test was measurement of the adrenal cortical reserve. A single dose of a recently developed ACTH gel preparation was injected, and an 8- to 12-hour urine collection made. (The urine was extracted for 17 ketosteroids and for neutral lipids.) The third special test, completing the physiological tests, was a measurement of the reactivity of the

LCDR Pace at a reasonable limit of advance. The sign reads "Caution, this is the MLR. The Reds direct traffic beyond this point." Dr. Pace first discovered the sign at night by flashlight after taking a wrong turn.

autonomic nervous system. This was made by examining the blood pressure and heart rate response to a single dose of the parasympathonimetic drug Mecholyl ®.

The psychological tests, aimed at quantitative behavioral changes in the soldiers, included measurement of visual flicker fusion frequency and auditory flutter fusion frequency. In addition, tests of higher mental function—such as digit span retention, color recognition, and recognition of geometric forms—were employed. General interviews with the men were also held by the psychologists. Finally, an attempt was made through psychiatric interview to assess the background of the individuals examined in order to correlate physiological changes with psychical characteristics.

Results from the study are not yet complete—in part because some of the analyses are not finished, but also because it will take some time for statistical analysis of the data. In general, however, we can say that combat stress results in marked organic changes indicating that both the pituitary-adrenal system and the autonomic nervous system are considerably affected. Specifically, a profound drop in white blood cell count was noted, a marked decrease in plasma cholesterol level occurred, and a significant change in the sodium potassium ratio of the blood, urine, and saliva was seen. Changes in both the nitrogen balance of the body and in the urinary sugar output were detected. The response to Mecholyl ® was also altered. Both the visual flicker fusion frequency and auditory flutter fusion frequency were depressed. No discernible changes occurred in the measures of higher mental function. However, there were noted subjectively pronounced personality changes of a transitory nature in the individual as a result of the combat stress. These apparently provide a promising field for future research.

The cooperation received from both the infantrymen subjects and all elements of the chain of command was excellent. We wound up our work on November 11 and returned to Tokyo. After writing a preliminary report on our findings, we left Tokyo for the States on December 7. Most important of all, our trip had demonstrated that such studies can be carried out effectively, and it is anticipated that others will be made in the near future.

"Radar Darkroom" Material Developed at NRL

A new absorbent material has been developed by the Naval Research Laboratory for use in creating "radar darkrooms." The material facilitates study of extremely high-frequency antenna patterns (2,500 to 35,000 megacycles), since it effectively cushions bounce-back from walls and ceiling. Called "Darkflex," the material is made of rubber-bonded curled animal hair, which is inexpensive, light in weight, convenient to handle, and readily available.

The Why of Climate

Werner A. Baum

...Head of the Department of Meteorology at Florida State University, is Editor-in-Chief of the American Meteorological Society's Journal of Meteorology.

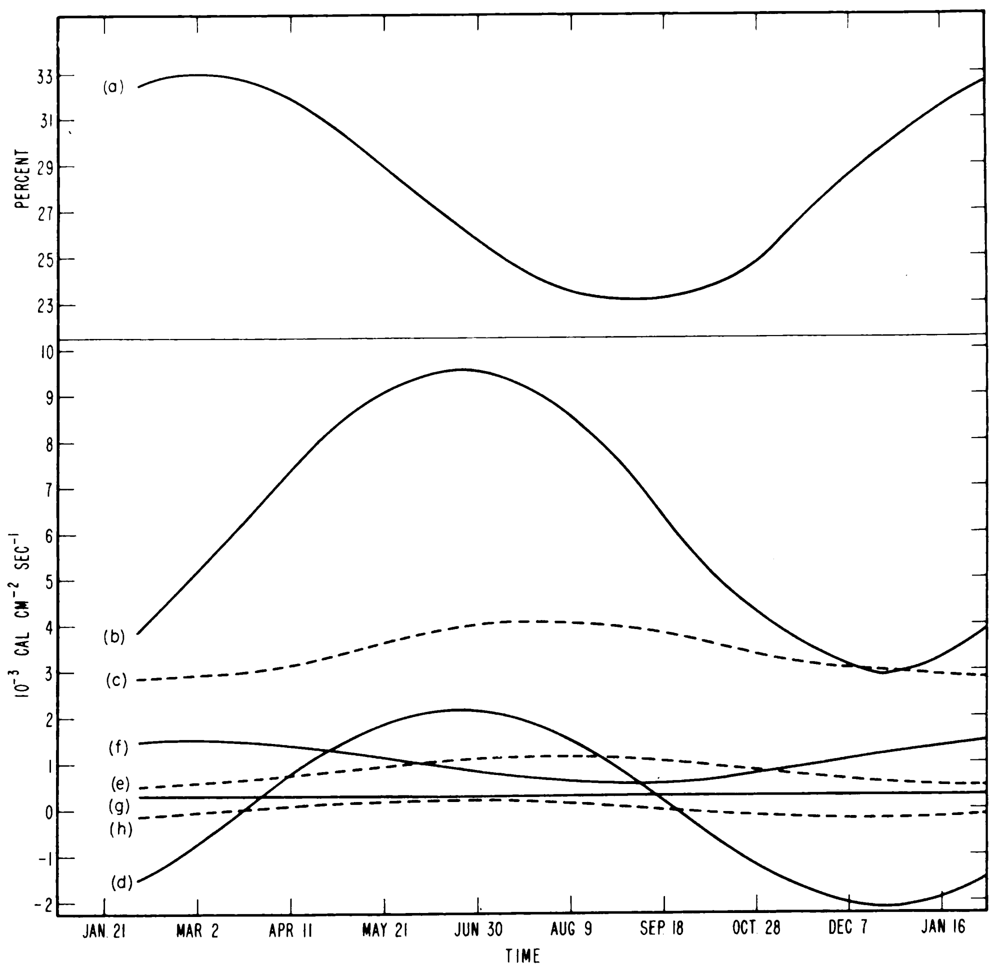
Because of its ever-present influence on virtually every human activity, the prevailing climate over our planet has long been a subject of wide attention. But the science of climatology has been largely in the descriptive phase. For a variety of reasons, the quantitative explanation and understanding of climatic phenomena has lagged exceedingly far behind the description. It is not our purpose to discuss the reasons; suffice it to say that the stress of the geographical (as opposed to meteorological) approach toward climatology, and the inherent mathematical and physical complexity of atmospheric processes, are major contributors to the dilemma.

Consider a "simple" problem. At locations north of latitude 23-1/2° N, the sun reaches its maximum altitude in the sky (and the days are longest) in late June. But, generally, the highest temperatures are not observed until the middle of July or even later. Why? Textbooks are likely to gloss over this point, or to make some superficial statement such as: The temperature increases for some time after the summer solstice, for, even though the solar radiation decreases, it is still for some time greater than the outgoing radiation.

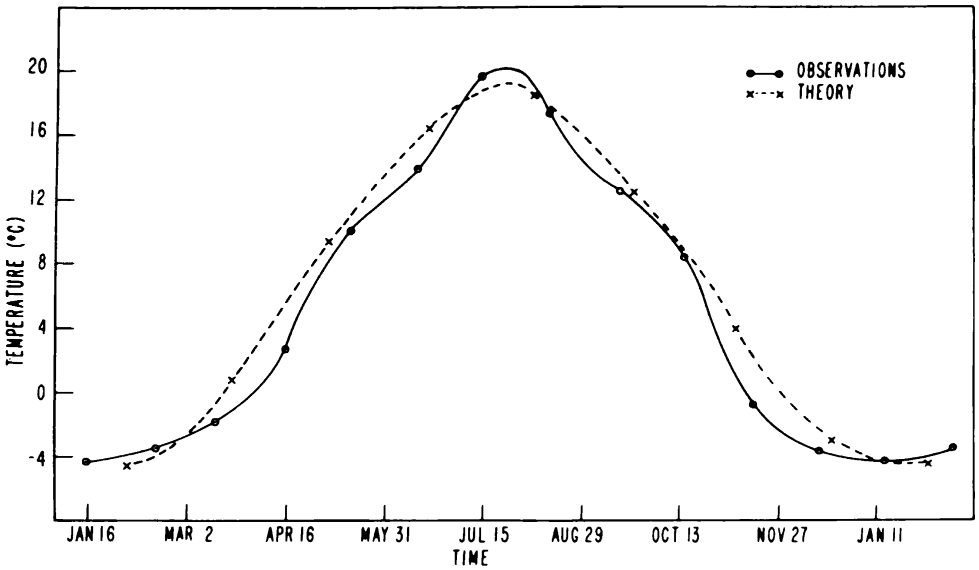
Actually, the vertical energy balance which determines the annual temperature variation at a particular location is quite complex. Involved are the annual variations of numerous factors: (a) reflectivity of the atmosphere and earth, (b) incoming solar radiation, (c) heat radiation to space from the earth's surface, (d) conductive and convective heat transport from the earth's surface to the atmosphere, (e) heat radiation from atmospheric water vapor to the earth's surface, (f) heat radiation from clouds to the earth's surface, (g) heat loss due to evaporation at the surface, and (h) heat conducted into the ground. The graph on the following page shows the annual variation of these quantities at Ely, Nevada, as determined by Dr. Thomas A. Gleeson of our group. Positive values for conductive and convective heat transport in the atmosphere (curve d), and conductive heat transport in the ground (curve h), indicate heat transport away from the earth's surface; negative values indicate transport toward the surface.

