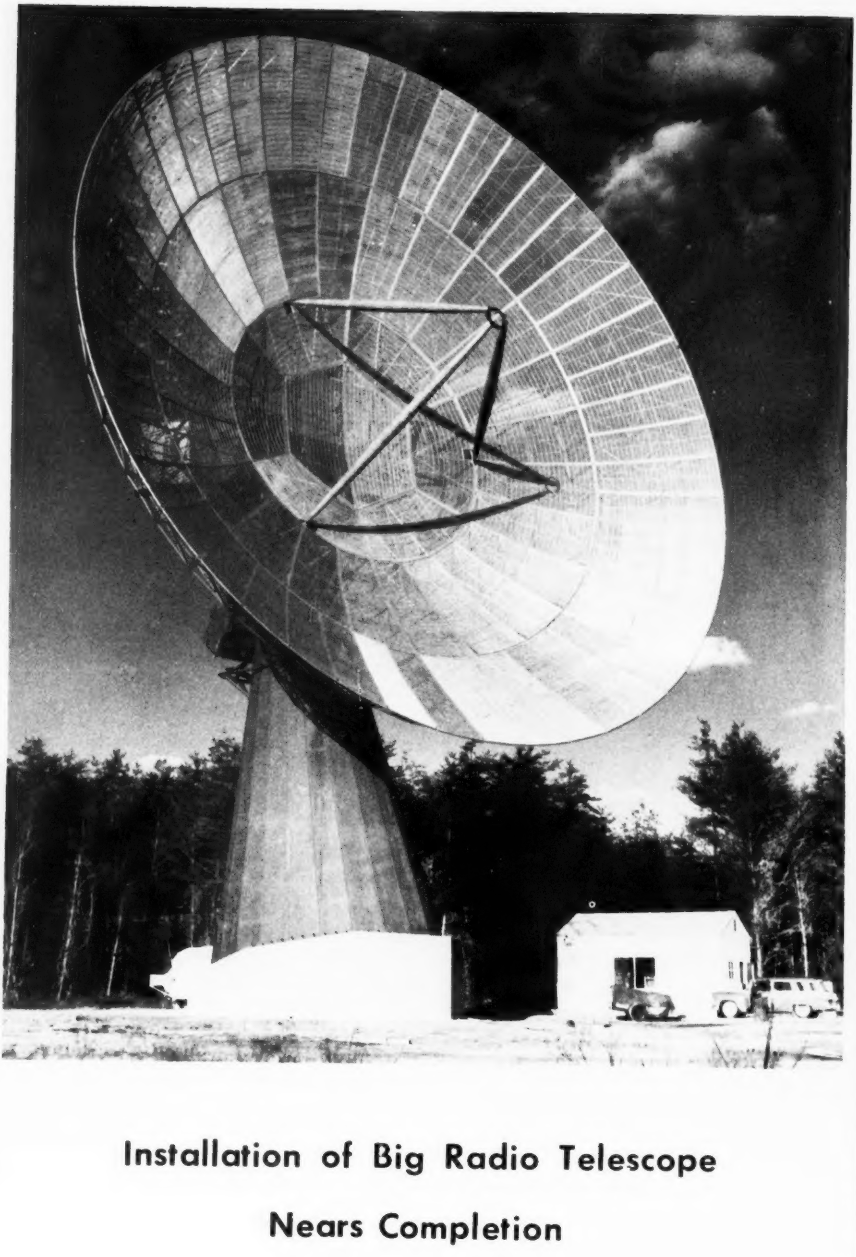
OFFICE OF NAVAL RESEARCH JANUARY 1958

RESEARCH REVIEWS

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

NAVEXOS P-510



Installation of Big Radio Telescope Nears Completion

Early this year, the Naval Research Laboratory will put in operation this 84-foot radio telescope, located at Maryland Point, about 45 miles south of Washington. The largest known equatorially mounted installation in the world, it will be used to study radiation from the sun, moon, and the planets, as well as to determine the composition of material in interplanetary and intergalactic space and to investigate the physical processes occurring in these regions.

Perspective*. . . .

Thomas S. Gates, Jr.
Secretary of the Navy

. . . . ON UNITY

The Navy believes in Unity . . .

There is a great deal more unity than you would believe from reading about service rivalries. Of course, there are honest differences. But these can be sharply focused and resolved within the framework of the present organization. There are differences because often there are no certain answers, and only time will evolve them. Many people, usually uninformed and looking for easy answers to gigantic problems, talk about reorganization as a panacea.

The Department of Defense has been reorganized three times within 10 years, always to achieve better unification, more economy and efficiency, and elimination of waste and duplication. We are not perfect. There is room for improvement, and we work at it daily . . . The criticism stemming from some isolated horror case, blown up to attack the concepts of organization and the worth of the Joint Chiefs of Staff, is not valid. It is true, someone said, we do pretty well and few could do better given the same circumstances and problems. We ought to be realistic—Russia will not go away, nor will the debt limit or the satellite or the rising tide of nationalism worldwide.

There is at least one thing I am quite clear we should not do. That is to substitute a single service or a single Chief of Staff for our present defense organization. We have watched and learned that in corporate life decentralization means efficiency and progress. It is surprising to hear people advocate rigid and monolithic control of defense. We do have top level authoritative direction. At the same time we place definite, fixed authority and responsibility broadly at all operating service levels. I believe this is as it should be. A rebuilding of the defense establishment into a highly concentrated organizational pattern can only result in great danger of fundamentally wrong decisions and a great many dollars wasted. The Secretary of Defense and the Service Secretaries have all the power they need. Our present Joint Chiefs of Staff system has been tested in wars which we have won. The substitutes have also been tested in wars—by our defeated enemies.

Let us never forget that the purpose of the military organization is to protect our most priceless commodity—freedom. To be prepared to fight and win wars. If you understand this, and restore sound dignity to the uniform, then you have a right to insist upon an organization within that context as efficient as possible.

---

* Excerpts from an address given in Oakland, California, October 29, 1957.

. . . . ON THE SOVIET THREAT

The Soviets, whose empire is held together by fear and force, recognize, too, the importance of unity—their version of unity. The basic Soviet strategy is to divide and conquer the nations of the Free World. This is true in cold war, in which foreign policy attacks are made against our collective security arrangements. And it will be true in hot war.

We must keep this struggle for survival constantly in mind, even while reading our newspapers or watching our TV broadcasts.

The implications of the Soviet launched satellite challenges our thinking. Unquestionably, it is a big part of this new era. . . Now the world agrees we have a tough competitor. We cannot with accuracy forecast the hidden meaning or the implications. However, behind the clouds of meteoric dust in outer space is a symbol—a sign to conjure with when a way of life is at stake.

As we focus our attention on this sphere as it circles our world each 96 minutes, we must put it in its proper perspective. We must be realistic and logical. The fabric of international events is complicated.

Yeats wrote in the Cloths of Gold, "Tread lightly or you tread on my dreams." We are now in the business of dreams—dreams that have produced scientific wonders, not all of which are Russian, and dreams of a future for all men.

The launching of the satellite adds an important factor in a tense international situation. This does not alter any of the fundamentals. World communism is characterized by constant factors.

We must not overlook or minimize the vital importance of the political satellite which the Kremlin has created on earth.

When the history of this struggle is written it may well relate how the satellite attracted our vision and thought, and, indeed, was the most successful decoy in history.

We may expect it to be employed against the Free World in support of threats, intimidations, blackmail, and subversions—and as part of a strategy designed to paralyze and lower the level of Free World reaction to Communist aggression. This will indeed make a nice bedfellow to the cold war tricks of military nibblings and economic pressures and the psychological forces which large and growing Communist land, air, and sea forces can generate.

The Soviet fleet of some 500 submarines is an example of th growing power of the Soviets and the direction it is taking.

Having exploited her land power to its practical, strategic, and geographical limits, must not the Soviets move on to a new phase in which targets are those nations separated by deserts, mountains, and seas from the land power base of Russia? It is for the direct or indirect conquest of these nations, largely those which are now uncommitted in the East-West struggle, for which it appears Soviet sea power exists. Isolation of the United States—the destruction of our collective security—is the aim.

. . . . ON THE NAVY'S ROLE

The U. S. Navy is the prime counter to this force. Its role is —

First, to provide military, economic, and political links across the seas for the nations of the Free World and to deny corresponding ties to the countries of the Communist block.

Second, to use the ocean areas as a springboard for offensive operations and as a vast dispersal area for the defense in depth of ourselves and our allies.

Mobile naval power protects our interests in areas where we do not and cannot maintain permanent bases.

Naval power gives us the power of choice. Our government needs a choice of action when confronted with a dangerous international situation. It is as true today as ever that military forces with many capabilities are an absolutely vital tool for providing needed alternative methods to project United States power overseas in cold, limited, or all-out war.

Thor, Jupiter, Vanguard, Sputnik, Atlas, Polaris— this is an awesome roll call of ballistic missiles and satellites! In the light of these developments, many people ask our view on the relationship of missiles and manned aircraft. Will the missile supplant the aircraft in military applications? I think the answer is simple—it will supplant the aircraft where it can do the job better, but it will never replace it where it cannot, Khrushchev's recent statement that fighter and bomber planes "can be put in museums" notwithstanding.

In air defense and in nuclear attack, the missile probably will supplant the aircraft some day. In reconnaissance-logistics, and in the numberless applications of sea-air power to limited war, to control of the sea, and to politico-military operations, it probably will not.

