OFFICE OF NAVAL RESEARCH • MAY 1951

RESEARCH REVIEWS

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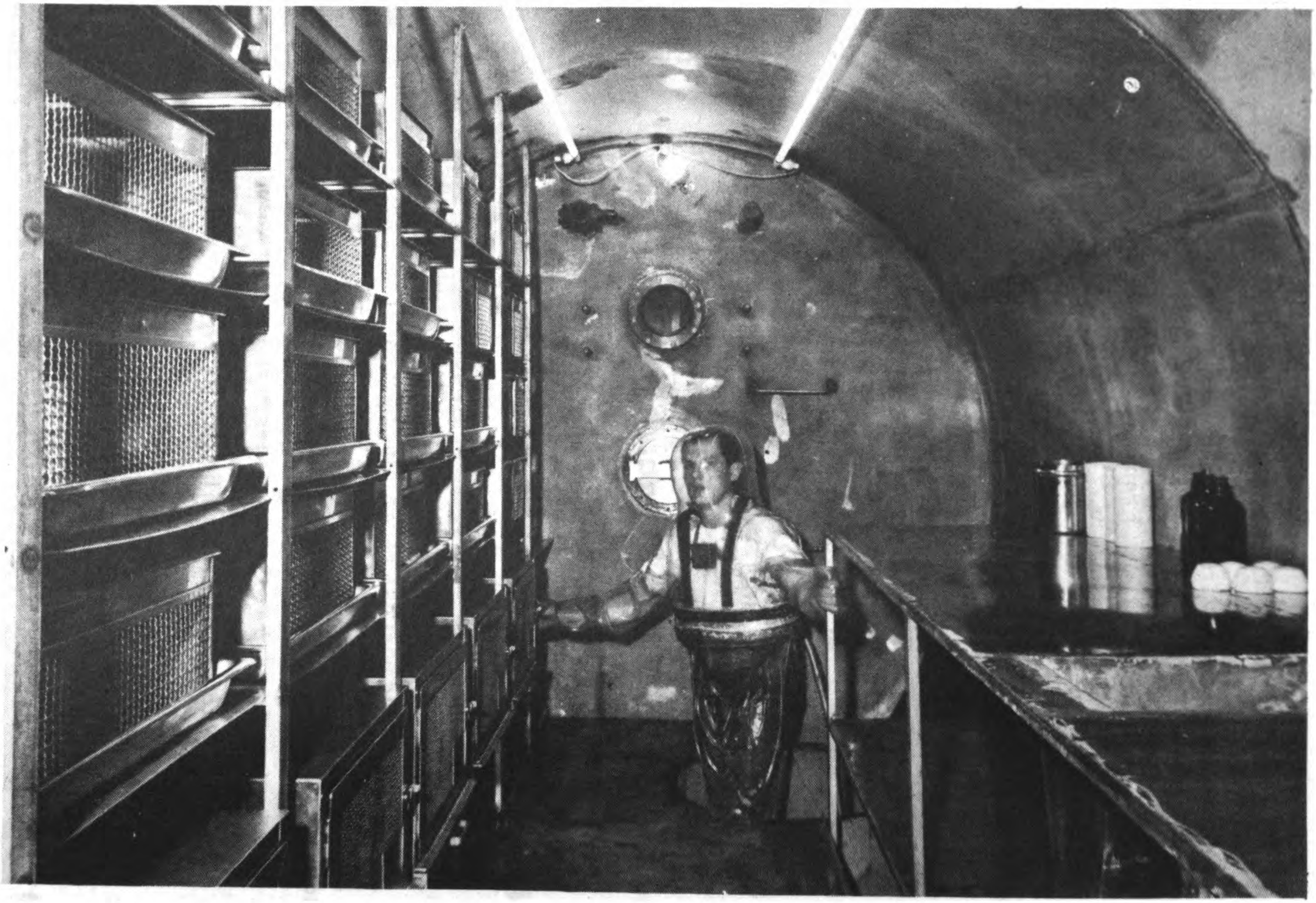
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: This model maker is building up a topographical likeness of the environs of Bergen, Norway, with material supplied in the Landfall Field Kit, developed at the ONR Special Devices Center. This is only one of the many gadgets developed at the Center to aid the Armed Forces. Seven pages of pictures (pp. 12-18) show other interesting phases of the Center's work.

Approved by Bureau of the Budget, 13 April 1948.

In this issue--



Attendant in sterile plastic suit enters germ-free chamber where experimental animals used in dental research are kept.

Living Test Tubes For Dental Research

by
J. R. Blayney and F. J. Orland
University of Chicago

Dental experts have been debating for years about what causes tooth decay. Many theories have been advanced, and the preventative measures that have been recommended are legion. Yet a great many people still have the same old bothersome toothaches and for the experts the question still is WHY?

When the Lobund Institute at Notre Dame began using germ-free animals for research work, fertile possibilities were opened for scientific experimentation. This project, described by its director Dr. James A. Reyniers in the January 1948 Research Reviews, developed equipment and methods which enabled animals to be born into and exist in an environment where not a single bacteria could rear its ugly head. (See frontispiece and Figures 1, 2, and 3.) Obviously the program would be helpful in studying infections, immunity and resistance to disease, formation of tumors and many other biological problems. And within the past few years the facilities of Lobund have also been used in the study of tooth decay.

If you wonder exactly how important to our Nation's welfare this program is, just consider a few figures. These show that the prevalent disease of the teeth, called "dental caries" by the medical men, is a major health problem. A survey was made a few years ago to determine the amount of tooth decay in children. It was estimated that 50 percent of the two-year-olds have cavities--a figure which rapidly increased to 98 percent as young adulthood was reached. Furthermore, it was estimated that to treat this condition in the mouths of young people between the ages of 6-18 years would require 244 million fillings, plus 33 million more to be added each year. To provide dental service for adults would require the placement of 285 million fillings with an annual increment of 79 million. In addition, the adult group would need 25 million teeth extracted and 11 million prosthetic appliances each year. The estimated annual cost of such services, on a moderate fee basis, would be close to the 5-billion-dollar mark, or approximately nine times the total annual income of the dental profession. In fact, there are not enough dentists in the United States to take care of the people

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James Roy Blayney, a dental surgeon and Director of the Walter G. Zoller Memorial Dental Clinic at the University of Chicago, has been interested in dental pathology for several years, and has done special research on caries. His work has been recognized by the Howard Taylor Ricketts prize and the John R. Callahan award.