Dr. Gleeson has utilized the indicated energy balance, in combination with solutions for the differential equation of heat flow, as applied to the atmosphere and to the ground, to obtain a theoretical representation of the annual temperature variation at Ely. From the second graph, the computed annual variation is seen to be in close accord with the observed variation. In fact, the theory leads to fairly accurate representation of the annual variation at land stations in general. Because of the increased complexity of the problem and the paucity of pertinent data, no attempt has yet been made to apply an analogous technique at oceanic locations.

One readily sees how an analysis of this sort greatly increases our insight into the nature of the annual temperature variation at a given location. While the most dominant influences in the energy balance are, indeed, solar radiation and heat radiation to space from the earth's surface, the annual variation of the temperature is in response to the superposition of a number of physical factors of varying amplitude and phase.



Theoretical energy balance in the vertical direction at Ely, Nevada: (a) Albedo; (b) incoming solar radiation; (c) heat radiation upward from the surface; (d) conductive and convective heat transport from the surface to the atmosphere; (e) heat radiation from atmospheric water vapor to the surface; (f) heat radiation from clouds to the surface; (g) mean annual heat loss due to evaporation at the surface; (h) heat conducted into the ground.



Computed and observed annual variations of temperature 2 m above the surface, Ely, Nevada.

A potentially important limitation of Dr. Gleeson's treatment is the fact that he considered only vertical energy exchanges. There remains the possibility that energy is "advected", i. e., brought to the place under consideration via the essentially horizontal motions of the air. Drs. Seymour L. Hess and Robert M. Frank, of our group, attacked the problem of temperature variations from a quite different viewpoint, with major emphasis on the horizontal mixing processes.

About 25 years ago a Yugoslavian meteorologist, Milankovitch, computed the variation of mean annual temperature with latitude which would exist if there were everywhere equilibrium between the incoming solar radiation and the outgoing terrestrial radiation, and if the atmosphere were at rest and therefore could accomplish no heat transport. Naturally, he obtained temperatures which were too high in equatorial regions and too low in polar regions, because in reality the atmospheric transport does accomplish a moderation of the temperature difference between these regions.

Drs. Hess and Frank reworked the problem, including the effect of large-scale turbulent heat transport by the atmosphere. With use of an approximate analytic expression for the incoming solar radiation and another for the outgoing terrestrial radiation, and under the assumption that the large-scale turbulent heat transport is proportional to the latitudinal gradient of temperature, an appropriate form of the heat diffusion equation was set up and solved in terms of Legendre polynomials. The solution gives the temperature as a function of time and latitude, after adoption of a reasonable value for the eddy-exchange coefficient and other physical constants.

By averaging over a year, one obtains from the solution a theoretical variation of mean annual temperature with latitude. The

Latitude (^{o}N):	0	20	40	60	80
Milankovitch:	91^{o}F	83^{o}F	57^{o}F	12^{o}F	-26^{o}F
Hess and Frank:	80	75	58	33	13
Observed:	79	78	57	30	2

accompanying table gives the temperatures at various latitudes as so determined; for comparison, the theoretical results of Milankovitch and the observed values for the northern hemisphere are also given. The agreement between the Hess-Frank theory and observations is quite good, the only serious discrepancy being confined to the polar area. The nature of the approximate analytic expression for the incoming solar radiation largely accounts for this discrepancy; the chosen expression had to be a mathematically tractable one, and it was not possible to find a sufficiently simple expression which reflects the complex fact that no solar radiation at all is received in large parts of the polar region for part of the year. Thus, the adopted expression exhibits too much polar heating in the winter and leads to mean annual temperatures which are too high.

But from the point of view of the original question, the cause of the temperature lag, it is more interesting to look at the solution for a specific latitude and examine the nature of the time-temperature curve at the latitude. When this is done, at any latitude, it is seen that the theory calls for the maximum temperature to occur only two to three days after the summer solstice, instead of the observed several weeks.

It is clear, then, that the lag is not the result of factors included in the Hess-Frank theory. Thus, this approach to the problem of temperature variations not only produced interesting results of its own, but supported the Gleeson conclusions by showing that the process of horizontal mixing, ignored in his treatment, indeed does not contribute materially to the production of the lag.

With respect to the problem at hand, there immediately suggests itself the desirability of an approach which will combine the vertical and horizontal energy exchanges into a single, unified treatment. But temperature is only one of the group of elements and complexes which is climate. In our work in theoretical climatology we are also concerned with the effect of various physical factors in the production of slope and valley winds, with the relative importance of mountains and heat sources (such as warm oceans adjacent to cold continents) in the production of the large-scale flow patterns observed in the atmosphere, and with other atmospheric problems.

Some of our results will find early application in weather forecasting, and some will prove useful in the climatological work involved in strategic planning. But our basic objective is to increase our understanding of one important phase of our physical environment, for whatever unforeseen benefits mankind may derive from that increased understanding.

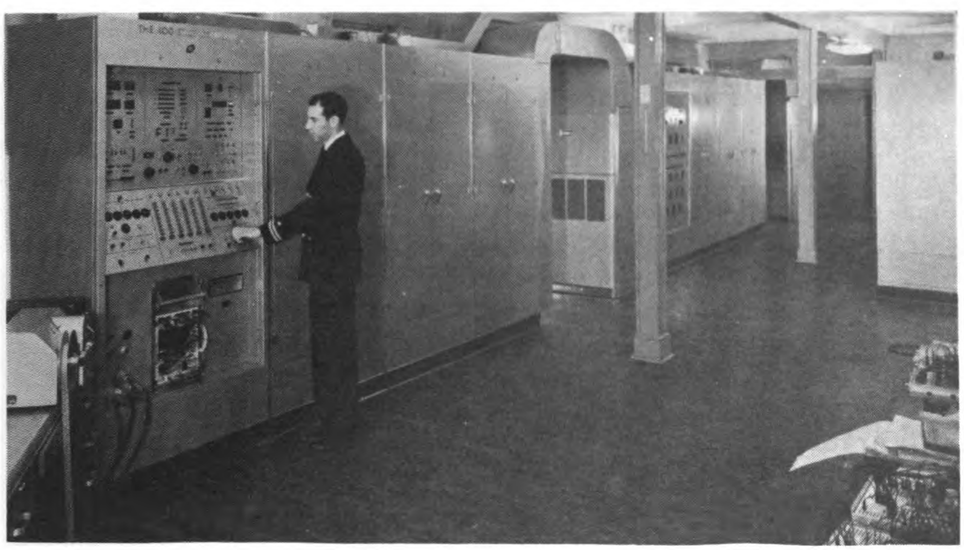
Logistics Computer

...an article on a computer developed by George Washington University's Logistics Research Project under contract with ONR. The present Principal Investigator is Dr. E. W. Cannon, who succeeded Dr. C. B. Tompkins.

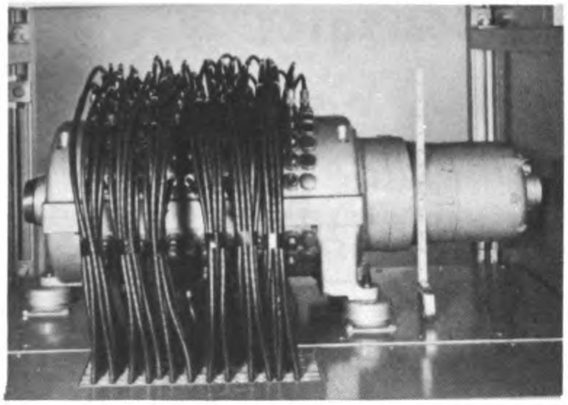
The George Washington University recently demonstrated a new logistics computer just completed by the Engineering Research Associates, Inc. It was developed under contract with ONR and in cooperation with the Logistics Research Project of the University.

Computers may be divided in a general way into two types: one which performs a succession of complex operations on a small amount of data, and the other which performs a few simple operations on large quantities of data. The new computer is of the second type. For example, according to the manufacturer, Engineering Research Associates, Inc., the new machine can add a column of 1000 numbers, each having a value of one billion, and arrive in half a second at a grand total of one trillion. This is very near, if not more than the number of dollars a shrewd Egyptian merchant could have amassed by today if he had saved $10.00 a second, every second since 1100 B. C.

Operation of the machine is more-or-less typical of all computers. The input unit receives data initially in coded form from punched tape,



LT Robert J. Rossheim, USNR, is adjusting a knob on the operating panel of the computer. The tape reader (on the desk at lower left) feeds data into the computer by means of punched paper tape. Plug boards, the nerve centers of the computer (shown at the lower right) are wired in advance for a particular problem, then placed in the lower central area of the operating panel.



Numbers are stored in the magnetic drum, the memory of the computer, by magnetizing the surface of the unit in small localized areas. The wires lead to the reading heads. Motor is at right of the drum.

An arithmetic stage then performs mathematical operations on the input data and works in conjunction with the storage unit which holds intermediate results as they are computed. On command, the output unit of the computer releases the results of the arithmetic functions in the form of punched tape which is converted later to typewritten data by a tape-reading machine.

The nerve center of the machine is a plugboard somewhat similar to a telephone switchboard. The commands that have been determined and set up on the program are now actually wired into the plugboard which will be used for the particular problem under consideration. Each problem will require its own "program," and the arrangement of the operations to be performed by the machine will have to be wired into a different plugboard.

The logistics computer uses 3,500 vacuum tubes in its circuitry (enough tubes, by the way, for 700 home radios or 175 TV sets). Since most of these tubes generate heat, an air-cooling system is required to insure stability of capacitors, resistors, tubes, and other components which may become undependable when continuously overheated. Cooling of the computer also maintains a comfortable heat balance in the room where it is operating.