So now we are going ahead to marry nuclear energy with aircraft carriers, in what we believe will be the most effective instruments of naval power ever built. With the almost limitless endurance at top speed provided by nuclear power, these sea-borne airbases can deliver effective airpower where it is needed, for cold war or hot, at every danger area the world around. The atomic depth charge and the nuclear powered aircraft carrier are a potent pair of answers to the huge Communist submarine fleet and the Soviet naval buildup.

Just as our naval supremacy is vital to our national security, so also is there a need for a deep and abiding appreciation of our Navy, its aims, its needs, its dynamic capability, and most of all, its heart and spirit, within which lies a great capacity to preserve a peaceful world. . .

A Tundra Landscape

Max E. Britton

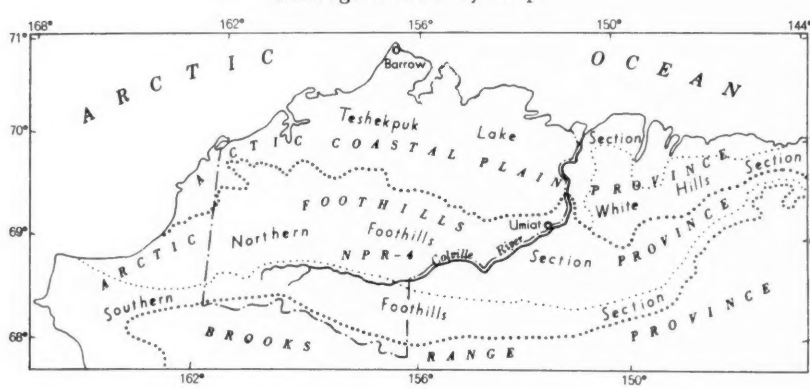
Geography Branch
Office of Naval Research

Aerial view of lake basins and of patterned ground formed by ice-wedge polygons near Point Barrow, Alaska. Scale, 1:25,000. U. S. Air Force photograph

"Well, we've seen it all now. Let's go home."

This was what one man was heard to say of the treeless tundra as he stepped from the plane which had whisked him in 3 hours from Fairbanks, Alaska, to the northermost point of the Territory at Point Barrow (Figures 1 and 2). Thus, expression was given to the frequent reaction that there is not much to see on the tundra and that what there is to see is seen too often. But first impressions are not always the most reliable ones. After looking more closely at tundra features, one might, instead, consider this to be a land of extreme diversity and inexplicable chaos.

Figure 1 — Physiographic provinces of northern Alaska. U. S. Geological Survey map.



But here, as with all landscapes, one's impressions depend upon the scale at which he views the land, the season of the year, his familiarity with intricacies of detail, and certainly his background and critical interests.

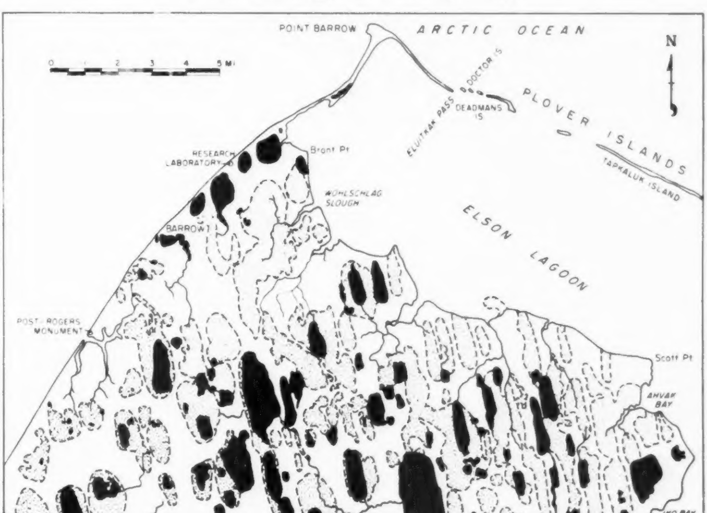
The objective of this review is to examine some of the factors that contribute to both the tundra's overall uniformity and its small-scale diversity, as studied in the vicinity of Point Barrow. The work leading to the interpretations discussed was accomplished through the arctic research program of the Office of Naval Research, at the Arctic Research Laboratory, Point Barrow.

THE POINT BARROW TUNDRA

Point Barrow lies at the north margin of the vast Teshekpuk Lake Plain (Figure 1), which constitutes the major part of the Arctic Coastal Plain. Features of the Lake Plain include very subdued relief, much standing water (see photograph on page 4 and Figure 2), conspicuous ground patterns (see photograph on page 4 and Figures 3 and 4), and a vegetation cover of low-growing grasses and grasslike plants (Figures 5 and 6). These are the features which give the tundra as a whole a reputation for monotony.

Subdued relief is due largely to the fact that the Lake Plain originated as an emergent portion of the essentially flat continental shelf. Apparently, the plain emerged from the sea in several stages, beginning in the Pleistocene, or Glacial, period of geologic history. The plain slopes, usually at low grade, from the highest and oldest surfaces adjacent to the Brooks Range to the lowest and most recent land along the north coast. At Point Barrow, the terrain is generally less than 20 feet above sea level, although a few miles to the southwest it reaches an

Figure 2 — Part of the Teshekpuk Lake Plain. Black areas are lakes; stippled areas, swamps of drained lake basins. U. S. Geological Survey map.



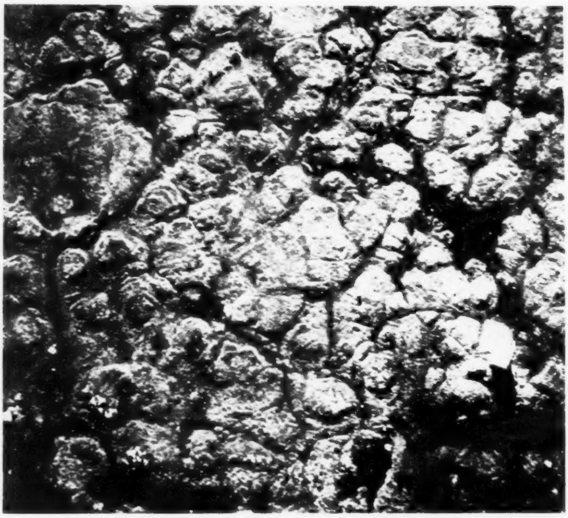


Figure 3 — Near vertical view of old polygon mounds on ridge near shore of an abandoned lake basin. A small drained pond appears at upper left. The roof of a building (about 9 feet square) can be seen at lower right.

Figure 5 — View large thaw pond which eroded moun of polygons occu The mound in for ground is about 6 f wide.

altitude of 40 feet. Inland from the coastal wave-cut cliffs, the tundra is a gently indulating surface dimpled by many shallow lake basins, notched by the ravines of occasional small streams, and, over large areas, rarely having a total relief of more than 20 feet.

The plain consists of unconsolidated gravels, sands, silts, clays, and peats, mainly of marine origin, to depths as great as 150 feet. These materials, believed to be of Pleistocene age, are overlain by only a few feet of similar deposits of recent origin—the parent materials of soils. Silts and peats, which make up most

Figure 6 — Marg ally ridged polygo The larger size some of the mou is due to peat acc mulation

Figure 4 — Oblique aerial view of flat and marginally ridged polygons and of coalescing thaw ponds. The polygons at lower center are about 10 to 20 feet in diameter.

of the top layer, usually occur in apparently chaotic mixtures, at least in the upper few feet of the deposits. Studies of excavations made in both uplands and lowlands led the writer to conclude that certain of these mixtures were laid down in lakes that are now extinct. Such deposits provide one basis for deciphering certain details of the landscape's history.

All substrate materials, with the possible exception of those underlying the deeper lakes, are perennially frozen to depths of several hundred feet below a surface zone that thaws each warm season. This zone, called the active layer (Figure 7), develops most rapidly, extending to depths of several feet, in well-drained sands and gravels. The

poorly drained ditchlike troughs which conspicuously pattern the ground thaw very slowly, to depths of only a few inches each season.

DEVELOPMENT OF PATTERNED GROUND AND VEGETATION

Within the tundra's framework of uniformity is found an array of vegetation and minor surface features which are bewildering to the newcomer. This diversity is brought about by interrelationships between plant populations and the geomorphic processes which initiate, modify, and ultimately destroy the surface features of patterned ground. On the Lake Plain, these processes are generally slow and orderly and do not indicate the instability of surface well known in tundra areas elsewhere. At Point Barrow, most surfaces are as stable as those developing under any other climatic regimen.

On the Lake Plain, patterned ground generally owes its existence to a mesh of sub-surface ice veins. These divide the ground into units ranging in diameter from a few feet to more than 30 feet. In shape, they are occasionally trigonal, but usually tetragonal, polygonal (Figures 4 and 8), or more or less round (Figures 3 and 9). Regardless of their shape, they are called polygons and the ground is said to be polygonally patterned.

The origin of ice veins has excited the curiosity of many scientists. Most of these workers now believe that the veins are initiated in contraction cracks formed in the frozen ground at very low temperatures. Repeated cracking, perhaps each year, followed by infiltration of melt water in the warm season, then by freezing, is one of the ways in which the veins may grow. In time they may become several feet wide (Figure 7) and more than 20 feet deep. They may have approximately parallel sides near the surface or may widen from bottom to top and have a wedge-like shape, from which the name "ice wedge" is derived.