Frank J. Orland, whose specialty is oral microbiology, took his present position as assistant dental surgeon at the Zoller Clinic after serving as a research associate at ONR. He belongs to several scientific societies, including the International Association of Dental Research and the Chicago Dental Society.

Figure 1. Here are some of the cages in which the animals are reared in a germ-free world.

in the State of New York if all the citizens were to be given adequate care. Surely it is not necessary to cite additional data to support the statement that a program of reparative dentistry alone will not successfully provide care for our people. Prevention is the only recourse. But prevention requires a better understanding of the causes of tooth decay than we now have.

What are the current opinions on the cause of tooth decay? At present it is blamed on three different things: germs, inadequate food and psychological troubles. Those who hold the bacterial theory to be true are divided into two groups: the group that believes that acid-producing bacteria cause decay and those who believe that protein-digesting germs are responsible. These hypotheses are termed respectively the acidogenic and proteolytic theories. We can go further and subdivide the protagonists of the acidogenic theory into those who believe that germs called "lactobacilli" are to blame and those who believe others termed "acidogenic streptococci" are responsible. Recently, certain workers suggested that

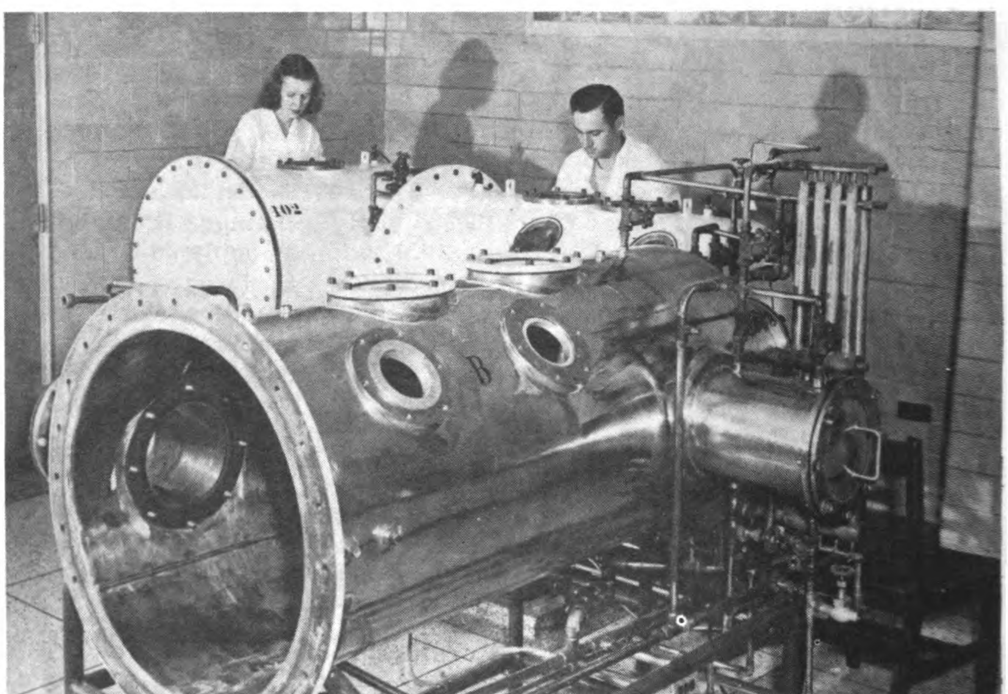

Figure 2. In the foreground is the type of tank used for various operations performed on the experimental animals. Animals can be transferred into it without removing them from cages.