One-third of the 28,000 watts of electricity used by the computer is consumed by three air-conditioning units which produce the cooling effect of 11 tons of ice melting every 24 hours. Every minute, 4,300 cubic feet of air enter the three cabinets of the machine at 60 degrees F, pass over the thousands of tubes, and escape through the top vents at a temperature of 78 degrees F.

The logistics computer is housed in three cabinets, each 19 feet long, 2-1/2 feet wide, and 8-1/2 feet high, including the air-conditioning units attached to each cabinet. A room 18 feet by 50 feet is required for operation of the 8 tons of equipment. The various cabinets are divided into sections called "bays" which accommodate the 263 unit chassis used in the computer.

The unit chassis, an advanced engineering feature incorporated in the computer by the Engineering Research Associates, Inc., contains tubes, resistors, capacitors, transformers, and other components mounted in an easily accessible manner. The entire unit chassis plugs into the bay and can be removed quickly for replacement, maintenance, or test purposes.

Who's Who in Naval Research

When the Naval Research Laboratory began operations thirty years ago this month, the man who is now its director, Captain Willis H. Beltz, already had behind him experience which was to be invaluable to him in understanding the practical problems of engineers and scientists. As a high-school boy in Kansas, he had been fascinated by a series of radio articles written by David Sarnoff (now Chairman of the Board of RCA). The years 1916-17 found him in the Merchant Marine as a wireless operator aboard the American liners SS KROONLAND and USMS PHILADELPHIA. Thus, early in his career, his natural bent for radio helped him in gaining a first-hand knowledge of the problems which he was to tackle later on at longer range.

Then came World War I and a commission as Second Lieutenant in the Field Artillery. When the war was over, he returned to the University of Kansas and in 1921 received the Bachelor of Science degree in electrical engineering.

After a year with General Electric, he went to RCA where he was employed in various engineering capacities from 1922 to 1941. Four years of this time he spent in Hawaii and here married a Kansas coed, Twilla Chappuis. He had been commissioned Lieutenant in the Naval Reserve back in 1925 and, in 1941, was called to active duty in the Electronics Division of the Bureau of Ships. By 1944 he had attained the rank of Captain. While serving as Officer-in-Charge of the Shore Radio Group, he was awarded the Legion of Merit for his outstanding efficiency and skill in obtaining and directing installation of the most advanced radio equipment for wartime fleet communications.

Captain Beltz' next duty was as Electronics Officer at the Navy Yard, Philadelphia; in that capacity he received a Letter of Commendation with authorization to wear the Commendation Ribbon, from the Secretary of the Navy. In 1946, after serving in two world wars, the Captain decided it was time to transfer to the regular Navy. The same year he reported as Industrial Manager of the Fifteenth Naval District, Balboa, Canal Zone. In 1948 he returned to BuShips as Deputy for Electronics and later Assistant Chief for Electronics. In June 1952 he became NRL's Director.

With this active career behind him, the Captain is still going strong and feels that his present duty is the most stimulating and challenging he has ever had. Captain and Mrs. Beltz, who now live at the Wardman Park Hotel in Northwest Washington, have a house in Hollywood, Cal., where they plan to live after his retirement. (SGF)

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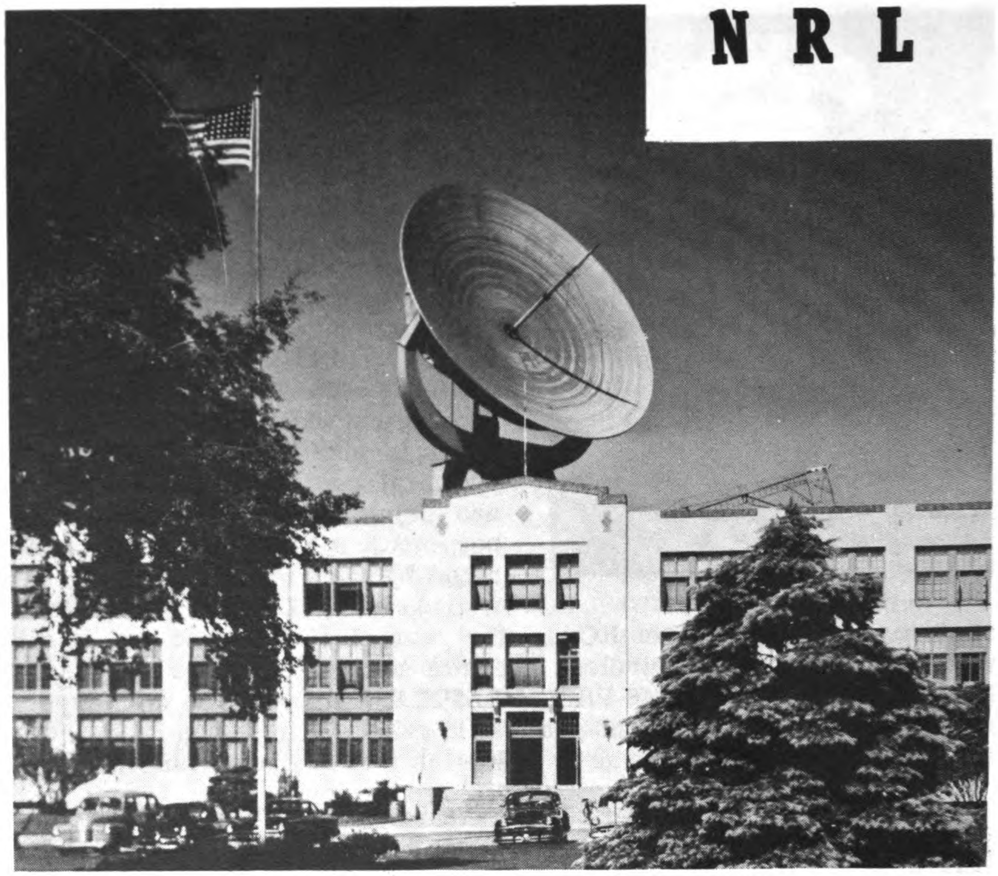

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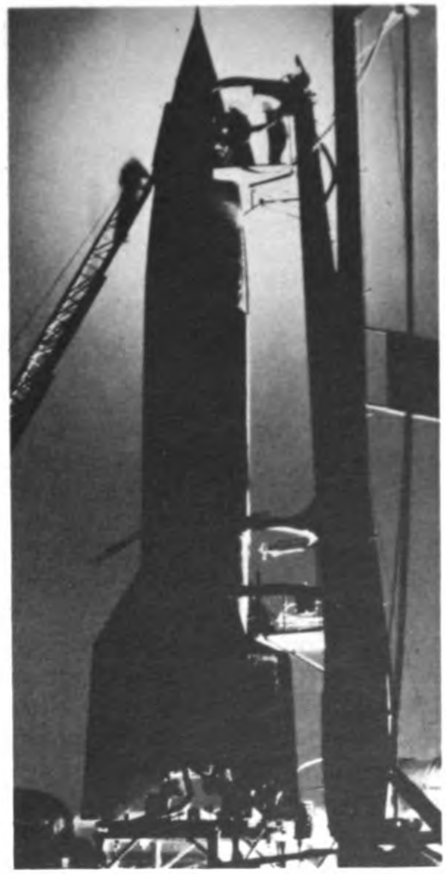
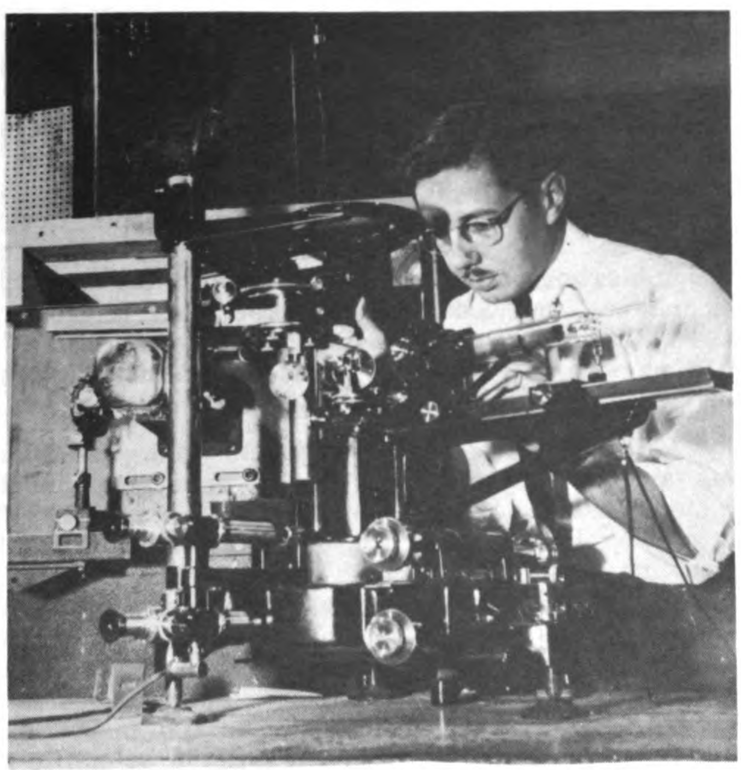


A. T. Drury

...Head of the Publications Branch at NRL, is the author of a book on the "War History of the Naval Research Laboratory."

The Battle Force was steaming silently through the low rollers of the Caribbean Sea. NEW YORK was leading, with TEXAS behind and the other battlewagons strung out in column astern. Somewhere out in the night, beyond the gray circle of the horizon, a destroyer squadron had probably already started the approach run of a mock torpedo attack.