The surface manifestation of ice wedges depends mainly upon the thawing of the upper parts of the wedges at a rate exceeding that of the adjacent frozen ground (Figure 7). When the surfaces are lowered in this way, ditch like troughs are formed. These are usually very poorly drained and may be either intermittently or permanently ponded. The tops of all polygons in areas of similar age and history, whether a few inches or a few feet above their troughs, and whether flat-topped, domed, or saucer-like, are, with minor exceptions, initially of the same shape (Figure 9).

Under certain poorly understood conditions, pressures are developed which force soil materials upward along the line of contact of the ice and the frozen ground, thus forming a ridge, usually only a few inches high, at the edges of the polygon (central polygon of Figure 9). This process appears not to be intensive, or if so, of limited duration, as there is no evidence of continuous formation and degradation of such ridges. As the ridges develop, the polygon may or may not become ponded. Peat accumulates on all surfaces, especially on the polygon rims, where peat moss often finds a favorable environment (Figure 6). Under proper conditions, the peat ridge gradually widens and thickens. In time, both depressions become partly or completely peat-filled. Also, the peat ridges on two adjacent polygons frequently merge across the intervening trough. Later, parts of the ridges may be eroded away, leaving individual peat mounds underlain by wedge ice.

Over thousands of acres of tundra, whether on one of the higher divides or in a drained lake basin (Figure 10), relief varies only by the occurrence of the multitude of mounds and ridges of the polygonal patterns (Figures 3 and 6). Differences between the elevations of the highest and lowest usually range only from about 1 to 5 feet, the minimum being the more common. The highest mounds, which simply represent greater degradation of the ice wedges in the adjacent troughs, occur where drainage lines are open along a system of troughs. Such conditions exist only near streams and the eroding shores of lakes, drained lake basins, and the sea.

Although the ice-wedge polygons display many different structures, all have the same origin and potentially pass through the same stages of development. They may have no relief, or their relief may be barely perceptible or pronounced; in any case it represents a stage reached in a developmental series. The "growth" of polygons may be slow, completely arrested for long periods of time, or may proceed at such a rate that the full course is run in a very short time. Many factors of the total environment influence the rates of differential thaw upon which the series largely depends.

The development of polygonal ground is in general paralleled by the development of vegetation. At Point Barrow, slightly more than 100 species of flowering plants occur, of which a very few predominate. Elsewhere on the Lake Plain, particularly southward, the number increases and the combinations are more complex. The small number of species found near Point Barrow represents limitations imposed largely by climate, but also, it is believed, by the fact that not enough time has passed since that part of the plain emerged from the sea to permit migration of a richer flora. A further limitation is imposed by the narrow range of habitats available there.

The Barrow tundra is a grassland made up of a mosaic of species assemblages, most of which are differentiated by the different structures of the patterned ground. Grasses and the grass-like sedges (Figures 5 and 6) make up a major part of the vegetation, but a variety of other flowering plants may be intermixed with them, in places constituting the principal species. Mosses and lichens grow in many places, are abundant in others, and are the major species in local areas.

Frequently, a difference in elevation of only a few inches separates one population from another. Probably no other environment exists where minor relief is so important over such large areas. Segregation of populations occurs along gradients extending from water depths of 4 to 5 feet, through shallowing water, to wet and moist ground, and to silt or peat ridges and mounds which, at least seasonally, are relatively dry. The environmental gradients may be shallow and the populations therefore extensive, or they may be steep and the populations narrowly restricted in distribution. Commonly, 4 to 5 well-marked assemblages occur along gradients in local areas of patterned ground, but they are not always the same ones. Usually, several different equivalent assemblages occur at each stage of development of the polygons. A complex of conditions, in which chance plays a role, determine which will occupy the ground.

Changes in environmental gradients resulting from geomorphic changes in polygons may destroy some species assemblages, modify others, or leave them relatively unchanged. Many species are ubiquitous and thrive in several different populations, and most of the species are able to hold ground, once they are established, in spite of considerable environmental change. Vegetation begins as a mosaic, undergoes much orderly modification, but probably never loses its mosaic character completely. Such appears to be an equilibrium condition. Time is an important factor; for example, the writer believes the destruction of patterned ground and vegetation by the encroachment of lakes and ponds occurs often enough on most surfaces to prevent the establishment of a uniform vegetation.

451192 O - 57 - 2

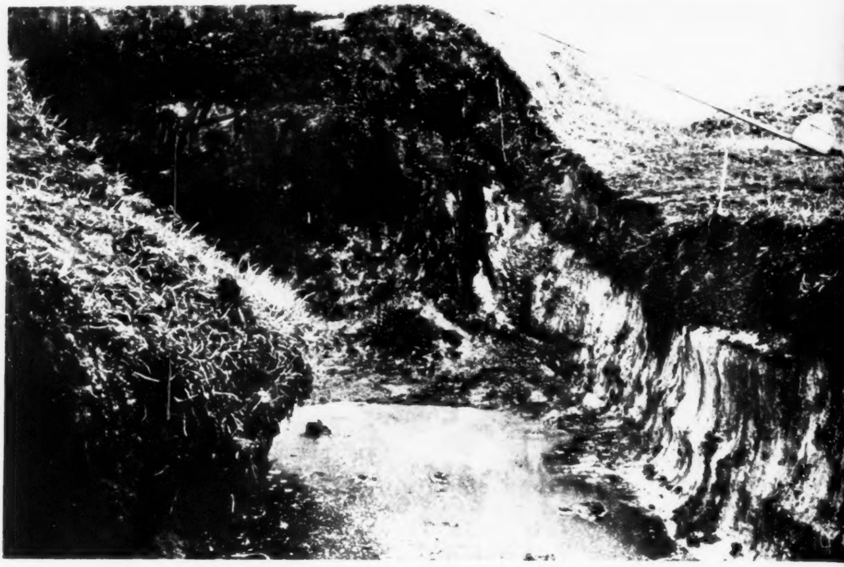
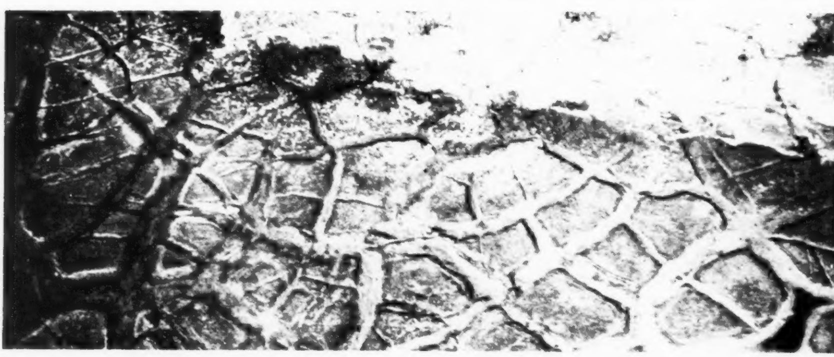


Figure 7 — Trench across two mounds and a trough in area of Figure 3. The "active" layer is the uppermost of the layers shown. The surveying pin at right is 9 inches high.

Figure 8 — Aerial view of shore of drained lake and reexposed polygons.



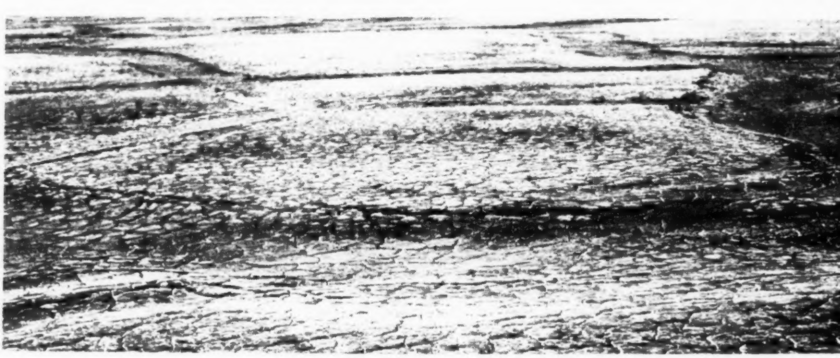


Figure 10 — Oblique aerial view southeastward across the drained lake appearing at lower right of photograph on page 4. Note that the reexposed pattern in the lake sediments is continuous with that of the tundra.

THE ROLE OF STANDING WATERS

Because the tundra's surface restricts stream development, its perennially frozen ground blocks internal drainage, and its widespread micro-relief retards surface-water runoff, almost all depressions are ponded at least seasonally. Water bodies are of many sizes, from pools only a few feet in diameter (Figure 4) to lakes 5 to 10 miles or more long. These may be regular in shape—for example, the larger lakes and drained lake basins tend to be elliptic (see photograph on page 4 and Figure 2)—or they may be irregular in shape. Most of the small ponds range in depth from only 1 to 4 feet, and the large lakes from 5 to 10 feet; few water bodies are more than 20 feet deep. However, erosion features at levels above the lakes now occupying certain basins indicate that the former lakes were two or three times deeper.

In areas in which the ground is perennially frozen, thaw is a necessary prerequisite to erosion. Rate of thaw depends upon a variety of conditions which include thermal properties of materials, exposure to sun, and insulating effects of vegetation. Thawed ground is eroded mainly by water action and by creep, slump, and flow of supersaturated materials under the influence of gravity. Erosion is most rapid in the larger lakes where not impeded by gravel deposits and slowest in the

---

ure 9 — View of polygons in drained lake of Figures 8 and 10. Note shallow ughs, which are about 4 to 6 feet wide. The central polygon is slightly ridged; st of the others are flat. The small polygons were formed by shrinkage cracks ch develop as the sediments dry out. Most of the surface is densely covered h mosses.

small ponds, where slow thaw, weakness of wave action, and resistance of vegetation inhibits it.