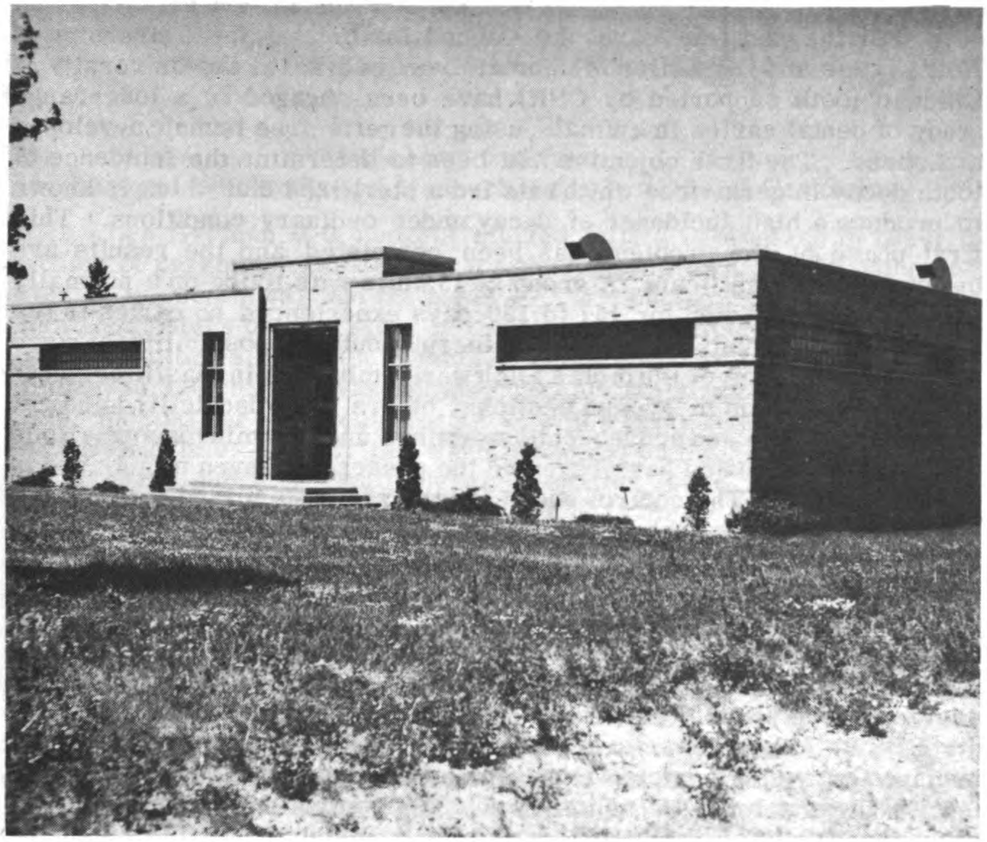

Figure 3. The Lobund Institute at Notre Dame

the earliest change in caries of the enamel occurs in the organic structure rather than in the calcified portion of the tissue. Accordingly, they now hold to the thesis that the first bacterial activity must be of a proteolytic nature rather than a decalcifying process.

There is a rather small group who are not willing to accept the bacterial theory of caries. They maintain that food which is adequate in all respects is the protecting factor, and attribute tooth decay to deficient diet. The writings of these workers strongly suggest that bacteria play no part in causing the disease.

As if these theories are not enough, it has been suggested that long-continued emotional stress or tension is responsible for decay, presumably through changes in mouth fluids which bathe the teeth.

Obviously, if we are to make progress in preventing tooth decay, we must find out which, if any, of these theories is correct. Studies are underway which aim to determine this. Such investigations must clearly indicate whether bacteria play an active role and if so, what particular microorganisms are responsible. The role of the diet must also be ascertained, both in the presence and absence of microbic life. The germ-free animal technic is the only known method which provides an opportunity for examining these factors independent of each other or in combination. It may even allow us to examine the effects of emotional stress in combination with bacteria and various foods, separately or collectively.

For the past few years, the Lobund Institute at the University of Notre Dame and the Zoller Memorial Dental Clinic at the University of Chicago (both supported by ONR) have been engaged in a long-range study of dental caries in animals, using the germ-free technic developed at Lobund. The first objective has been to determine the incidence of tooth decay in germ-free white rats fed a sterilized diet which is known to produce a high incidence of decay under ordinary conditions. This first phase of the problem has been completed and the results are believed to be significant. A group of 13 white rats living on a normally caries-producing diet for 137 to 150 days experienced no caries in the absence of microbic life. In order to rule out the possibility of very early lesions, some of the molar teeth were embedded in plastic briquets for the preparation of ground sections; others were decalcified and cut on the microtome and subsequently examined under a microscope. None of the teeth so studied have revealed the presence of even minute areas of caries attack. The control group fed the same sterilized rations, but reared under normal laboratory conditions, had a caries experience of approximately 97 percent. Thus, the germ-free-animal technic has positively demonstrated that dental decay in the white rat does not occur in the absence of germs.

At present the second phase of the study is underway. It involves use of a group of rats fed the same diet, after having been inoculated at birth with a strain of bacteria (lactobacilli) associated with caries in the human. Other single bacterial strains are to be used in the future. The teeth of these animals living in this uniquely controlled environment may show the result of the single bacterium's metabolic action on them. Thus, with these "living test tubes" we hope to learn much of the fundamental nature of the all-too-prevalent disease of tooth decay.

New Greases Produced at NRL for Use at Extreme Temperatures

Greases suitable for use at temperatures ranging from -65° C. to +250° C. have been developed by the Naval Research Laboratory. Besides their utility at high and low temperatures, these lubricants will stand up under storage much longer than conventional greases, thereby extending the shelflife of equipment on which they are used.

The Armed Services, as well as industry, need greases for use under extremes of temperature and climate. Low-temperature performance is required for aircraft and for operation under Arctic conditions. On the other hand, small high-powered electric motors require lubricants for operation at temperatures of 200 to 225° C.

In order to utilize the upper range of temperatures indicated, ball bearing manufacturers will have to make available bearings of tool steel or high chromium steel capable of withstanding such heat for long periods. This development is in progress, however, stimulated mainly by the reports of the work at the Naval Research Laboratory.

The NRL work is under the technical direction of Dr. W. A. Zisman, head of the Lubrication Branch of the Chemistry Division, and is being sponsored jointly by ONR and the Bureau of Ships.

Measuring Meteor Trails

by
Luigi Jacchia
Harvard University and Massachusetts Institute of Technology

When German V-2 rockets started falling in England in 1944, it became of paramount importance for the Allies to locate their launching sites on the continent. On the basis of a few photographs of rockets in flight, computers on both sides of the Atlantic attempted to reconstruct their trajectories. It soon became evident, however, that an essential element of information was missing: no accurate atmospheric density tables existed for the great heights at which the rockets spent most of their flying time. This writer, when consulted on the subject, suggested that perhaps the best available air densities were those derived by F. L. Whipple at the Harvard Observatory from the study of meteors. Consequently, tables based on these densities were used at M.I.T. for the computation of rocket trajectories by means of the Rockefeller Differential Analyzer.

Whipple's atmospheric densities were founded on the observed decelerations of only 17 meteors, and for 8 of them the decelerations were perilously close to their probable errors. If so few meteors could supply so much information it seemed logical to expand Whipple's pioneering research. The supply of meteors is inexhaustible; you only need some telescopic equipment to photograph them, machines to measure the photographic plates, and expert computers to reduce the measurements. A comprehensive research program on meteors was thus started, with the support of the Naval Bureau of Ordnance, at the Harvard Observatory and at the Massachusetts Institute of Technology.