Above NEW YORK's blacked-out bridge, a strange aluminum-and-wire frame, looking for all the world



like a huge upended bedspring, was slowly revolving in the darkness. A few feet aft, in a closely guarded corner of Air Plot, a small group of men were gazing intently into the greenish glow of a small fluorescent screen.

"There's one of them!" said Page suddenly, pointing to a slightly higher hump in the jagged green line wavering across the screen. "About eight miles, I'd say."

As they watched, a second pip, and a third, were identified on the magic screen. "He's getting cagey," remarked the Admiral. "He has apparently divided his cans into three groups."

"Yes Sir," answered the Captain, "And he thought he'd fool us by sending the third bunch in on the same bearing as the second. We'll let them get within searchlight range and then pick'em off."

At the precise moment the nearest group had approached to 5,000 yards, the searchlight stabbed into the darkness to starboard. Far out, where the cone of blue-white light began to fade, the observers could see a tiny mustache of white foam and above it the narrow silhouette of an oncoming destroyer. Then the light switched off, swung over to port, and again stabbed out into the night. And again ten minutes later. Both times the lead ship of the would-be attackers was caught dead-center in the probing beam.

The date: February 21, 1939; the occasion: Fleet Problem XX and the acceptance trials of American radar; the cast: Vice Admiral A. W. Johnson, commanding the Atlantic Fleet, Captain R. M. Griffin of the TEXAS; and R. M. Page, R. C. Guthrie and H. E. Reppert of the Naval Research Laboratory.

It was a dramatic high-point in an outstanding success story, the story of a then little-known scientific institution that had cost the American taxpayers less than the price of a light cruiser in sixteen years of research operations for the Navy. If the Naval Research Laboratory had done nothing else except produce radar, it would have justified itself as one of the best investments Congress ever made. But it also, in those same years, gave to the Navy the finest radio-communications afloat, greatly shortened the life-expectancy of enemy submarines, and contributed diverse other improvements and "black boxes" that proved their worth in the great sea battles of World War II. Furthermore, it gave solid vindication to the once-tenuous proposition that academic research can prosper in a military environment.

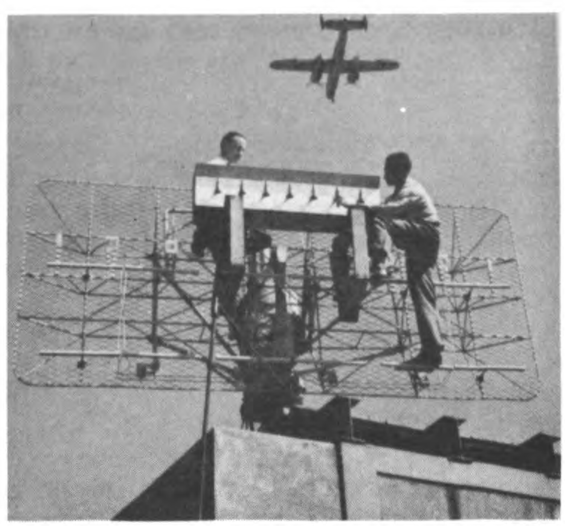
The proposition, as has oft been told, was Thomas Edison's. It was taken up enthusiastically in 1915 by Secretary of the Navy Josephus Daniels, and Congress passed the enabling act in 1916. But the sands of peace ran out too swiftly, and we were in World War I before an experimental laboratory could be built. The postwar Congress, though economy minded and in a mood for disarmament, had learned that America could not with impunity afford to stay technically behind the other nations of the world. So on July 2, 1923, the Laboratory came into being, as planned by Edison, Daniels, and the Naval Consulting Board. And their blueprint—a research institution headed and administered by Naval officers, but with the scientific work in the hands of civilians—was followed to the letter.

The key to the whole plan, of course, lay in the choice of the original staff—particularly the civilian scientists. The Navy already had three small radio research groups working in Washington, and one in underwater sound at the Engineering Experiment Station in Annapolis. These four groups—about 20 men in all—were moved bodily to the new laboratory. Later in the initial year the staff was filled out to four officers and 92 civilians.

As it turned out it was a remarkable cadre. It included Dr. A. H. Taylor, the Navy's Chief Physicist, who was probably more than any other American responsible for the development of radar, and Dr. Harvey Hayes, for 25 years the Superintendent of the Sound Division. Dr. E. O. Hulburt, the present Director of Research, joined the complement in 1924. Practically all of the charter members remained through World War II, and in 1953, eight are still aboard in responsible positions.

Nowadays you can run down the alphabet from A-bomb to Zodiacal light and find at NRL almost every branch of physical science that has been given a label. But in its first two decades nine-tenths of the program was confined to two fields, radio and underwater sound. The limitation was imposed not only by economics but by "consumer demand" and by the research talent available.

Back in the early twenties, the terror of the German U-Boat was still fresh in people's minds. War beneath the sea had become an awesome reality, and the Navy was willing to spend money on any likely device or weapon that would restore the supremacy of the surface ships. Meanwhile, radio was just coming into its own. President Harding had broadcast the dedication of the Lincoln Memorial in 1922, and commercial programs were making their first impact on American life. Furthermore, wireless communication had made itself indispensable to the Fleet in 1917 and 18. Radio and sound research offered foreseeable results; the naval construction bureaus (whose backing provided two-thirds of NRL's operating funds) were willing to support them.



Greater-range, around-the-clock communication, more channels, and stability within channels—these were the goals of the Navy's radiomen. By seeking ever higher frequencies, by adoption of crystal control and continuous waves, they had achieved in 1930 reliable transmission from such remote places as Australia and the South Pole. Thanks largely to the wide-awake research and salesmanship of NRL, Naval Communications became the recognized leader in American radio development.

Naturally the Navy's modest laboratory, with only a handful of radio engineers and little money to spend, couldn't do this alone. Radio improvement depends probably more on the development of better tubes, capacitors, resistors, transformers, and similar components, than on intuitive research. These were a mass accomplishment of the radio industry, both in America and abroad. But what Taylor and his associates did do was some highly effective "scientific bird-dogging"—sniffing over new discoveries and pointing the way to new applications. Lacking the wherewithal to make components themselves, they prodded the radio industry into making them.

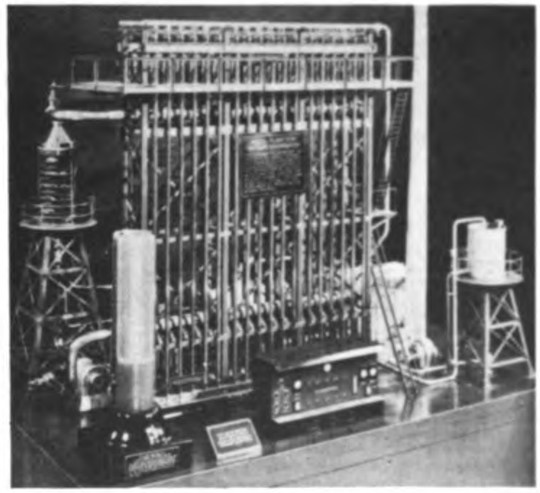
Along the way, NRL did some impressive radio research on its own—such as the Taylor-Hulburt wave-propagation theory which revolutionized prior thinking on how radio waves travel. And it did some very ingenious gadgetry, like the guidance circuits for the first successful radio-controlled aircraft, flown by C. B. Mirick in 1923, and for the first target drones in 1938. As for prototype development, many an NRL "breadboard" model was translated into specifications for standard equipment used throughout the fleet—for instance, radio direction-finders.

It was this combination of "bird-dogging" the work of others, and home-base research where necessary, that led NRL to radar.

The task wasn't easy. Pulses of radiant energy are measured in millionths of a second, and they travel out to the target and back at the speed of light. Fortunately, the men of the Navy's laboratory had the know-how, and they had ten years of radio-detection studies behind them (see table). A project was established for the program in 1932. Two years later two operable systems—one continuous-wave, the other pulse—had been worked out, and by 1938 a reliable pulse system had been designed, built, sea-tested, and was ready for submission to the Fleet.

It is always an interesting pastime to speculate on "who done what first." It is particularly interesting in the case of radar, because without any interchange of specific information the development was almost concurrent and parallel in the United States and in England. The wonderful new device was sea-tested in the same year, 1939, aboard the U.S. Navy's NEW YORK and TEXAS and aboard the Royal Navy's RODNEY and NELSON. Our Navy was apparently a year ahead of the British in the original development, but the RAF closed the gap by greater speed in producing an operational prototype. The significant fact is that both Allies had radar when the shooting began, and were able to use it to great strategic and tactical advantage in overcoming the common enemies. Let credit be where credit is due, however; American radar was conceived and born at the Naval Research Laboratory.

Meanwhile sound research at NRL, while attracting less notice, followed much the same path. As a matter of fact, there is a striking similarity between radar and what is called "active" sonar. Substitute "supersonic" for high-frequency, "pings" for pulse-echoes, "transducers" for antennas, seawater for air, and you get what amounts to radar under water. The analogy should really be reversed, because the sound engineers got there first. By 1935 they had developed a complete echo-ranging system using the NRL Rochelle-salt transducer. This, together with the "passive" listening devices, became the integrated sonar of World War II.



Just as the Japanese blamed their loss of the turning-point sea battles of the Solomons on the U.S. Navy's possession of radar, so did Admiral Doenitz, the Commander of the German U-Boat fleet, cite American and British antisubmarine devices as the major reason for Germany's failure in the Battle of the Atlantic.