As the shorelines of lakes advance, they may breach drainage divides. Also, many lakes are emptied as the result of the headward erosion of streams along systems of polygon troughs. Lakes are no doubt drained somewhere on the plain each warm season, for drained basins are to be seen on every hand (see photograph on page 4 and Figures 2 and 10). Along the coast, drainage occurs more rapidly, as the divides are attacked from one side by lakes and from the other by the more active sea. Basins emptied in this way and now occupied by swamps can be seen at many points along the coast (Figure 2).

Few surfaces have escaped destruction, reworking by water, and redevelopment of features previously present. These processes are so thorough that a surface once occupied by a lake is, in time, changed to such an extent that it gives no indication of the former existence of the lake, except to the trained observer. Only through a knowledge of variations of patterned ground, vegetation assemblages, and underlying sediments can one "find" the ancient lake. As a new lake may form on such a surface, it appears that the development, extinction, and redevelopment of lakes may be in some measure cyclic.

As the larger and deeper lakes, which are believed not to be underlain by permafrost, erode the perennially frozen land surrounding them, the shallow, over-ridden zones become underwater benches which can be distinguished readily, particularly from the air. Polygonal patterns are often preserved as visible features under water for a time, but as the lake continues to enlarge, the benchs are covered with sediments and the pattern is buried.

In the process of lake-shore erosion, coarse chunks of peat, which disintegrate very slowly, are carried only a short distance into the lake, the smaller pieces increasingly farther, and all are embedded in a matrix of silt, sand, and clay. The oldest of these deposits—the ones that form the lake bottom farthest from shore—consist of lower zones of peat mixed with silt and other fine material, and of upper zones of fine material only. Shoreward, the coarse-peat profile rises, emerges from the surface at near-shore points, and mantles the surface from there to the lake margin. This pattern of deposition is maintained as the lake margin advances. Deposits of this kind are to be found in many places on uplands and in all of the drained lake basins of the lowlands.

As the large lakes are drained, relatively flat terraces (such as the one fringing the south half of the central lake in the photograph on page 4) are exposed at their edges and eroded by the residual body of water. Wherever ice wedges buried in these terraces extend upward into the active layer, differential thaw quickly exposes their polygonal pattern, presumably as it does when shallow lakes are completely drained (Figures 8, 9, and 10). But as drainage continues, sediments lacking ice wedges should be exposed. Potentially, these could develop a completely new pattern system.

Lakes which have originated on permanently frozen ground, and which are shallow enough to freeze completely to the bottom, probably preserve buried ice wedges which, following drainage of the lakes, should be once again revealed as patterned ground. Numerous basins which appear to have been drained relatively recently have well-developed patterns throughout. The two "twin lakes" in the photograph on page 4 (the lakes at center and lower right) were artifically drained in 1950. Within 4 years, and probably within a much shorter period, the pattern was beautifully reexposed in certain peripheral areas and along the drainage system of the south lake, but very weakly in the north lake. Trenching in the south lake revealed many wedges too deeply buried for differential thaw to produce patterning. It was not determined whether ice wedges were present in the central part of the lake.

Small ponds formed either within polygons or in interpolygonal troughs enlarge in the same way the larger lakes do. Once the polygon ridges are breached, adjacent ponds coalesce (Figure 4), and the rate of thaw and erosion is stepped up. In old lake basins, erosion leads ultimately to the development of lakes 1 mile or more long. On the divides, particularly the narrower ones, the ponds are smaller than in the basins. The minor ridges impounding them are breached easily because the opening of a single frost crach is often all that is required to initiate water flow and the cutting of an outlet. The tundra is replete with examples of ponds in all stages of formation and drainage, and of basins being filled by accumulating peat.

Polygons reexposed on drained lake bottoms have the same shapes and structures as those found elsewhere on the tundra (Figures 6 and 9), excepting those which have been modified by peat accumulation. They range from simple, flat-topped, unridged mounds to mounds having incomplete or complete ridges. The troughs may be only barely perceptible or several feet deep. Environmental gradients depending upon relief are established rapidly and set the pattern for many years in the future. This ground is soon repopulated by plants, the diversity of gradients resulting in the rapid sorting of vegetation types. Surfaces having little or no relief at first are still subject, in time, to the same results. Differences in the ages of surfaces and differences in the rates of processes which modify the surfaces contribute importantly to the bewildering array of features which occur.

Although the tundra is indeed monotonous in its overall uniformity, it is endlessly varied in detail; and it is neither chaotic nor inexplicable, but splendidly orderly in dynamic equilibrium with an environment strange to visitors from other parts of the world.

The work which has made possible the discriptions of tundra features given here represents but one "feel of the elephant." Much more research must be accomplished before many details of the landscape will be fully understood. Through its arctic research program, ONR is now sponsoring studies in the fields of geology, geomorphology, geophysics, pedology, and ecology at the Arctic Research Laboratory. This work is expected to contribute substantially to the solution of these intricate problems.

Metallurgy in the Public Service*

Julius J. Harwood
Head, Metallurgy Branch
Office of Naval Research

During the past 15 years, a clear realization of the importance of metallurgical research to the national security and public welfare has developed within government circles. The large amount of money which the government — particularly the Department of Defense and the Atomic Energy Commission — is spending for metallurgical and related research being conducted under contract and in government laboratories, testifies to the recognition of the growing stature of metallurgy. In a recent article in the New York Times, which discussed the activity underway in the United States and the Soviet Union for the application of modern science to warfare and peaceful pursuits, metallurgy was listed as one of the four major fields of technology, the other leaders being atomic energy, supersonic flight, and rocketry.

The scientific and technological revolution which this country—and the world at large—are experiencing is in large part dependent upon progress in materials research, development, and design. There is no

* Condensed from an address presented at the 25th Anniversary of the Metals Research Laboratory, Carnegie Institute of Technology, on the theme "The Metallurgical Scene in 1957 - and the Shape of the Future."

doubt that the limitations of present day materials, and equally important limitations in design and application concepts, represent some of the chief obstacles to the development of new and advanced military weapons, equipment, the utilization of nuclear energy and other sources of power, and of new industrial processes.

On October 4th, the piercing of the outer space barrier by the satellite launched by the Soviet Union formally opened the "space age" — an age which undoubtedly will introduce equally revolutionary developments in supersonic aircraft, missiles, rockets, nuclear propulsion, thermonuclear fusion power sources, space travel, and ultimately interplanetary flight. Seldom before have metallurgists and their colleagues in solid state physics, chemistry, and ceramics been faced with the challenges which now confront them. The continuous rise in operating temperatures of military equipment, the development of completely new weapons systems (which border on the realm of fantasy), the exploitation of nuclear power, the introduction of powerful and aggressive fuels and propellants, and the ever present desires for more speed, more power, and more range have posed a fantastic set of materials problems. These increasingly severe operating requirements—higher stresses, temperatures, pressures, and environmental agressiveness which alloys and other structural materials must withstand— are not confined to military equipment alone; on a more modest scale a similar trend is being encountered in the chemical and processing industries. Whether we look at the materials problems associated with jet aircraft and missiles, nuclear reactors, conventional power plants, or electronic devices, one common factor is apparent—the need for materials with higher temperature resistance and stability. Breaking through "the thermal barrier" has become an apt expression, indeed.

The magnitude of the new demands on materials has led to the realization that slight improvements in our present commercial alloys will not be sufficient. Entirely new classes of materials must be made available, and radically new concepts in their design and engineering application must be developed. The successful solutions to these complex materials problems will determine, in large part, the rate of advance of our military and industrial technology.

This challenge, in the writer's opinion, dominates the current scene for metallurgy in the public service. The entire government apparatus for metallurgical research and development, both in and out of the Department of Defense, is alive to the realization that the needs for materials are advancing at a faster rate than our knowledge of the properties and behavior of materials.

In speculating about the shape of the future of metallurgical research performed in government laboratories or under government contract, I should like to examine some of the implications of this challenge with particular reference to the role of research and to research trends which may be extrapolated.

Direct attempts to overcome the materials barriers are being made in extensive government applied research and development programs. Because of their very nature, these programs can provide answers only to those problems which can be readily identified or which are of immediate practical concern. Thus, the approach to improving the ductility of beryllium may be made by semi-empirical alloy and fabrication studies. But it is equally important to recognize that the brittleness of beryllium may have its basis in its inherent crystallographic structure. An essential component of the over-all government effort, therefore, must continue to be directed toward maintaining a strong, vital, and expanding basic research program in metallurgy and related material sciences. Basic research can provide the roadbeds for new paths around the roadblocks.

It almost has become a cliché to state that research cannot be divorced from development and must be carried on as a parallel effort in order to open up broader areas of development. Despite this apparent recognition and the experiences of the past 10 years, the need for the justification of research continuously arises. It is time that the issue was faced squarely and the need for spectacular justifications was obviated. Breakthroughs, if we must use the word, do not occur fortuitously—they are the end result of much (and often non-programmatic) research. A rational approach to the problem of "ductile ceramics" is possible now only because of the knowledge and experimental findings which have accumulated from past research on the mechanical response of ionic crystals to environmental influences, the mechanical behavior of ice, stress-corrosion cracking, and the application of dislocation theories of flow and fracture to metal systems.