The program called for the construction of new powerful cameras and extremely precise measuring machines. The cameras (see **Figure** 1), of a rather revolutionary type evolved from the Schmidt telescope, were designed by J. G. Baker at Harvard and built by the Perkin-Elmer Corporation. They have an aperture of 12 inches and a focal length of 8 inches. The first of this type are being used now to photograph meteors as faint as the 5th magnitude, or practically all those visible to the naked eye. Heretofore, to be recorded, a meteor had to be brighter than magnitude zero (i.e., at least as bright as the brightest stars in the sky).

The measuring engines (see Figure 2) were built by D. W. Mann in Lincoln, Mass., and have been in use at M.I.T. for the past three years. They essentially follow, in design, a previous type of polar-coordinate machine built by Mr. Mann for the Aberdeen, Md., Army Proving Ground. Like their predecessors, they are equipped with a 265-mm screw and a revolving drum, but in addition they possess a

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Luigi Jacchia received his Ph.D. in Physics at the University of Bologna, Italy, where he subsequently worked as an astronomer at the Observatory there. He is now a Research Associate in Astronomy at Harvard University and a Research Associate in Electrical Engineering at the Massachusetts Institute of Technology. He also serves as a member of the Meteor Commission of the International Astronomical Union. The research he describes here has been sponsored by the Bureau of Ordnance and will, in the future, be supported by ONR.

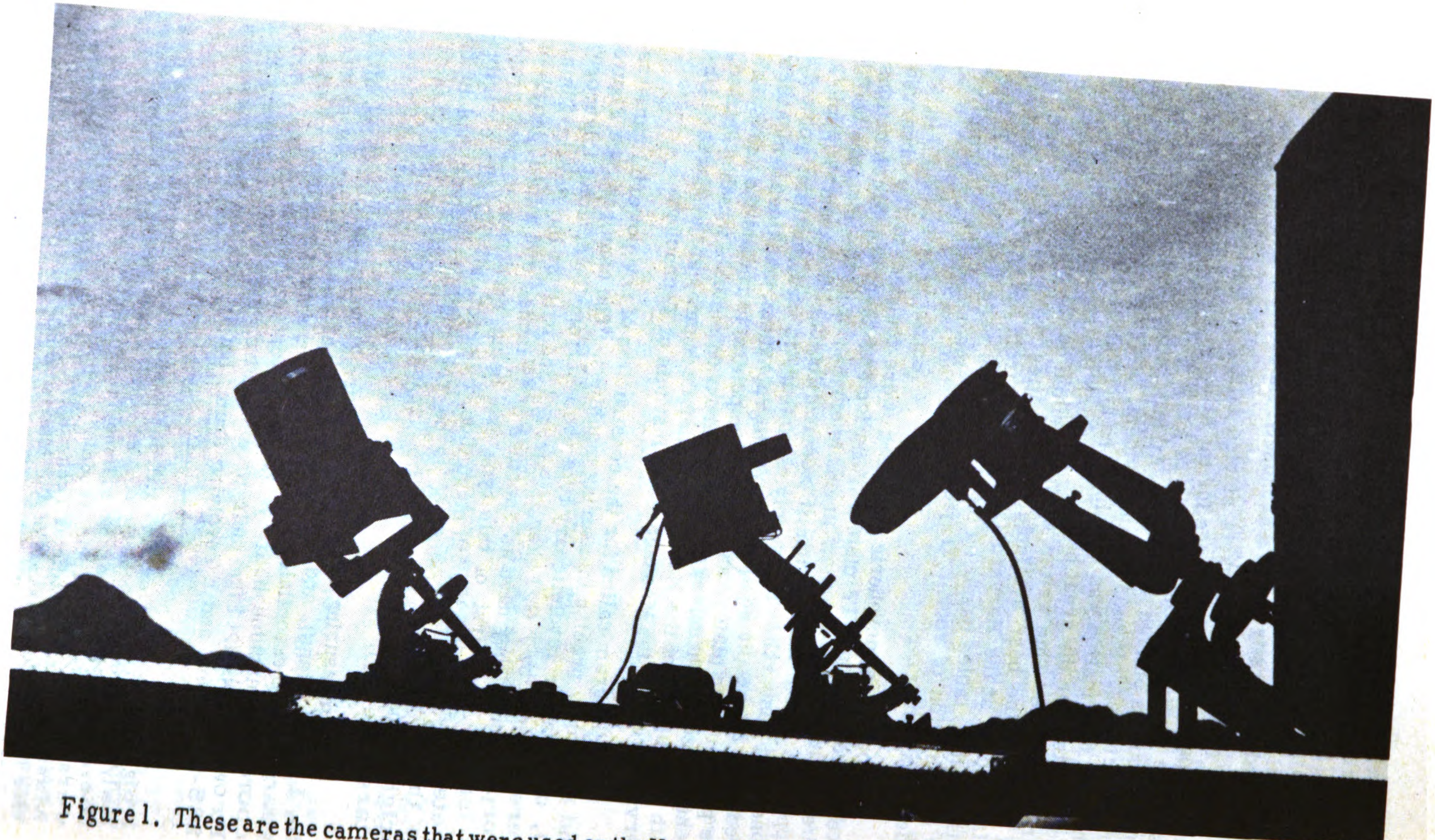


Figure 1. These are the cameras that were used on the Harvard Meteor Expedition at Soledad Canyon Station, N.M.

smaller screw, 50 mm in length, and perpendicular to the main screw. Both screws were found to be free from progressive or periodic errors exceeding 0.002 mm over their entire length. The rectangular coordinates of any point over an area of 265 x 50 mm can, therefore, be determined at one setting to the instrumental precision of the order of one micron. To make the instrument also available for measurements of smaller accuracy over a larger area, the upper carriage (which, in clamped position, is driven by the smaller screw) can be moved by hand over a length equal to that of the main screw; the ordinate can be read off a scale equipped with vernier to the nearest 0.02 mm. The drum carrying the plate can be rotated by hand and the position angle read off with a precision of 10". Because of their versatility, the Mann machines have been occasionally used to measure photographic plates and films in problems involving not only meteors, but also solar spicules, supersonic flow around projectiles, and boundary layers.