We can grant, then, that NRL helped the Navy score touchdown after touchdown in the middle of the game, but how about the one that finally won the War, the A-bomb? Was the Laboratory in on that too? Indeed it was—at ground level. The Naval Research Laboratory, although the initial program was very small, was the first U.S. Government

TIME TABLE OF RADIO-DETECTION AT NRL

1922 – A ship was detected passing through a high-frequency radio field (by Taylor and Young, later to join NRL).

1925 – NRL built the pulse transmitter and receiver used by Carnegie Institution to measure the height of the ionosphere.

1930 – Airplane in flight detected by CW radio.

1932 – Project established at NRL by BuShips for "Location of Enemy Ships and Aircraft." Complete plans for an early-warning system turned over to Army.

1933 – Use of pulses suggested and work started on a pulse system.

1934 – CW radio detection system demonstrated to members of Congress. Workable pulse transmitter and receiver built.

1936 – 80-Mc pulse-radar detected aircraft at 40-mile range.

1937 – 200-Mc radar tested at sea on USS LEARY

1939 – Greatly improved 200-Mc radar tested on USS NEW YORK (Range to 98 miles; bearing to ± 1°; shell-splashes spotted; navigation by radar.) Contracts let for commercial production.

1940 – U.S. compared notes with British.

1941 – 19 NRL-model radars installed on naval vessels.

agency to take an active interest in nuclear energy. In 1939 Ross Gunn, of the Mechanics Division, enthusiastically backed by his Director, Admiral H. G. Bowen, established a project that later led to an isotope-separation process (liquid thermal diffusion) which produced some of the materials for the Hiroshima bomb.

This effort in nuclear physics serves to point out that busy and alert research was going on at NRL in fields other than radio and sound. Studies in Optics began about a year after the Laboratory opened, and by the mid-thirties, three other divisions had been established: Metallurgy, Chemistry, and Mechanics. Always short on manpower and shorter still on funds, their achievements were fewer in number, and less glamorous, than those of the two larger more powerfully supported groups. Taken together they accomplished two big things, however. They proved that there was both a place and a need for basic-science research in the Navy, and they gave the Naval Laboratory professional stature among the critical brotherhoods of learned men.

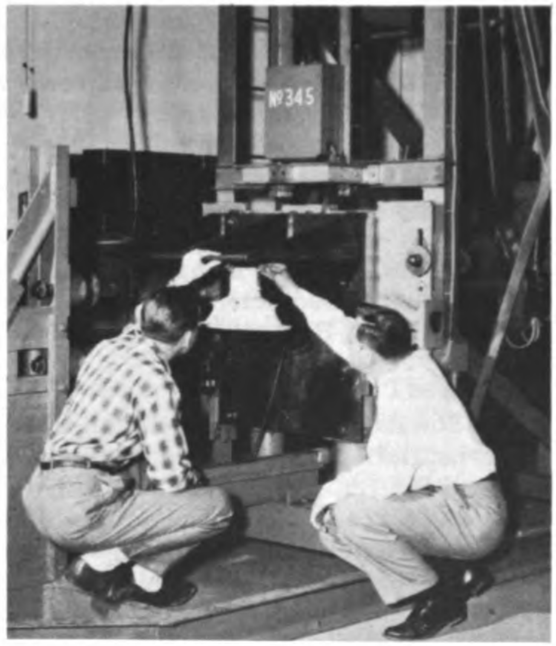
NRL had—in all its divisions—done something else for the Navy; it had continued or resurrected scientific problems of purely military interest. The American Government and American industry had marshalled a vast developmental effort for World War I, but after the Armistice military research was dropped like so much excess ballast. When OSRD and NDRC were established on the eve of Pearl Harbor, scientists flocked to the Laboratory by the dozens and scores to be "briefed" up to date on such matters as camouflage, protection against gas, submarine batteries, body armor, infrared signalling devices and the like. Furthermore NRL in keeping these subjects alive had prepared its own house for the even vaster emergency to come.

It was fortunate that NRL had eighteen years in which to grow, and to establish a firm organization and operating procedure. Because when the war came the Laboratory was swamped with rush projects. In the years between 1940 and 1945 the number of buildings increased from 12 to 70, the number of projects from a few score to over 900, annual appropriations from $900, 000 to $14, 000, 000, and the station personnel from about 400 to over 5000. But mere increases in size and numbers tell only part of the story. Far more significant changes had taken place.

Most apparent was the increase in proportion of naval officers and men. In an extremely tight labor market, the only way to get technicians, stenographers, and even scientists was to requisition them from the Bureau of Naval Personnel. And often the only way to keep draft-eligible engineers was to put them into uniform.

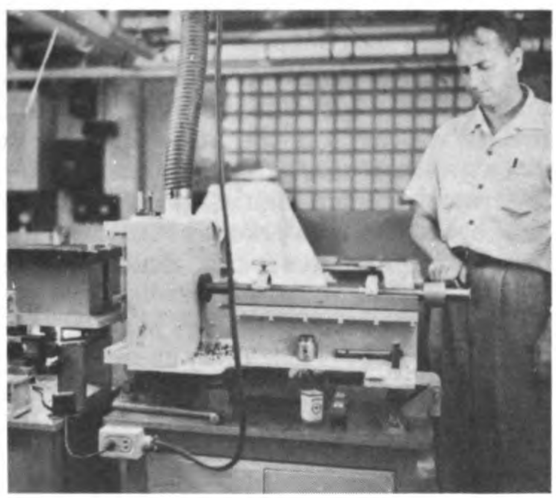
Basic research almost went by the board as long-term investigations gave way to hurry-up applied research or prototype development. Such a wartime evolution had been foreseen and NRL was prepared for it. The amazing diversity of the "inventions-on-demand" ranged all the way from radio sonobuoys to the sea markers that increased the chances of shipwrecked seamen and down flyers being found by rescue planes.

At the same time, the search for new offensive and defensive weapons extended into every technical field, giving new importance to the so-called "basic-science" divisions. Chemical-warfare research alone more than doubled the size of the Chemistry Division; the building of thousands of welded ships handed a host of new research problems to the Metallurgy Division. And so it went, leaving the Laboratory at the end of the war with a far better balanced program than it had at the beginning.



Shock and vibration↑

Ballistics↓



The demands of wartime research also solved the problem of space for future expansion. To provide long, open-water ranges for experimental radars, the Laboratory purchased in 1941 a magnificient 140-acre site high on a bluff overlooking Chesapeake Bay. So NRL now has, in its "Annex," a well-equipped testing station within easy commuting distance yet remote from the clutter of a big city.

A typical, if somewhat extreme, example of the wartime "crash" research was the countermeasures program against the German radio-controlled air bombs which were threatening the sea convoys supporting the North Africa campaign. Two American destroyers, equipped with signal-analysis gear, sailed into the Mediterranean, recorded the German signals, and returned with the data. Then, in twelve weeks, NRL scientists built a successful countermeasure. In the Sicily campaign—and later, in the Normandy invasion—this equipment not only jammed the German signals but (on a couple of occasions) apparently took over control of the air-dropped missiles and diverted them harmlessly into the sea.

The Laboratory emerged from World War II in an enviable position: It was big, it was affluent, it had a preeminent reputation among government laboratories. Above all, it was riding high on a wave of unprecedented public faith in scientific research. The most technical of all wars, with its Wagnerian climax at Hiroshima-Nagasaki, had been won largely because America was able to keep a technical stride ahead of its enemies. Now Congress was willing to bear the cost of extensive military research.

So the Naval Research Laboratory was not cut back. While ships were being placed in mothballs by the thousands, research was maintained on a near-wartime footing. New equipment was acquired almost for the asking, and manpower was limited only by the competitive market for trained scientists. Furthermore, the merger with the new Office of Naval Research assured NRL an ample and continuous backing for basic research.

The first postwar task was a weeding-out job. The hectic war years had left the research department with nearly a thousand unfinished or partially finished projects. Many of them were of purely transitory interest, already obsolescent, and others were performance tests or application jobs which could be more profitably pursued elsewhere. The remaining projects—the carry-over ideas and developments that seemed to have a future—were set forth in a well-balanced program which has been aportioned among twelve research divisions: three for radio and electronics, two for nuclear physics and radiation, and one each for electricity, chemistry, mechanics, metallurgy, optics, sound, and systems-coordination. The organizational designations are more or less arbitrary; actually there are some seventy-five different "branches," each one following a distinct line of scientific endeavor.

This diversity means that the Naval Research Laboratory is no longer devoted predominantly to applied research in electronics. Fundamental research in the basic physical sciences now has equal standing, and it is this characteristic above all others that makes the postwar laboratory unique among Government-managed military institutions. It has enabled NRL to poke its roots into the newer fields such as solid-state physics, nucleonics, cryogenics, and engineering psychology—without first having to prove that an end-use item will probably result.

The 1953 Laboratory has also dropped much of its former singularity. Since 1945 it has been one arm (together with the Special Devices Center) of the bureau-level Office of Naval Research. ONR's other arm, of course, is its vast network of private contractors at universities and industrial laboratories. The two arms have learned, in the past seven or eight years, to work increasingly together—the one supplementing the other in a highly effective partnership. This teamwork extends into some of the largest programs supported by the government. Guided missiles, for instance, has over 100 participating agencies in the Navy, Army, Air Force, in the colleges and in industry. The same wide collaboration is evident in postwar radar development and in atomic research and—to a narrower extent—in the prevention of corrosion in ships, and in the tremendously complicated problem of fitting arrays of electronic gear into already crowded ships and aircraft.