The major contribution of basic research in metallurgy lies in providing the solid background of information, both theoretical and experimental, which permits the selection, design, and application of presently available materials with confidence, and which makes possible a rational approach to the search for and development of new and improved materials. The intriguing speculations as to what might be achieved with improved materials, in both military technology and civilian industry, are sufficient to dramatize and emphasize the needs for research. It certainly is not in our best interests to allow the balance between research and development to deteriorate.

The science of metals has developed rapidly during the past 15 years—in great part due to the impact of advances in solid state phisics. Our knowledge about the structural features of metals and alloys and the factors influencing their mechanical response has reached a high degree of sophistication. There are many, in fact, who believe that we are on the threshold of exciting developments in metallurgy—both from the scientific viewpoint and in the application of new concepts and information for developing alloys of vastly superior properties. However, this tremendous growth in metallurgical science imposes the responsibility of being alert against "diminishing returns" in any given research area or approach. It necessitates a highly critical analysis of research programs in terms of their real potential toward making a significant advance. Acquiring data, per se, is obviously important and often necessary, but of greater importance is the need for imaginative, bold research and the application of new concepts, new techniques, and new approaches. Metallurgical research must not stagnate in the comfort of familiar and over-exploited principles and experimental techniques.

While government laboratories will participate to a significant extent in the metallurgical research program, of necessity, the bulk of the basic research will continue to be conducted through the "off-site" government contract research program. This places an unusually heavy responsibility upon the university scientist. We in the government look to him for the formulation of research problems basic to the long-range improvement of materials; the development of imaginative, independent approaches to these problems; and the exploration of new fruitful fields of metallurgical research. He must also become more concerned with the translation of research findings into engineering language, so that new ideas, principles, and theories can be fed directly, when practicable, into more applied areas. In short, the universities will continue to occupy a key position in maintaining the proper balance between pure and applied research.

There has been one area of metallurgy in which government interest has had a singular and profound influence. As a direct result of government support, several entirely new metal systems have been developed to the stage of commercial production as structural or engineering materials, and others are rapidly approaching this stage. Titanium, molybdenum, zirconium, hafnium, and, of course, uranium and plutonium are becoming commonplace metals. Beryllium, niobium, and other refractory metals, the rare earths, and other types of metals are now the subject of extensive government-supported research and development programs. New industries for the preparation and fabrication of these metals and their alloys have been created. While the initial impetus for their development arose from military or atomic energy needs, their wide future usage in industry is a certainty.

It is possible to extrapolate, from certain current trends and the anticipated needs for materials for military and nuclear power applications, areas of metallurgical effort which are likely to receive future government emphasis:

- A major effort will be concentrated upon the preparation of high purity metals and single crystals, and upon the study of their fundamental physical properties and metallurgical behavior. The development of more sensitive and reliable methods for analyzing impurities and interstitial elements will be involved also. It may well be that a government-supported center (or centers) will be established for this purpose.

- In the field of high-temperature materials, emphasis will be placed upon:

★ Exploration of new metal and alloy systems—the refractory metals, such as tungsten, tantalum, osmium, iridium, and rhenium, will receive particular attention. Methods of preparation, determination of properties, and alloying behavior will be investigated.

★ Continued study of the principles of dispersed-phase and fine-particle strengthening of metals and the application of these principals to practical systems.

★ The fundamentals of metal-ceramic composite materials with particular attention to bonding mechanisms and the fundamental factors influencing the mechanical behavior of such composites.

★ Graphite and, in particular, the problem of surface protection.

★ Thermal protection systems—the possible use of surface chemical reactions, physical cooling methods, ablation, and other heat-alleviating techniques to by-pass the fundamental high-temperature limitations of metals and alloys.

★ Study of high-temperature thermodynamics and properties of metals and alloys.

● Research on ceramics and inorganic solids will be expanded greatly. Basic scientific information is seriously needed regarding the electrical, thermal, chemical, and mechanical behavior of ceramic-type materials. These sub-problems will receive particular emphasis:

★ The deformation and fracture behavior of simple ceramics.

★ A systematic study of the structure and properties of high-purity intermetallic compounds as well as oxides, carbides, borides, nitrides, silicides, phosphides, sulphides, and other such compounds.

★ Mechanisms and kinetics of solid state reactions in ceramic systems, such as phase transformations and precipitation reactions. Also, the relationships between structure, chemical composition, and dielectric, ferroelectric, ferromagnetic or thermoelectric properties of ceramics. Such studies will have a particular bearing upon the development of improved high-temperature electronic materials and materials for thermoelectric power devices.

★ Basic thermodynamic studies involving ceramics, such as gas-solid equilibria in mixed oxide systems.

★ Studies of transport phenomena in inorganic solids, such as electrical and thermal conductivity, and mass transport or diffusion in oxide systems.

● Research on the structural features of metals and alloys and the factors influencing their mechanical response.

★ Exploration and application of new metallurgical instrumentation and techniques for studying the structure and properties of metals and alloys; for example, electron microprobe, magnetic resonance, neutron diffraction, and isotopic enrichment.

★ Elucidation of the fine structure of metals and alloys and the relationships between structures and properties. Increased use of "radiation damage" as a tool for studying the imperfection structure of metals and alloys.

★ Deformation and fracture with particular emphasis on the influence of state of surface and environment on the mechanical response of metals and alloys. Increased attention will also be placed on research involving high strain rates and the dynamics of imperfections (dislocations).

★ Reactions and phase transformations at high pressures and high temperatures.

★ Transport phenomena in solids; for example, the mechanisms of diffusion, electrical conductivity, and thermal conductivity.

★ Exploration of properties and alloying behavior of rare earths and other new metal systems.

● Structure and reactivity of solid surfaces. While it has become commonplace to regard corrosion losses as inevitable, the reactivity of materials with high-temperature environments, and the corrosion problems associated with propellants, fuels, and nuclear propulsion systems makes this a research area of vital importance.

★ Kinetics of solid-gas interactions at very high temperature and under high-velocity gas conditions.

★ Fundamentals of liquid-metal and fused-salt attack on metals and alloys.

★ Application of new and more sensitive techniques to the study of surface structure and surface reactions.

★ Effects of nuclear radiation upon the mechanisms and kinetics of corrosion reactions and the study of mechanisms of corrosion reactions related to nuclear propulsion.

★ Fundamentals of stress-corrosion cracking.

The above list represent some of the areas of research which are now receiving increased emphasis. Obviously, it is impossible to predict the long-range, future directions of new research—this, itself, is one of the objectives of research. New paths of metallurgical effort will be the result of the contributions of research now underway.

In the more practical vein, it can be stated with certainty that there will be, in the future, a much closer relationship between design and materials. The recognition of the temperature limitations of materials and the realization that metallurgical panaceas are not in the near offing are bringing about long-awaited revisions in materials design concepts. New design and application principles will be developed to take maximum advantage of advances in materials technology.

On closing, perhaps a word of explanation is in order concerning my treatment of the subject of metallurgy in the public service. In the light of recent events, it seemed more opportune to discuss some of the philosophical aspects of the topic rather than to deal with the more prosaic aspects of the organization of the government for metallurgical research or to describe the areas of research being supported by government contract or underway in government laboratories. In point of fact, the degree of involvement between government, industry, and university makes it difficult to draw sharp boundary lines of individual research interests. I would like to conclude on the note that the interest of the Federal Government in metallurgy, both from the viewpoint of national defense and the full utilization of our natural resources and scientific potential, is not so much a matter of metallurgy <u>in</u> the public service as metallurgy <u>for</u> the public service.

Automatic Approach and Landing System

H. W. Chitty
P. J. LaRochelle
R. R. Zirm

Electronics Division
Naval Research Laboratory

The first landing of an airplane on the deck of a U. S. Navy ship was made in 1911, when a pilot by the name of Eugene Ely set a plane down on a platform built on the stern of the USS PENNSYLVANIA. While the PENNSYLVANIA'S improvised landing strip was only 120 feet long, those of modern carriers are as many as 900 feet from stem to stern. But increases in the length of carrier landing surfaces constitute only one of several improvements that are enabling safer landings to be made at sea. Of equal importance is another, now being effected, which permits automatic ship-controlled landings to be made.

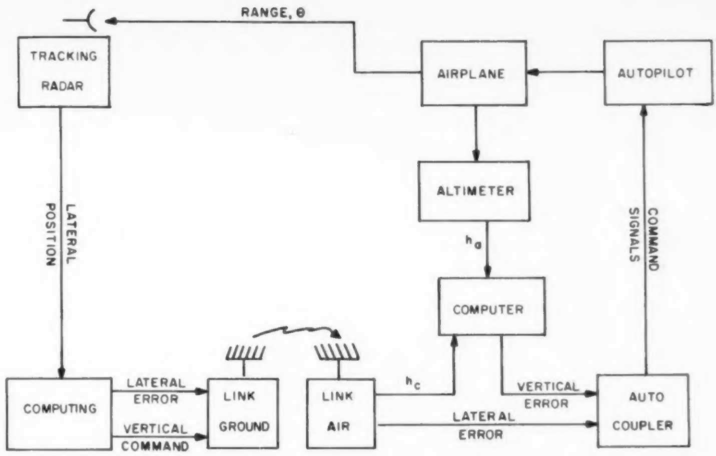
For many years, the landing of planes aboard carriers was controlled by an officer stationed at the after end of the flight deck. Highly experienced in the operation of carrier aircraft, he watched the approach of each plane, indicating to the pilot through a series of hand signals the proper moves to make in bringing the plane in. The new system, being developed by a commercial contractor as an outgrowth of the Navy's carrier all-weather flying (CAWF) program, does away with this man, relying instead on radio, radar, and electronic computers to guide the plane down.