Before we discuss how meteors can be used to determine the properties of the upper atmosphere, it will probably not be out of place to say a few words about meteors in general. Since 1866, when the Italian astronomer Schiaparelli discovered that the August Perseid meteors revolve around the sun, following the orbit of Comet 1862 III, it has been recognized that meteoric particles are formed by the gradual disintegration of comets. Parent comets have been found for most of the best-known recurrent meteor showers and it stands to reason that at least a good fraction of the "sporadic" meteors were at one time associated with richer cometary showers, but were later scattered through planetary perturbations. Until a few years ago it was thought that some of the sporadic meteors were not members of our solar system, but rather guests from interstellar space. Such a belief was based on inaccurate visual observations; it was dispelled by photographic and radar measurements. These showed that no meteor enters the earth's atmosphere with a velocity greater than 72 km/sec, which is just exactly the upper limit for a body moving in a parabolic orbit around the sun and meeting the earth in a head-on collision. There were no hyperbolic orbits, but only closed, elliptic orbits. The lowest theoretical velocity for a meteor entering the atmosphere is that of a body in free fall from infinity, or 11 km/sec (which, by the way, is also the escape velocity from the earth's gravitational field).

As far as we know, ordinary meteors are rock splinters measuring anywhere from 1/100 of an inch to a few inches across. When they enter the earth's atmosphere, friction causes their surface to become heated and gradually the whole meteor body is whittled away by melting and vaporization. There are also, as everybody knows, huge fireballs which pierce the whole atmospheric cushion and land on the ground; but these are exceptional occurrences and some astronomers even doubt that these large meteorites have the same origin as ordinary meteors.

The light of a meteor does not come primarily from its incandescent surface, but rather from its halo and wake of vaporized material. (This is plainly shown by its spectrum, which exhibits an array of bright lines with only the faintest trace, if any, of a continuum.) It is the collision of meteor atoms with air molecules which produces most of the radiation ("impact radiation"). Recent ballistic experiments have shown that exactly the same phenomenon can be observed in the laboratory when small metallic pellets are fired at highly supersonic speeds.

The Harvard Observatory systematically photographed meteors for 12 years (1936-1948) using a set of twin cameras located in

Cambridge, Mass., and at the Oak Ridge branch observatory. The baseline provided by these two stations measures about 24 miles. Since 1948 the Harvard meteor stations, under the new Navy-sponsored program, have been transferred to the vicinity of Las Cruces, New Mexico, not far from the White Sands Proving Ground, where V-2 rockets probe the upper atmosphere in quite a different fashion. The meteor baseline in New Mexico is a little shorter--only 18 miles--but amply sufficient to insure great accuracy in locating true meteor paths in space.

The meteor cameras photograph a field 60 degrees across and are provided with shutters rotating at pre-determined speed, which eclipse the field 20 to 50 times a second. Thus a meteor trail (Figure 3) appears interrupted by regularly spaced breaks, from which, once distances have been accurately determined along the path, the velocity of the meteor can be evaluated at each point of its trajectory. The precision with which meteor positions in space can be determined varies a little with the location of the meteor in the sky and relative to the radiant, and also with the quality of the neighboring star images. Under favorable conditions the error in the determination is of the order of one meter. The visible path of an average meteor measures about 40 km.

In the course of its trajectory the meteor experiences a deceleration which, just as for gun projectiles, is a function of its mass, its velocity and the atmospheric density. This means that, if we knew the meteor's mass, velocity and deceleration at a given point of its trajectory, we could determine the atmospheric density at that point, provided we knew also the constants of the problem. There are two such constants and neither of them has been determined by direct experiment. The trouble with meteors is that nobody has ever attempted to catch them in flight to see what their mass is and nobody has ever succeeded in firing missiles in a rarefied medium with velocities approaching those of meteors, to see what their drag is. The situation, however, is not so desperate as it may seem at first.

The luminosity I of the meteor is caused by the impact against air molecules of the evaporated meteor material, whose amount at each instant is proportional to the rate (-dm/dt) at which the meteor is losing its mass. Assuming that I is proportional to the kinetic energy of the vaporized meteor material, we shall have:

$$I = -\frac{1}{2} \tau v^2 \frac{dm}{dt} , \qquad (1)$$

where v is the velocity of the meteor and τ a proportionality factor. Since we know v and I at each instant, we can determine dm/dt and, integrating backwards in time from the end of the trail (where the mass has, presumably, all but vanished), we can compute the mass m --or, rather, the mass multiplied by the unknown factor τ.

Since the Mach numbers corresponding to meteor velocities are very high (from 50 to 200 for most meteors), the coefficient of v^2 in the resistance law can be considered as constant, and the acceleration can be expressed in the form

$$\frac{dv}{dt} = - Kv^2 m^{-\frac{1}{3}} \rho(H) , \qquad (2)$$

where K is a constant and ρ is the atmospheric density, which is a function of the height H above sea level.