And if postwar research has become interdependent and more complex, it has also become vastly more expensive. The research "tools" are no longer a few coil-winding machines and generators and laboratory crockery; they are such things as multimillion-electron-volt betatrons, 2000-tube electronic calculators, electron microscopes, huge shock-testing hammers, or a 50-foot astral-radiation reflector. So thousands of postwar manhours have gone into tooling-up for the future, for preparedness, to enable the Navy to have within its own establishment one of the great laboratories of the world.

The scope of today's research at NRL is so wide—about 480 projects at present—that it would be out-of-focus to describe the whole program. The type of work can be illustrated, however, by a few selected samples.

Certainly one of the outstanding examples has been the upper atmosphere research at White Sands and elsewhere—first with the German V-2's and more recently with the NRL-designed "Vikings." The Laboratory's chief interest has been in the fundamental knowledge that might be gained by sending recording and telemetering instruments far above the earth. In the 37 flights so far, two of the single-stage rockets (one V-2, and one Viking) have reached a height of 135 miles.

A far different program—one which seldom hits the headlines yet over the years has amassed as much professional credit to NRL as any other—has been the outstanding basic research in metallurgy. The painstaking investigations of "freezing" of metals (what goes on inside a mold when the molten metal solidifies), the study of welds and the analysis of metal adjacent to welds, the explosion-testing of plate metal, and the nondestructive testing of castings by x-rays and gamma rays, have attracted the attention of foundrymen the world over. Not only that, the basic knowledge thus acquired and disseminated means that the Navy's ship's are better built, less liable to break apart on the high seas, and less vulnerable to enemy attack.

The chemists have, in their line of special-purpose lubricants, synthesized products that promise to be as useful commercially as they have been to the Navy. These non-petroleum oils and greases, that stay oily at temperatures down to -70°F, have stopped our aircraft machine guns from jamming in high-altitude combats over Korea, yet retain their viscosity at engine temperatures as high as 450° F.

As might be expected, electronics research has greatly expanded in the last several years, so much so that it extends far beyond the so-called "radio" divisions. Most of the recent work on radar, radio, and underwater sound is still "under wraps," but some successes can be talked about. An NRL engineer, for instance, developed the "memory tube," an electron video-tube that can store a picture indefinitely and play it back when desired. Other engineers, bird-dogging again, have found naval applications for the marvels of postwar electronics: the transistor and the magnetic amplifier.

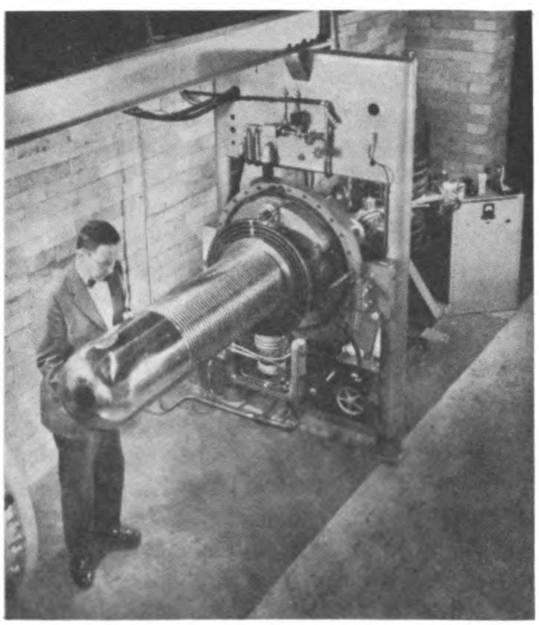
Because it has the specialized shops and facilities, or because it has on board recognized experts in their field, NRL has become, if not the leader, certainly a leading participant, in special lines of investigation. Typical of this category are the research on mechanical shock and vibration, harbor defense, radio astronomy, piezoelectric crystals, tropical deterioration, new fuels and fuel additives, fire extinguishants and extinguishing methods, and studies of materials and phenomena at temperatures within a degree or two of absolute zero.

So NRL is doing all right. Production at the Navy's thirty-year-old idea factory is at the highest level in its history. There is every indication, moreover, that this production will continue. NRL still has the academic freedom that attracts the best type of scientists and holds their loyalty; there still exists an environment that permits these men to expand their own capabilities and to pursue their ideas; and it still has the support of the Office of Naval Research, of the material bureaus, and of the Fleet. Furthermore, today's Laboratory has that indefinable yet challenging esprit that is the heritage of a great past.

Horizontal Van de Graaf Accelerator Built for Naval Postgraduate School

A two-million-volt Van de Graaf portable accelerator, being built for the Naval Postgraduate School, Monterey, California, is ready for test this month at the High Voltage Engineering Corporation of Cambridge, Mass. The new machine will be used in the nuclear physics laboratory of the Engineering School. It will be installed early next year in a specially shielded nuclear research laboratory in the basement of a five-story building, part of a large construction program presently underway at the Naval Postgraduate School.

Requiring a year to build, the 23-foot-long generator is one of the few electrostatic accelerators of the horizontal type in existence. Older models of the vertical type require a two-story room. It will be equipped with an electron conversion unit for the acceleration of electrons and positive ions. At left, a representative of the High Voltage Engineering Corp. is inspecting the accelerator tube. The tube is operated under a high vacuum; in use it is immersed in a cylinder containing nitrogen gas at a pressure of 80 pounds per square inch (about six times atmospheric pressure). Heavy hydrogen particles, accelerated down the tube, hit a target of beryllium which produces neutrons as a part of nuclear reaction.



Improved Meteorological Soundings

...an article describing equipment developed for BuShips by P. D. Lowell, W. Hakkarinen, and D. L. Randall of the Bureau of Standards electronic instrumentation laboratory.

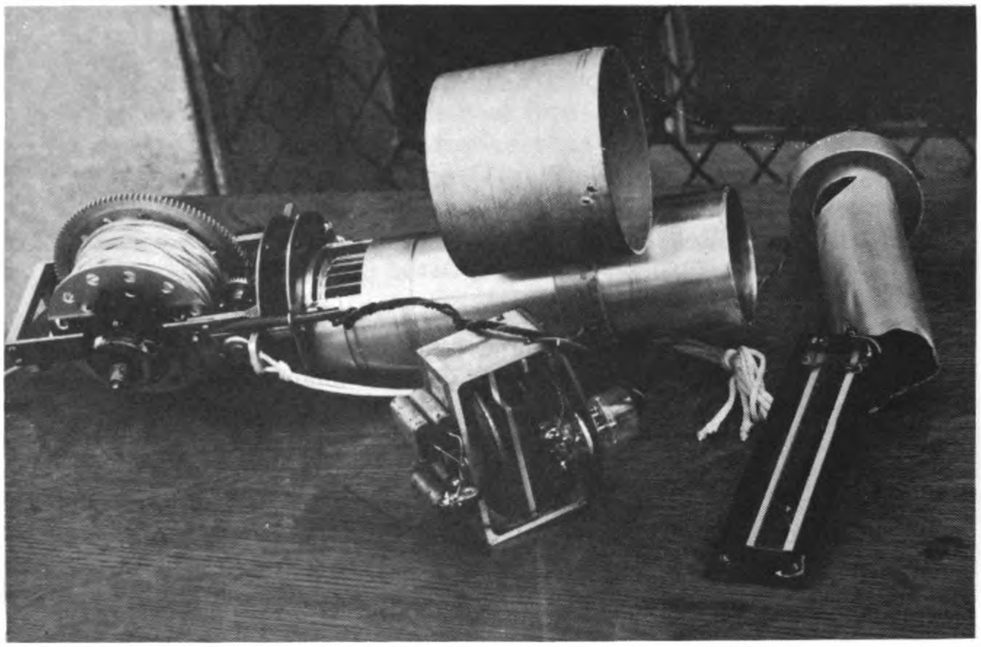
Atmospheric temperature and humidity gradients—the rates at which air temperature and moisture content change with altitude—can be measured with increased accuracy, at heights up to 2000 feet, by means of a low-level sounding system developed by the National Bureau of Standards. The system was designed for use in connection with measurements of the propagation of radio waves in the troposphere (lower atmosphere). The curvature of the path followed by radio waves initially tangent to the earth's surface varies with the refractive index of the atmosphere, and the refractive index in turn depends on temperature and humidity. At certain critical temperature and humidity gradients, the refraction produced is equal to the curvature of the earth.

Since wave propagation is affected by changes in refractive index occurring in atmospheric layers of the order of one wavelength in thickness, changes occurring in relatively thin layers of air become important at the higher radio frequencies. For instance, studies of 100-megacycle transmission require evaluation of the gradient averaged over no more than a 10-foot thickness. The measuring equipment must therefore be able to give high resolution in the analysis of air layer structure.

The NBS system is a form of "wiredsonde"; airborne instruments are carried aloft by a balloon or kite and are connected to a light-weight 3-conductor electrical cable that is reeled out from the ground. However, several unusual features of the NBS arrangement make it more satisfactory than previous wiredsondes for the intended high resolution measurements.

A novel electromechanical altimeter, because it permits more accurate measurement of small changes of height, gives the NBS system a notable advantage over previous wiredsondes; these have had to depend on optical observations for determinations of the height of the airborne instruments. The NBS electromechanical altimeter, carried aloft in the airborne unit, is a pressure-sensitive device consisting essentially of a pressure capsule, a coil of about 10,000 turns of fine wire wound over a U-shaped high-permeability core, and a bar of high-permeability metal. As the pressure capsule expands with increasing altitude, it moves the bar and varies the air gap between the bar and the core, thus varying the inductance of the coil. Changes in the inductive impedance of the coil are sensed from the ground, using 60-cycle alternating current.