Radar locates the airplane and determines its altitude and position in relation to the carrier deck. Electronic computers then calculate the course corrections that must be made to put the plane in the position it should be in to approach for a safe landing. Finally, this information is radioed to a device in the plane which automatically makes the required adjustments in course. If the airplane is not in the best attitude for a safe landing, it is automatically sent around to make another approach.

The system will not only make all-weather flights possible, but it can also be used to land pilots who are either wounded or overly fatigued after flying long missions. About 10 years of research and development have gone into the achievement.

The original and precontractual phases of the CAWF program were carried out by the Naval Research Laboratory in 1947, soon after the Chief of Naval Operations formally established the Navy's desire for a completely automatic aircraft navigation system. This system was to be designed to control, especially during bad weather, landings and take-offs on carrier decks, to guide the approaches of aircraft preparatory to landing, and to regulate "stacked" aircraft traffic in the neighborhood of carriers.

Early in 1948 the Laboratory completed an analytical study of all-weather flying from carriers. The general conclusion reached from this



Block diagram of the ACCA system.

work was that all data relative to the operation of an aircraft in a given area should be centrally collected, interpreted, and correlated by carrier personnel and then relayed in a directly usable form to the pilot.

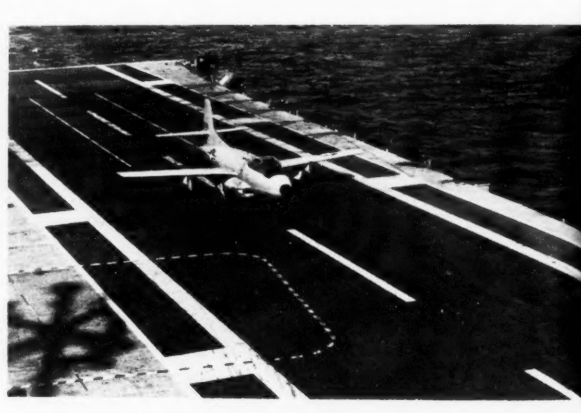
By about a year later, NRL had formulated and established a comprehensive research and development program. Although many projects of a similar functional nature were being carried out at other government and industrial establishments, few, if any, were directed primarily toward the overall solution of the Navy's carrier problem, as this one was. The program was supported first by the Office of Naval Research and the Bureau of Ships. Later, the Bureau of Aeronautics joined in supporting the program. At the present time, the work is sponsored by the Air Navigation Working Group, which is made up of representatives of all three organizations.

Once the CAWF program was firmly underway, NRL scientists began choosing components for the new automatic carrier controlled approach (ACCA) system. As the purpose of the project was to provide sufficient instrumentation to evaluate the system through flight tests, rather than to provide the ultimate in equipment, existing radar, data-link, and autopilot elements were utilized in but slightly modified form. However, other equipment, such as the computers, had to be specially designed and built, or radically modified, to fit into the system. Airborne elements of the ACCA system were designed to accept the control signals from the carrier station and insert them into the autopilot control system in such a way as to cause the aircraft to assume the desired computed position in a rapid, stable, and safe manner.

As shown in the diagram below, the basic form of the final ACCA system includes a tracking radar, an altitude sensor, computing equipment, data link, and an autopilot installation. The flow of information is continuous around this loop, the reference information being stored in the computer in the form of a precomputed path over which the aircraft should fly. The position, range, and azimuth data obtained from the radar, and elevation from the altitude sensor, are compared with the

Guided by the ship-controlled automatic approach and landing system, a jet (F3D) aircraft approaches the deck of the USS ANTIETAM for a test landing.

The plane, seen between mobile units of the shipboard controlling equipment, touches down . . .



and rolls forward . . .

reference data, and correction signals (up, down, right, and left) are sent to the autopilot.

Other NRL contributions to the solution of the automatic-landing problem include the following:

- Development and construction of breadboard instrumentation.
- Assembly of the first experimental ACCA system.
- Conduct of successful preliminary flight tests of the system.
- Writing of the broad contract specifications for further development of the system by a commercial firm for use in sea trials.

In addition, members of the Laboratory staff are serving as technical consultants to the contracting agency and are working progressively on other phases of the CAWF problem.

The next major step in effecting fully automatic control of planes returning to Navy aircraft carriers required a precise landing system. The equipment for this was built by the Bell Aircraft Corporation under a contract sponsored jointly by the Bureau of Ships and the Bureau of Aeronautics, and was tested at sea late last summer. Thirty-one automatic approaches to touchdown, including six arrests, were made aboard the USS ANTIETAM off the coast of Pensacola, Florida. The flights demonstrated conclusively that automatic carrier landings are safe and practicable.

Several problems remain to be solved before general acceptance of the system for fleet use can be considered. Foremost among these is overcoming the effects of deck motion at the time of touchdown. NRL has pioneered in the design of data-acquisition equipment in this field, as well as of data-reduction techniques and equipment. Now underway in commercial firms are contract investigations for the design of deck-motion predictors and of a computer that will determine whether or not the predicted motion of the deck is favorable for landing. Meanwhile, various types of displays are being studied, some of which utilize color, to provide monitoring facilities for the automatic-landing system and to provide the means whereby landing can be effected manually in case the automatic equipment is not functioning properly.

. then taxies by the controlling equipment, toward the catapult, which will assist its take off for another test approach and landing.

Research Notes

Orientation in Bats

Dr. Donald R. Griffin of Harvard University has been conducting an ONR-sponsored investigation of the comparative physiology of sensory mechanisms of orientation. This has led him to a consideration of the homing ability of bats. The study has shown that bats of one species (the small Myotis lucifugus) are able to return to the "home" cave when liberated as far as 200 miles away. They are able to cover 20 miles of this distance in a single night and can fly as many as 5 miles when completely blinded. The next step in these studies will be to find out if the bats' orientation system can be put out of action. To determine this, Dr. Griffin expects to transport the bats to the point of release under the influence of an anesthetic, or to move them while they are in the hibernating state, or possibly to carry them to the point of release in some sort of rotating mechanism.

The investigation also is aimed at discovering how bats are able to avoid obstacles while in flight. It has been found that the bats' "sonar" system functions adequately even in the presence of loud noise of their own frequency range. The animals are able to react to echoes at least 20 decibels less loud than ambient noise of the same frequency. This work has demonstrated that the bats' "sonar" system is difficult to jam by any sort of imposed noise.

New Instrument Measures Gravity at Ocean's Surface

The first successful surface measurements of gravity in the open sea were made late last November by J. Lamar Worzel of the Lamont Geological Observatory as part of a program to chart gravity variations throughout the world during the International Geophysical Year. To collect the unprecedented data, a new sea gravimeter, developed by Anton Graf of Munich, Germany, was used. This instrument was mounted on a gyro-stabilized platform installed aboard the USS COMPASS ISLAND.

Previously, gravity values for ocean areas were measured in submarines submerged to quiet depths. But the difficulty of obtaining and fitting submarines for this purpose reduced to a minimum the amount of data that could be gathered over the 80 percent of the earth's surface covered by water. The new sea gravimeter makes it possible to take gravity measurements simply and quickly anywhere on the ocean surfaces. Thus it assures that data long needed but difficult or impossible to obtain will now be available.

Surface gravity measurements from the USS COMPASS ISLAND were taken in 9 hours, as compared with 2 days for the earlier submarine measurements. The data were reduced in just half a day, as compared with the 2 weeks needed to adjust and compute data from submarine measurements.

To date only 4,000 measurements of gravity have been made at sea throughout the world. Roughly half of these have been made during the past 10 years by the Lamont Geological Observatory, which used pendulums carried in submarines.

Gravity measurements are used to determine the shape of the earth, the true direction of the earth's center, and the density of the material of the topmost layers. When gravity and seismic measurements are used together, the thickness of the earth's crust can also be determined. Gravity determination of the true vertical and the shape of the earth are among the most important mapping tools we have. Once sufficient values of gravity are taken over a wide enough area of the oceans, maps and charts will be greatly improved.

The USS COMPASS ISLAND left New York November 18 and returned November 22. The surface gravity measurements were begun 200 miles southeast of New York on November 22 and were continued on a track moving from the deep ocean basin across the continental slope and onto the continental shelf, ending off Long Island.

Argentine Navy and ONR Join Forces

The Argentine Navy has invited the Chief of Naval Operations to place several United States scientists aboard its icebreaker, the GENERAL SAN MARTIN, for an expedition to the Weddell Sea. Two biologists, one meteorologist, one oceanographer, and an official Navy observer will make up the United States group. The voyage will provide cold-region field experience for these men and will enable them to obtain valuable data in their respective fields.

The expedition will be under the auspices of the Arctic Institute of North America and will be sponsored by the Office of Naval Research. It will be the third such cooperative effort made in as many years by ONR and the Argentine Navy.

Research Budget Juggling

One cannot compensate for an inadequate research budget simply by juggling the money appropriated. This fact was emphasized recently by Dr. Thomas Killian at a meeting of the Defense Science Board. Dr. Killian said such juggling was like telling a group of men in a room that their allowance of oxygen would have to be cut 10 percent during the next hour. By reducing their activity, and hence their metabolism, over the entire period, they could get along on a 90 percent supply. Alternatively, they could all stop breathing for 6 minutes, at the end of which there would be no activity whatsoever when the 100 percent supply of air was turned on.