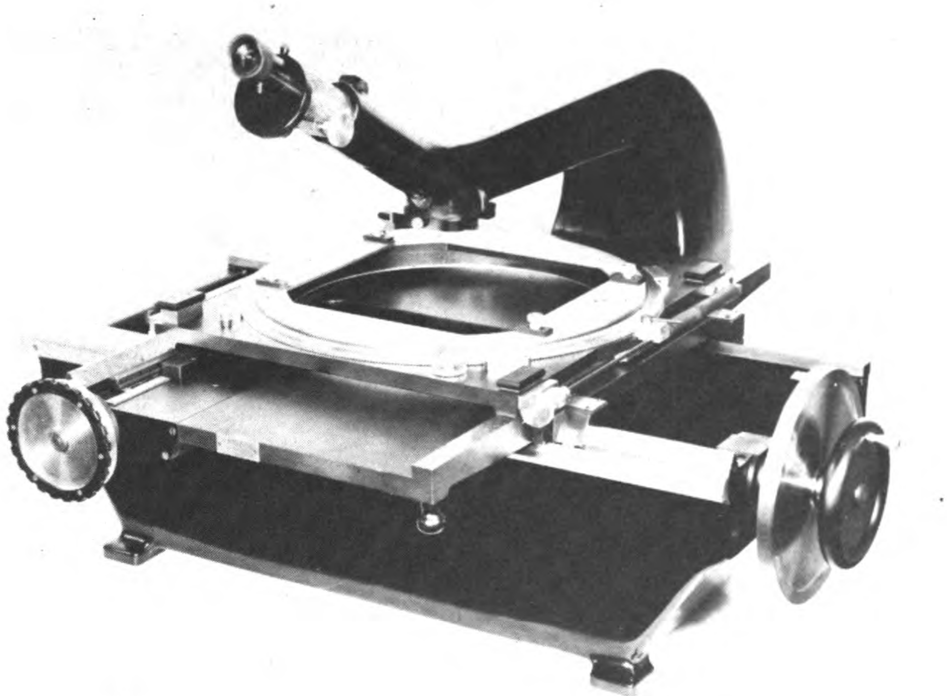


Figure 2. The Mann Measuring Machine.

Now, if we try to determine ρ from (2), where the value of m has been obtained by integrating (1), we see that the two constants K and τ can be lumped together into a new constant $R = K \tau^{1/3}$. This constant can be determined by calibration, i.e., by adjusting the zero point of the atmospheric density curve obtained from meteor observations to make it coincide with the known density curve at lower levels, where balloon observations are available. The overlap between pilot balloons and meteors is very narrow: only a few meteors penetrate to heights lower than 50 km and those which reach 40 km or less are a rarity. Recent observations, however, have extended to even greater heights than directly explored regions of the atmosphere. The pressure-gauge data obtained from V-2 rockets, for example, have provided more than a qualitative check on meteor results up to the greatest heights at which they can be observed.

At first there seemed to be a considerable discrepancy between densities calculated from meteor observations and those obtained from V-2 data. For heights greater than 80 km the meteors photographed from the Massachusetts stations gave atmospheric densities which were systematically larger, by a factor of 2, than those obtained from the New Mexico rockets. Preliminary calculations from the most recent meteor observations seem to indicate, however, that there is practically no discrepancy between the V-2's and the New Mexico meteors: the difference between the Massachusetts and the New Mexico results must be attributed to a real variation of the atmospheric density profile with latitude.

An important result of meteor studies was the discovery of a seasonal variation in the upper atmospheric density. At heights

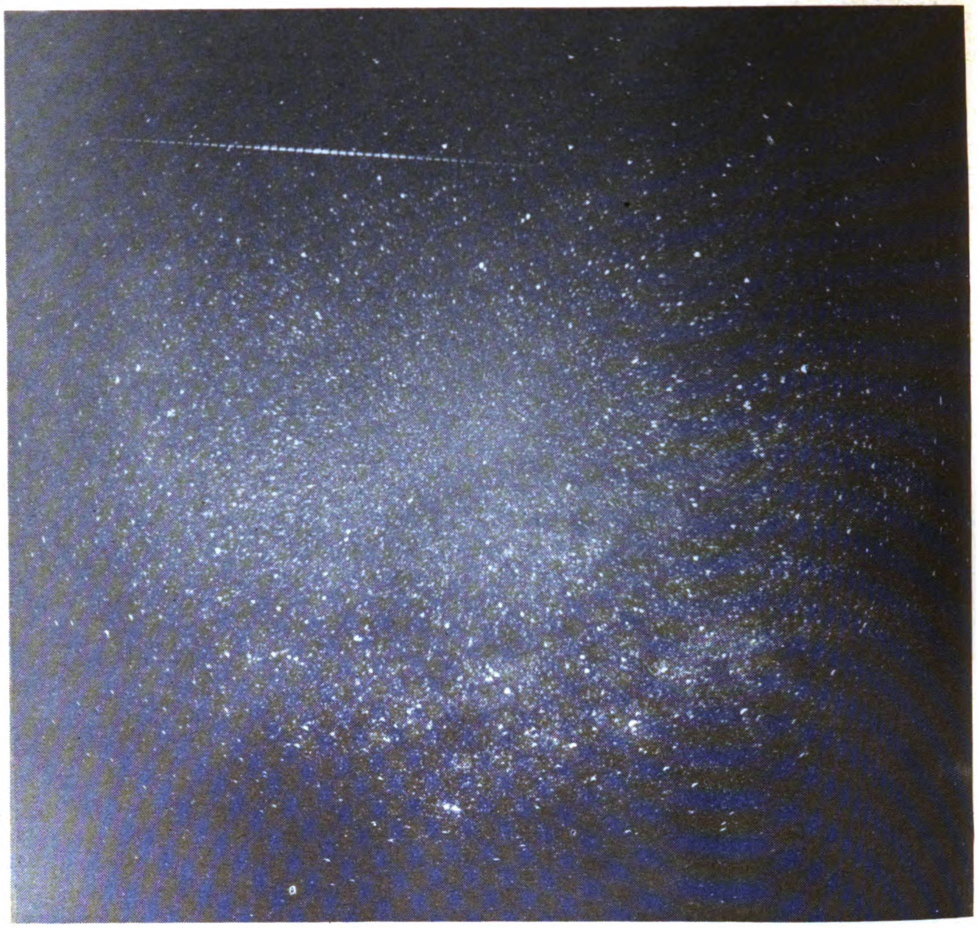
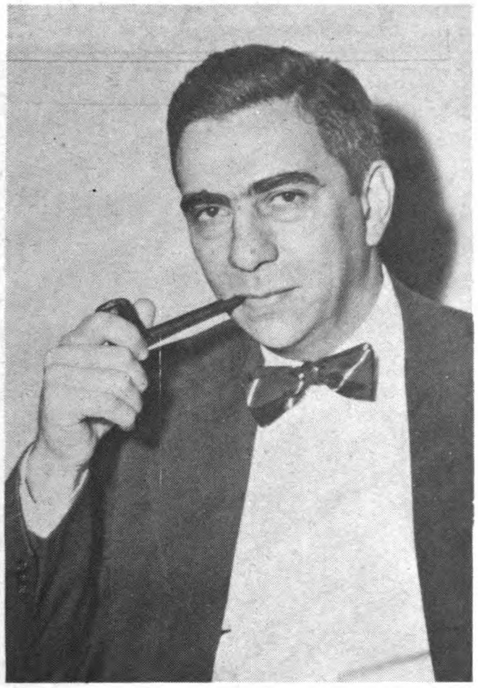