Humidity is measured by sensing changes in the resistance of a conventional radiosonde strip hygrometer, which consists essentially of a non-hygroscopic insulator with metalized edges, coated with a



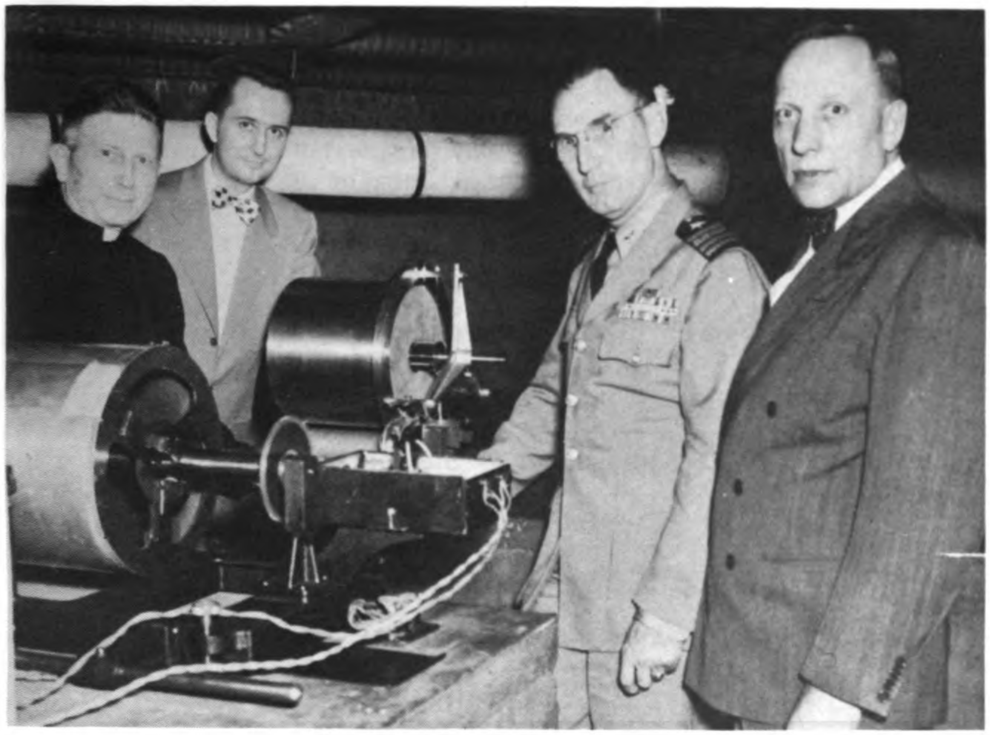
The airborne unit of the low-level sounding system is partially disassembled here. Visible are the gravity motor (left); altimeter, removed from housing (center); and elements for sensing humidity and temperature (on black rectangular mounting at right). In operation the gravity motor is uppermost, fastened to the balloon that carries the airborne unit aloft. A light-weight 3-conductor tethering cable (not shown) runs from the bottom of the unit to auxiliary measuring and recording equipment on the ground.

film of polyvinyl alcohol containing lithium chloride. However, instead of the direct current generally used for the purpose, the NBS arrangement uses 60-cycle alternating current. The earlier d-c methods caused rapid polarization and deterioration of the hygrometer element unless mechanical current reversing was employed. Use of alternating current in the NBS system greatly extends the life of the element.

A weight-saving innovation of the NBS system is the use of a gravity motor, instead of the usual battery-powered electric motor, for ventilation and switching in the airborne unit. Besides driving the blower that is needed to circulate air past the temperature and humidity elements, the motor switches the sensing elements into the ground measuring system. A 40-foot length of nylon cord is wound around the drum of the gravity motor and attached to the balloon, while the airborne instruments and tethering cable are fastened to the bottom of the motor. A tension of 4 pounds—the total weight of the airborne unit, motor, and 2000 feet of 3-conductor tethering cable—drives the motor at about 1000 rpm. In the actual operation it takes about 35 minutes for the 40-foot cord to become unwound. On the ground, housed in the truck and small trailer that provide a mobile base of operations, are a 60-cycle, 110-volt generator, a cable reel, an electronic panel, and a recorder. A final advantage of the NBS system is that all its measurements, including altitude, are automatically recorded on standard instruments.

On the Naval Research Reserve

CAPT Cook Addresses Cincinnati Panel



CAPT A. B. Cook, Director, Military Services Division of ONR, is seen above inspecting a Navy research project conducted at Xavier University in Cincinnati, Ohio. Left to right are: Rev. Victor C. Stechschulte, S. J., chairman of the department of physics at Xavier U.; John B. Hart, Officer-in-Charge of the Cincinnati Panel, Company 4-9; CAPT Cook; and CDR Roy E. Hale, in charge of the Naval Reserve and Marine Corps Reserve Training Center.

CAPT Cook addressed the Cincinnati Panel on the procedures to make the best possible use of the nation's pool of scientifically trained manpower in the event of national emergency. Said CAPT Cook:

"We want, through careful advance planning and adequate personnel records, to place men into positions commensurate with their special scientific training and talents. We are fully aware in this program that we are dealing with one of the nation's most critical commodities—our scientifically trained manpower—and we must use it wisely."

CAPT Cook said that personnel records now are being kept that indicate a scientist's civilian pursuits since, in many cases, it is likely he can better serve the nation and its military requirements by remaining in a civilian scientific job than by active military duty.

LCDR Churchill Speaks at Memorial Day Service in Michigan

LCDR E. S. Churchill, Washington Training Officer, recently completed a profitable trip visiting a number of Reserve companies in Michigan, Minnesota, and the Chicago area. While visiting Research Reserve Company 9-16 in Lansing, Michigan, he had the honor of being Officer of the Day in a Memorial Day parade held in Grand Ledge (a suburb of Lansing), as well as main speaker at the Memorial Day service.

Well Done, Company 9-6!

Research Reserve Company 9-6 (Minneapolis, Minn.) commemorated Armed Forces Day in one of the best ways we have heard yet. The Company went en masse—all 24 members—to donate blood at the local Red Cross.

Excellent Speakers Address Psychological Warfare Group

Reservists attending the Psychological Warfare Course sponsored by Company 11-4 have been extremely fortunate in the excellent speakers whom they have heard at the four meetings held to date. The first two have been reported in previous issues. The third meeting of approximately 100 Reserve officers, held on 6 May, was addressed by Lt Col F. I. Robinson, USAF. His presentation was exceptionally well planned, effectively presented, and held the constant attention of the group. Two captured propaganda films taken at New York and filmed in Korea, gave a dramatic illustration of the methods used by the Communists in their forced trials of captured airmen. At the close of the meeting, a questionnaire was distributed to all officers attending to get their reactions to the course. They were also asked to indicate what contribution each felt he could make in the field of psychological warfare.

The fourth meeting, equally successful, was addressed by Dr. Victor Hunt of the Rand Corporation. Dr. Hunt effectively presented the basic principles of psychological warfare, giving vivid illustrations for each point of his discussion. He has an exceptional background as the director of policy for the Voice of America, as a delegate to the Paris Peace Conference and to the Foreign Ministers' Conference in London in 1947.

Louisville, Kentucky, Company Activated

CAPT A. B. Cook (above), Director of the Military Services Division, ONR, congratulates LCDR Raymond H. Wilson, USNR, Commanding Officer of NRRC 5-7 activated at the University of Louisville, Louisville, Kentucky, on 16 May.

PRNC Reservists Participate in Armed Forces Day Exhibit

A number of Reserve Officers from the Potomac River Naval Command participated in the Armed Forces Day exhibits at Bolling Air Force Base, Washington, D. C. on 16 and 17 May.

Those who gave their services were: CDR Homer R. Baker, LT Frederick S. Frantz, Jr., LCDR Norman A. Maier, CDR Judson I. Mather, CAPT Beauregard Perkins, Jr., LTJG Julian C. Renfro, CDR William M. Smedley, LCDR Albert E. Smith, LT Walter A. VonWald, Jr.

A Reminder of Coming Seminars

Reservists are reminded to make plans for seminars to be held this summer. Applications to attend should be submitted as promptly as possible.

The psychological Warfare Seminar begins at Chapel Hill, N. C. on 2 August 1953. The West Coast Seminar starts two weeks later on 16 August in Pasadena, Calif. Then comes the Naval Research Laboratory Seminar in Washington, D. C., which begins 23 August. Quotas by district for the three seminars are given below:

Psychological Warfare

District	No. of Officers
1	5
3	9
4	9
5	2
6	6
8	3
9	12
11	1
12	1
13	1
PRNC	8
	57

West Coast

District	No. of Officers
8	10
9	14
11	17
12	17
13	14
	72

N.R.L.

District	No. of Officers
1	5
3	7
4	8
5	4
6	6
8	3
9	10
11	1
12	1
13	1
PRNC	6
	52

RADM Bolster Welcomes Washington Seminar Members

The Chief of Naval Research, RADM Chester M. Bolster, greeted officers attending the Washington seminar which opened on 14 June. The Admiral's message is given in part below:

"It is a pleasure to welcome the Research Reserve Seminar for its Sixth Annual meeting.... The rapid changes of both national and international scope that are currently taking place necessitate a significant scientific endeavor on the part of each of us. It is felt that the Research Reserve Seminars have well established their value as a medium for the exchange of information germane to the activities of scientists and engineers represented in the Research Reserve Program.