—From an address given by Garrison Norton, Assistant Secretary of the Navy for Air, Washington D. C., October 8, 1957.

AV-CIR Moves West

It is one thing to conduct a research project, but often quite another to apply the results to the maximum benefit. Because of this fact, the Aviation Crash Injury Research Project (AV-CIR) (Research Reviews, August 1956), which has been located at Cornell University since it was first organized more than 10 years ago, now has a new home—the Sky Harbor Airport, Phoenix, Arizona. The move, made this past fall, places the research group nearer to the airframe manufactures and engineers who must apply the group's recommendations for changes in design if the project is to lead, as intended, to greater flying safety.

Still administered by Cornell, the research group is continuing its studies of airplane crashes involving impact forces suspected of being well within the tolerance limits of the human body. The aim of the studies is to identify the features of aircraft that are responsible for injuries. Once identified, these can be eliminated or modified so as to reduce the number or seriousness of injuries occurring in future accidents.

AV-CIR is now being supported financially by ONR, the Navy's Bureau of Medicine, the Army Transportation Corps, and the Air Force. The Civil Aeronautics Administration is providing guidance and consultation services.

Fish Talk

During the past summer, Dr. William Tavolga, Research Associate of the American Museum of Natural History, has been listening to "conversations" carried on by tiny dull-gray fish called gobies. Working under an ONR contract at the Cape Haze Marine Laboratory at Placida on the Gulf coast of Florida, Dr. Tavolga has assembled a voluminous set of tape recordings of sounds produced by this fish.

Although the inch-long goby is often thought of as a shy little fellow who frequently inhabits empty oyster shells, he is usually quite aggressive in his relations with other members of his species. This is particularly true during courtship.

The goby seems to be practically tone deaf. Dr. Tavolga's tape recordings show that both males and females respond to any reasonably fair imitation of the male's grunt. The females, however, are not quite as gullible as the males. They swim towards the source of the sound if a goby is visible there; but if none is seen, they hang back. Male gobies, on the other hand, dart towards the source of the grunt, irrespective of whether a goby is present there or not. Therefore, the utterance of grunts by a male sets off an interesting train of events. Because neither male or female can distinguish which sex has made the sound, both sexes are attracted to the source of the sound. Thus, the gobies converge, and a virtual melee ensues, with the males competing vigorously for the females present.

Dr. R. M. Page Appointed Director of Research at NRL

The man who built the first pulse-radar system—Dr. Robert M. Page—is the new Director of Research at the Naval Research Laboratory. As such, he will direct and coordinate the Laboratory's over-all research program, which includes investigations in 14 fields of the physical sciences. The important post was vacated several months ago, when Dr. O. T. Marzke, the former director, left the Laboratory to become Vice President of the U. S. Steel Corporation in charge of fundamental research. Dr. Page was formerly Associate Director of Research for Electronics at the Laboratory.

Dr. Page came to NRL in 1927. In 1934 he built his pulse-radar system, and with it detected aircraft in flight in December of that year. Following further research, he developed the theory of radar-receiver design and, with a small group assigned to him, led in the invention and development of the circuits and components necessary to the military use of pulse radar.

High-Vacuum Electron Gun

Recently, the Temescal Metallurgical Corporation of Richmond, California, developed a new apparatus for melting metals and other solid materials by bombardment with high-energy electrons. By means of the new device—a high-vacuum electron gun—niobium ingots 1.5 inches in diameter and 1 foot long are being drawn at a rate of 80 inches per hour (40 pounds per hour). The degree of improvement obtained by this device over that of others is by a factor of 10, at least.

Now working under an ONR contract, this company is exploring the application of this technique of melting to a number of refractory metals, such as molybdenum, tungsten, and tantalum, in order to effect the removal of non-metallic impurities, mainly oxygen, nitrogen, and carbon. Indicative of the extent of purification which can be achieved is the recent finding that the oxygen content of niobium can be reduced from an original 1.5 percent to less than 15 parts per million in a single high-vacuum melting operation.

Light and Depth

The feasibility of determining the near-shore depth of the ocean by night aerial photography of an intermittent light shining up from the ocean bottom has been demonstrated by the Broadview Research Corp. of Burlingame, Calif. The work was done under an ONR contract with aircraft and photographic services provided by the 7th Infantry Battalion, USMCR, San Bruno, Calif.

The method involves dropping an intermittent light source into the water, then photographing the surface image of the light cone emanating from it. By measuring the diameter of this image on the photograph, a remarkably precise indication of the water depth is obtained.

On the Naval Research Reserve

New Reserve Assistant at Chicago Branch Office

CDR Hiram F. Cromer, USNR, reported to the Office of Naval Research Branch Office, Chicago, on September 13 as Assistant to the Commanding Officer (Research Reserve). He relieved CDR H. T. Wordell, USNR.

Before World War II, CDR Cromer graduated from Iowa State Teachers College, studied for 1 year in the Graduate College of Education, University of Iowa, and held various positions in elementary and secondary schools of the Midwest. He entered the Navy as an enlisted man in 1943, and was assigned to the aircraft carrier YORKTOWN (CV10). In 1944, he was commissioned lieutenant (JG) and reassigned to the YORKTOWN as deck and gunnery officer. In this assignment he participated in 36 enemy engagements. Later he was transferred to the battleship MARYLAND (BB-46) and promoted to first lieutenant.

Upon his release from active duty in 1947, he resumed his graduate studies, this time in the College of Education, University of California at Berkeley. After receiving his Doctor's degree in 1950, he was recalled to active duty in the Navy, reporting to the Pacific Reserve Fleet, San Diego Group. Two years later he was appointed Commanding Officer of the Navy and Marine Corps Reserve Training Center in Amarillo, Texas. Following this assignment, he served 30 months aboard the USS UNION (AKA-106) as Operations Officer.

Naval Reserve Research Company 4-8 Assists in Conference and Exhibit at Cleveland

CDR Victor Schreckengost, USNR, the Commanding Officer of Naval Reserve Research Company 4-8, Cleveland, Ohio, and members of the company received recognition from the Chief of Naval Research for the services they performed in connection with Navy exhibits. These exhibits were shown at the Twelfth Annual Conference and Exhibit of the Instrument Society of America in Cleveland, Ohio, in September 1957.

Here are some of the ways the members of the company assisted in the exhibits:

- Provided preliminary information and advice on local available facilities.
- Assisted in the planning of a press conference.
- Explained exhibits of contractors at the press conference.
- Served as reliefs for the regularly assigned personnel at the exhibits.

In rendering these services CDR Schreckengost and members of NRRC 4-8 aided the ONR representative immeasurably in effecting the necessary coordination.

CAPT Ralph A. Sawyer, USNR, Retires

CAPT Ralph A. Sawyer, USNR, a member of NRRC 9-3, Ann Arbor, Michigan, was retired from the Naval Reserve on November 1, 1957. In civilian life he is known to students at the University of Michigan as the Dean of the Graduate School. Dr. Sawyer is also Professor of Physics and Director of the Michigan—Phoenix Project.

CAPT Sawyer's naval service dates back to World War I, in which he served as an ensign, designing optical instruments. During World War II, he returned to naval service as a Lieutenant Commander and was assigned to the Naval Proving Ground at Dahlgren, Virginia. Here he served as officer in charge of the Armor and Projectile Laboratory, and later, as Experimental Laboratories Officer in charge of the Laboratory and research facilities for the entire Proving Ground. In recognition of his work, he was decorated with the Navy Commendation Ribbon.

After release from active duty in 1945, Dr. Sawyer made another noteworthy contribution to the welfare of the nation when he directed the technical operations of Joint Task Force One in Operation Crossroads—the atomic bomb tests at Bikini Atoll. For this service he received an official commendation from the Navy Department.

Dr. Sawyer is a native of New Hampshire. He received his A.B. degree from Dartmouth College, his Ph.D. from the University of Chicago, and honorary degrees from Dartmouth (Sc.D.) and Wayne University (LL.D.). Dr. Sawyer is a member of several professional societies, and he is now serving as the president of the Optical Society of America, president of the Association of Graduate Schools in the Association of American Universities, and a member of the Governing Board of the American Institute of Physics.

Notes From Research Reserve Companies

Naval Reserve Research Company 11-8, which meets at the Naval Air Missile Test Center, Point Mugu, California, acted as host on December 6, 1957, to a group of aviation Reserve officers attached to Naval Reserve Composite Company 11-16, San Bernardino, California. The program included a briefing, film, and tour of the Center. Earlier this year NRRC 11-8 was host to 25 air intelligence officers of the Twelfth Naval District.

CDR Hubert D. Rose, USNR, was honored at a dinner given by NRRC 3-8, New York, of which he was Commanding Officer for 3 years. He was relieved recently by CDR Leo J. C. Murphy, USNR. Under CDR Rose's leadership, the company expanded to its present complement of 40 members. Before he was Commanding Officer, CDR Rose served as permanent program officer for 4 years. He is a plank owner in the company. CDR Rose continues actively in the company's work as head of the program advisory committee.

NRRC 8-4, Houston, Texas, has planned a series of meetings in connection with the International Geophysical Year. This program, which consists of lectures and field trips, is designed to cover as many as possible of the Navy's diverse interests in the IGY. The meetings have been scheduled at various times throughout the fiscal year. The topics and speakers on what promises to be a program of high interest and value to Reservists are as follows:

"Overall Structure of the Earth," by Dr. M. K. Hubbert, Chief Consulting Geologist for the Shell Oil Company.

"General Orientation to IGY," by Dr. J. A. Rider, Associate Professor of Physics, University of Houston.