Figure 3. Meteor trail photographed December 10, 1950 by the Harvard Meteor Project in New Mexico. Breaks on the trail are caused by a shutter revolving at 1200 rpm.

between 60 and 80 km the density varies in phase with the ground temperature, with a minimum at the end of January and a maximum at the end of July.

The range of the variation, at least over Massachusetts, is surprisingly large; summer densities turn out to be twice as large as those observed in winter. In view, however, of the relatively small number of meteors which have been available so far for the investigation, it would appear necessary to take this last result with a little caution.

Meteor astronomy seems to be at the threshold of new, important developments. At the Naval Ordnance Test Station at Inyokern, California, a series of astro-ballistic experiments have been started, in which small missiles are fired in a laboratory range with velocities not far from those of the slowest meteors and under conditions simulating those prevailing in the upper atmosphere. It is hoped that these experiments will provide precious information on the drag coefficient of meteors and also on the mechanism of their light production. On the other hand, the new powerful Super-Schmidt cameras, which will be installed in New Mexico and in Canada, are expected to bring within the photographic domain much smaller meteors, adding one more dimension to our investigations.



Who's Who in Naval Research

We are happy to introduce this month to Research Reviews readers ONR's new Deputy Chief of Naval Research and Chief Scientist, Dr. Emanuel R. Piore. Dr. Piore relieves Dr. Alan T. Waterman, who left ONR to become first Director of the new National Science Foundation.

"Mannie", as his friends know him, is much more than just a scientist - he's a well-rounded human being. He's a little man with a big voice, a big pipe, sparkling black eyes and a puckish smile. His mischievous sense of humor tickles but never stings, and reveals behind it the brilliant mind which has made Dr. Piore a nationally known and respected physicist.

Born in Wilno, Russia, he came to America as a child and was graduated from the University of Wisconsin in 1930. He received his Ph.D. from that university five years later.

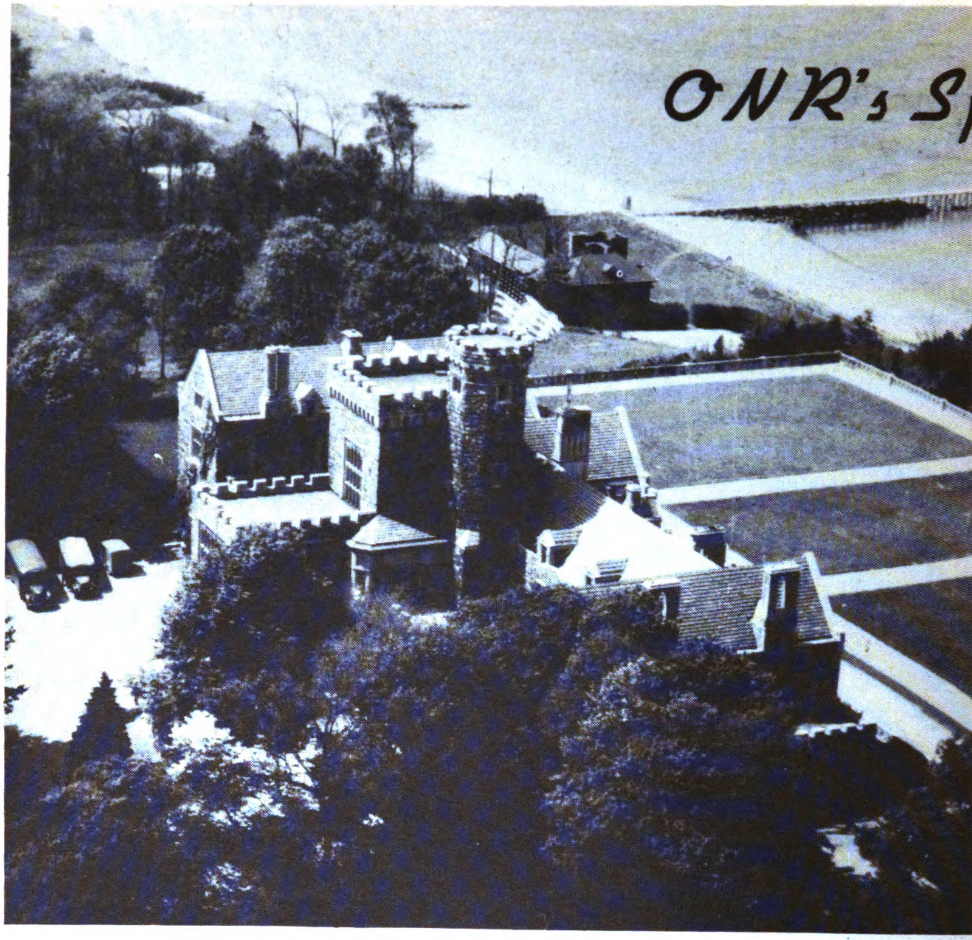
Electronics is Dr. Piore's special field. By 1942 he had been for four years engineer in charge of Columbia Broadcasting System's television laboratories - and had already helped to develop color television.