"It is my earnest hope that your visit to Washington will be both profitable and pleasant, and that this Seminar will afford an opportunity for us to become better acquainted as we meet together to discuss the over-all objectives of Naval Research. I wish to extend my personal greetings and best wishes to you at this time."

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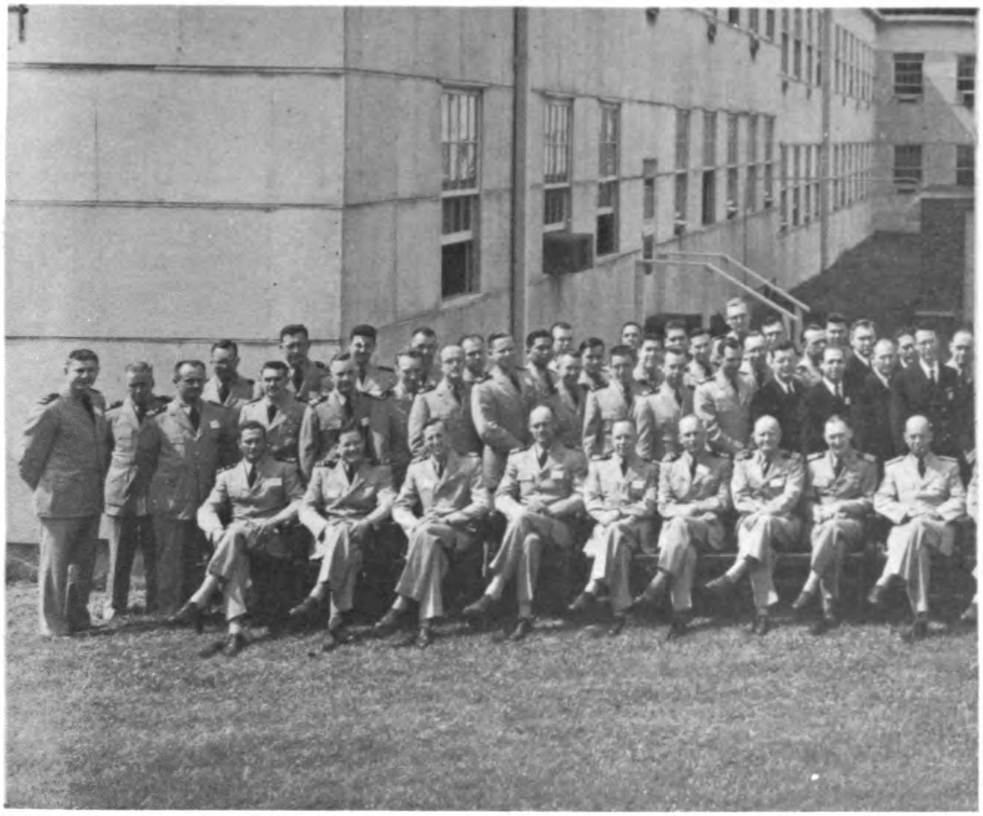
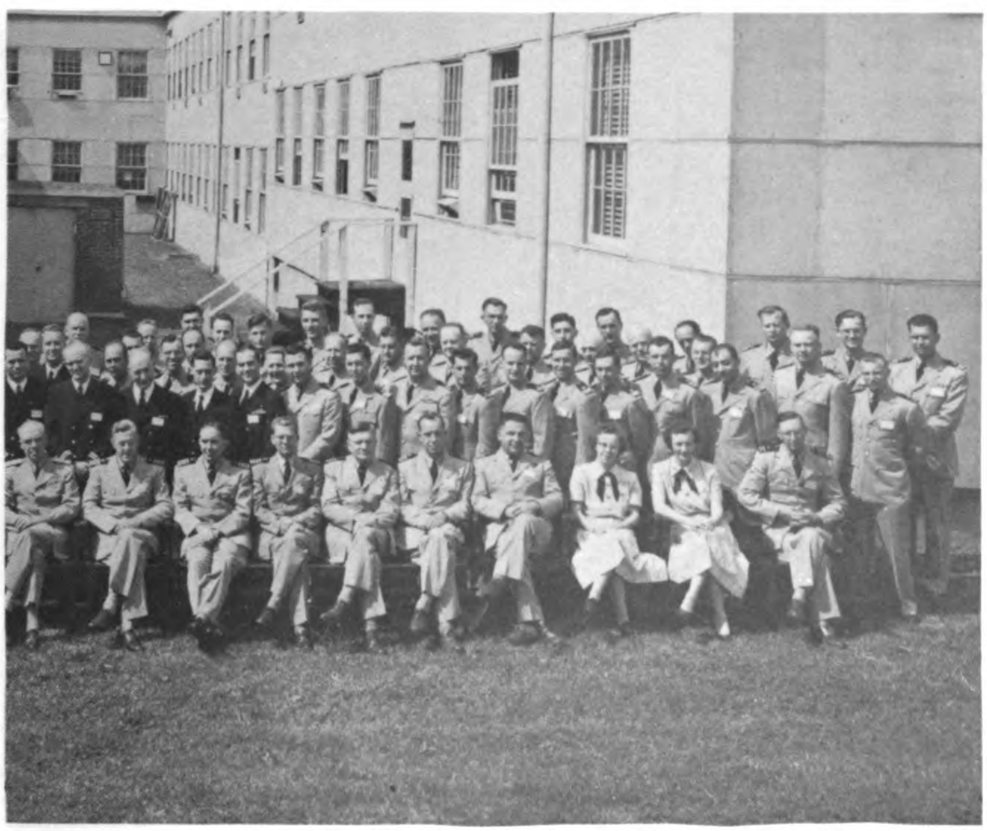
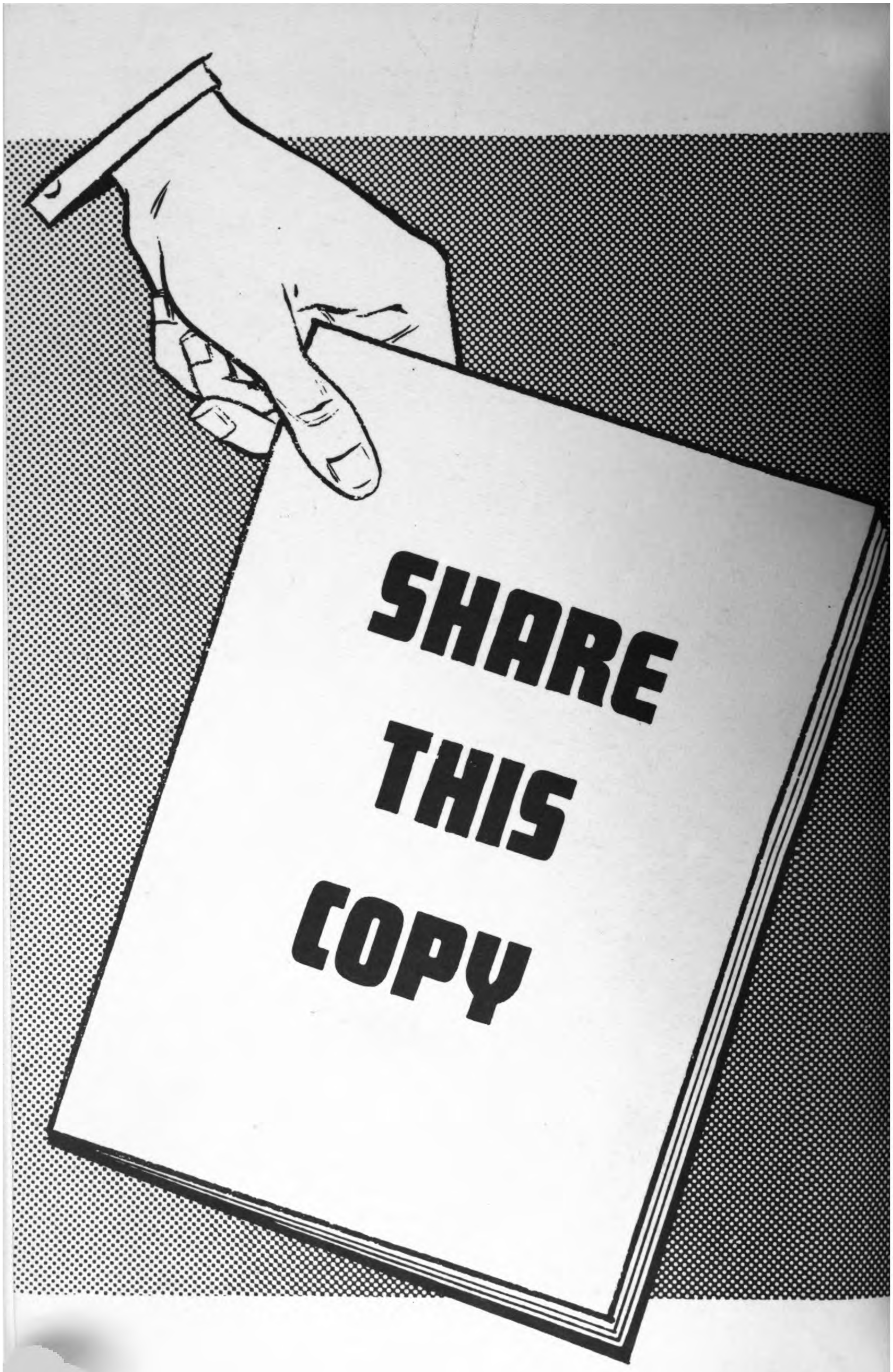




Sixth Annual ONR Washington Seminar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