"Meteorology of the Gulf Coast Area," by DeWitt Gale of the A. H. Glenn Weather Associates.

"Worldwide Weather Forecasting," by Dr. L. F. Graves of the Physics Department, University of Houston.

"IGY from the Viewpoint of Oceanography and Meterology," by Dr. Dale Leipper, member of the United States Committee for Oceanography for the IGY, and Director of the Department of Oceanography and Meteorology, Texas A & M College.

Field trip to a commercial engineering corporation working on a Navy contract relative to developments during the IGY.

"Rockets," by Mr. Larry F. Megow, General Manager of Hahn and Clay's Steel Fabrication Division.

"The Earth's Gravitational Field," by Dr. Richard A. Geyer, Assistant Manager, Geophysical Service, Inc., Gravity Division.

Outstanding Companies

The Commander, Naval Reserve Training Command, has sent Letters of Commendation to Commanding Officers of Naval Reserve Research Companies which were evaluated as OUTSTANDING by the Commandants of Naval Districts for fiscal year 1957. These letters read in part,

> "This creditable showing could result only from noteworthy leadership on your part and from excellent cooperation and performance of duty by the personnel under your command. I commend your entire company for its excellence and extend to you and all members of the unit a sincere and hearty 'Well Done!'"

Commendatory letters were received by the following Commanding Officers who served during fiscal year 1957:

CAPT Robert W. Hart	NRRC 1-1
CAPT John S. Medd	NRRC 3-9
CAPT Oram C. Woolpert	NRRC 4-7
LCDR James L. West	NRRC 5-2
LCDR Albert V. Faloon	NRRC 6-3
CDR Dariel E. Howell	NRRC 8-13
CDR Everett T. Curry	NRRC 9-2
CDR Omar B. Richardson	NRRC 11-10

LCDR Eugene Haderlie, USNR, Awarded NSF Fellowship

LCDR Eugene Haderlie, USNR, a member of Naval Reserve Research Company 12-8, Monterey, California, has been awarded a National Science Foundation fellowship for a year of study and research in Europe. Dr. Haderlie is chairman of the Natural Science Department at Monterey Peninsula College. His field is oceanography.

The fellowship received by Dr. Haderlie was one of 60 awarded in all fields of science by the National Science Foundation. Awards were made on the basis of letters of recommendation and by evaluation of published works. The fellowship normally carries with it a full salary, transportation, and a "generous grant" for any special equipment the recipient might need to carry out his research.

Dr. Haderlie will begin his year of study in the fall of 1958. For 9 months he will work at the two oldest and best known marine biological stations in the world—Stazione Zoolica at Naples, Italy, and the Marine Biological Laboratory of the United Kingdom at Plymouth, England. The remaining 3 months will be spent touring and visiting all the important marine stations and universities in Italy, Germany, France, and possibly Russia.

Nuclear Sciences Seminar Held at Oak Ridge

Naval Reserve Research Company 6-3, Oak Ridge, Tennessee, again was host to Reserve officers for the Ninth Annual Nuclear Sciences Seminar. The seminar was held the first 2 weeks in December 1957 under the sponsorship of the Naval Research Reserve in conjunction with the Atomic Energy Commission and the Oak Ridge National Laboratory. The Commanding Officer of NRRC 6-3, LT William A. Pryor, USNR, served as Seminar Chairman. A total of 65 Reserve officers attended the seminar, of which 33 were Navy, 17 were Army and 15 were Air Force officers.

The objective of the seminar was to refresh the knowledge of Reservists on the fundamentals of nuclear science and to acquaint them with recent developments in nuclear reactors. The latter subject was given particular emphasis. During the seminar, the Reservists met some of the nation's leading research scientists and authorities on nuclear science and reactor technology.

The first address of the seminar was made by CAPT J. C. Myers, Assistant Chief for Research, Office of Naval Research. This was followed by two other excellent presentations: Mr. Ned Williams, Deputy Assistant Manager for Operations, Oak Ridge Operations Office, Atomic Energy Commission, discussed "Operations at Oak Ridge," and Dr. W. G. Pollard, Exectuve Director, Oak Ridge Institute of Nuclear Studies, spoke on "Nuclear Structure." In the sessions that followed, presentations were made by scientists and engineers attached to Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies. Presentations were also made by the following officers of the Navy and Army: CDR D. E. McCoy, USN, Weapons Development Division, Armed Forces Special Weapons Project ("The Armed Forces Special Weapons Project"); LCDR Edward Biddle, USN, Development and Production Branch, Atomic Energy Division, Office of the Chief of Naval Operations ("Nuclear Power for Propulsion of Ships"); CAPT N. R. Richardson, USN, Naval Aircraft Propulsion Program, Bureau of Aeronautics ("The Army Package Power Reactor Program"); and CDR John K. Hicks, USNR, Training Officer for Research Reserve ("Mobilization and other Problems Related to the Research Reserve Program").

Field trips to activities in the area were also made as part of the seminar. These included a lecture tour of the American Museum of Atomic Energy, a tour of Loudon Dam and the Kingston Steam Plant, a tour of the Abbot Laboratories, and a tour of the Oak Ridge National Laboratory facilities.

U. S. GOVERNMENT PRINTING OFFICE : 1957 O - 451192

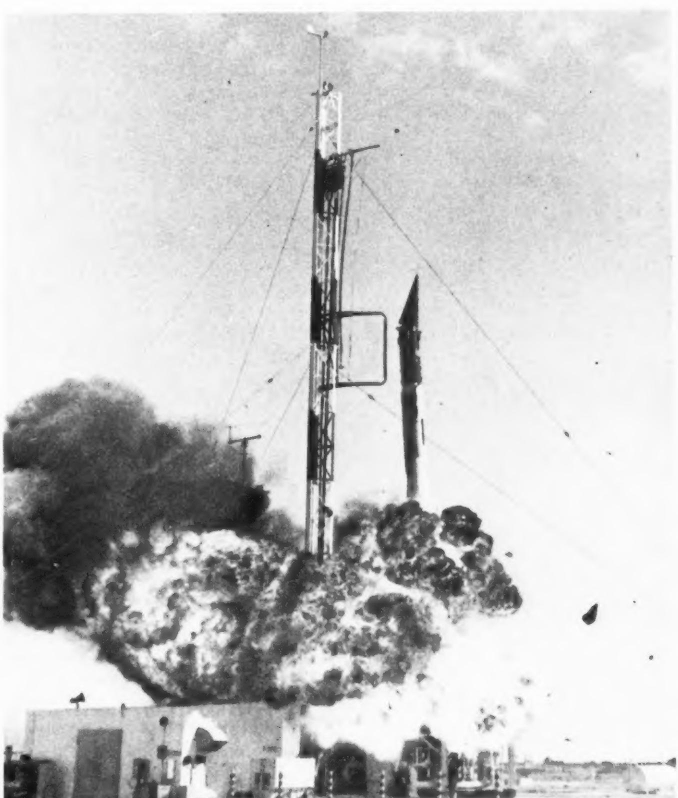
LAST MONTH WITH "VANGUARD"

Shortly after VANGUARD Test Vehicle 3 sank back to its launching pad and exploded, at Cape Canaveral on December 6, Dr. Hagen stated:

"The count down for this test was quite normal after the early hold near the beginning of the count. It was what we call a smooth count, with electronics, radars, and beacons operating well. Shortly before 11:45 the vehicle lifted off and in 2 seconds settled back on the pad. It fell over and burst into flames. Both the first and second stages were destroyed, with the third stage thrown safety clear. . ."

Later, the Office of Naval Research announced that the unsuccessful launching was caused by a mechanical failure in the propulsion system, details of which are classified.

The damage to the test stand was moderately serious, but as we go to press it has already been repaired and work is proceeding on the preparation of another test vehicle for firing.



In This Issue

Perspective . . . . Thomas S. Gates, Jr. 1

The Secretary of the Navy discusses some of the important problems faced by the Nation, the Department of Defense, and the Navy as the result of Russia's recent technological advances.

A Tundra Landscape Max E. Britton 4

One of the outstanding features of the tundra is its multitude of polygons—small plots of ground surrounded by wedge-shaped cracks filled with ice. This feature and others, equally as puzzling, are explained here in the light of ONR sponsored research.

Metallurgy in the Public Service . . . . Julius J. Harwood 14

Metallurgy is now one of the most important fields of technology. This article describes some of the avenues along which metallurgical research will be directed in the future.

Automatic Approach and Landing System . . . . H. W. Chitty, P. J. La Rochelle, R. R. Zirm 20

During sea trials held recently, a jet plane was guided to 31 successful automatic landings aboard the USS ANTIETAM. Thus one of the most serious obstacles to all-weather flying from aircraft carriers has been overcome.

Research Notes 24

Orientation in Bats. . . .New Instrument Measures Gravity at Ocean's Surface. . . .Argentine Navy and ONR Join Forces. . . .Research Budget Juggling. . . . AV-CIR Moves West. . . .Fish Talk. . . .Dr. R. M. Page Appointed Director of Research at NRL. . . . High-Vacuum Electron Gun. . . .Light and Depth.

On the Naval Research Reserve 28

COVER PHOTO: An F3H "Demon" being catapulted from the USS SARATOGA. An important development in aircraft operations aboard carriers is discussed in an article beginning on page 20.

RESEARCH REVIEWS reports 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. Research Reviews 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; $.15 per individual copy. Approved by the Bureau of the Budget, February 28, 1955.