In 1944, from a position as senior physicist in the Bureau of Ships, he was called to active duty in the Navy as a Lieutenant Commander.

Dr. Piore joined the Office of Research and Inventions (which later became the Office of Naval Research) in February 1946, as Head of the electronics branch. His service to ONR has been continuous except for the year 1948-1949, when he was on leave of absence as a guest scientist in electronics at the Research Laboratory of the Massachusetts Institute of Technology.

Since 1949 he has been Deputy for Natural Sciences, and as such has guided the Navy's research programs in the earth sciences, the physical sciences, and the mathematical sciences.

Deputy Chief is a big job and a big responsibility. Dr. Piore's proven scientific ability gives him ample vision and competence to administer ONR's research program. But more than that, "Mannie" has the understanding, wit, and tact that make a good administrator - and ONR has long known he's a good "shipmate".



Visual Education

Perfection of mass training techniques, useful in peacetime, takes on particular importance in emergencies. At the Center, the television education program is the most important medium being developed for mass teaching. A small but complete modern studio has been set up and television instruction was tested in closed-circuit programs to nearby service installations. Now a regular program, "Drill Call", is being telecast on a commercial channel to teach Navy fundamentals to reservists in classrooms at training centers.

TV camera is trained on a mockup o

?evices Center

Its Laboratories and Workshops are the Link Between Navy Men and Navy Research

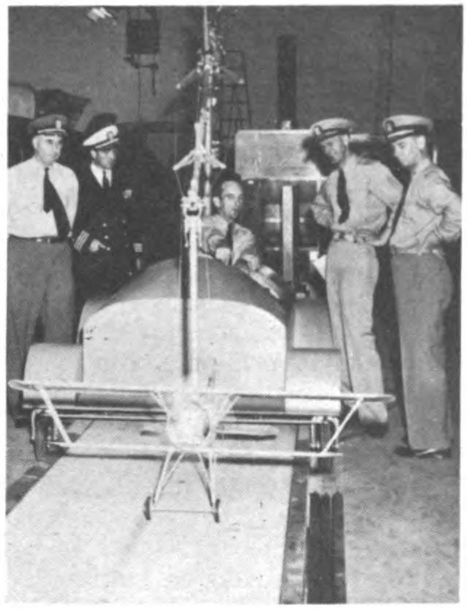
Scattered over a 163-acre tract that was once the estate of Daniel Guggenheim are the laboratories, workshops and television studios of the ONR organization that has the vital job of bridging the gap between the Navy's men and today's complex weapons of war. Here, after research and production have accomplished their tasks of turning out new machines, the technicians take over the equally hard job of turning out men who can run them.

To do this, the Special Devices Center has developed training devices, teaching aids and instruction systems. It conducts research into the relations between man and the machines he must operate in order to insure that science will not fashion armament that requires skills beyond human abilities.

With the modern growth of research and technology, SDC has expanded from a "desk" in BuAer to an activity big enough to occupy the sprawling facilities of its present site in Port Washington, N. Y. The pictures which follow show important phases in the Center's program of training Navy men to operate new weapons as soon as, or before, they roll off the production line.

aircraft.

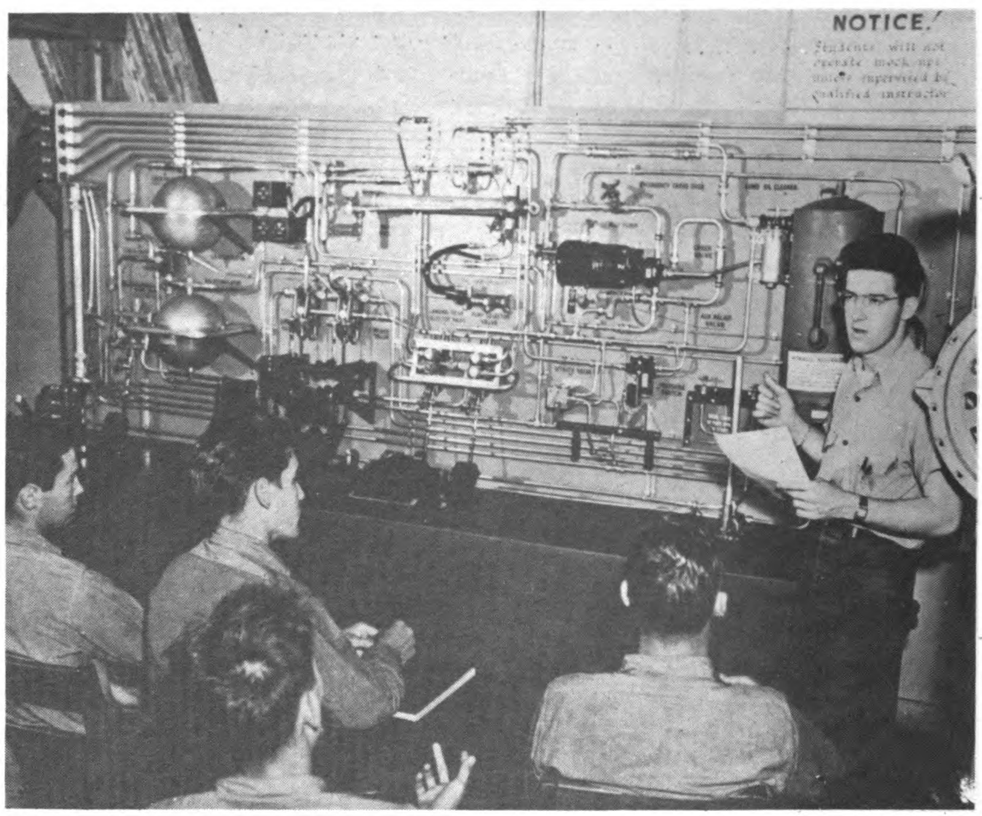
Demonstration of jet engines in first Navy telecast.



Aviation Training

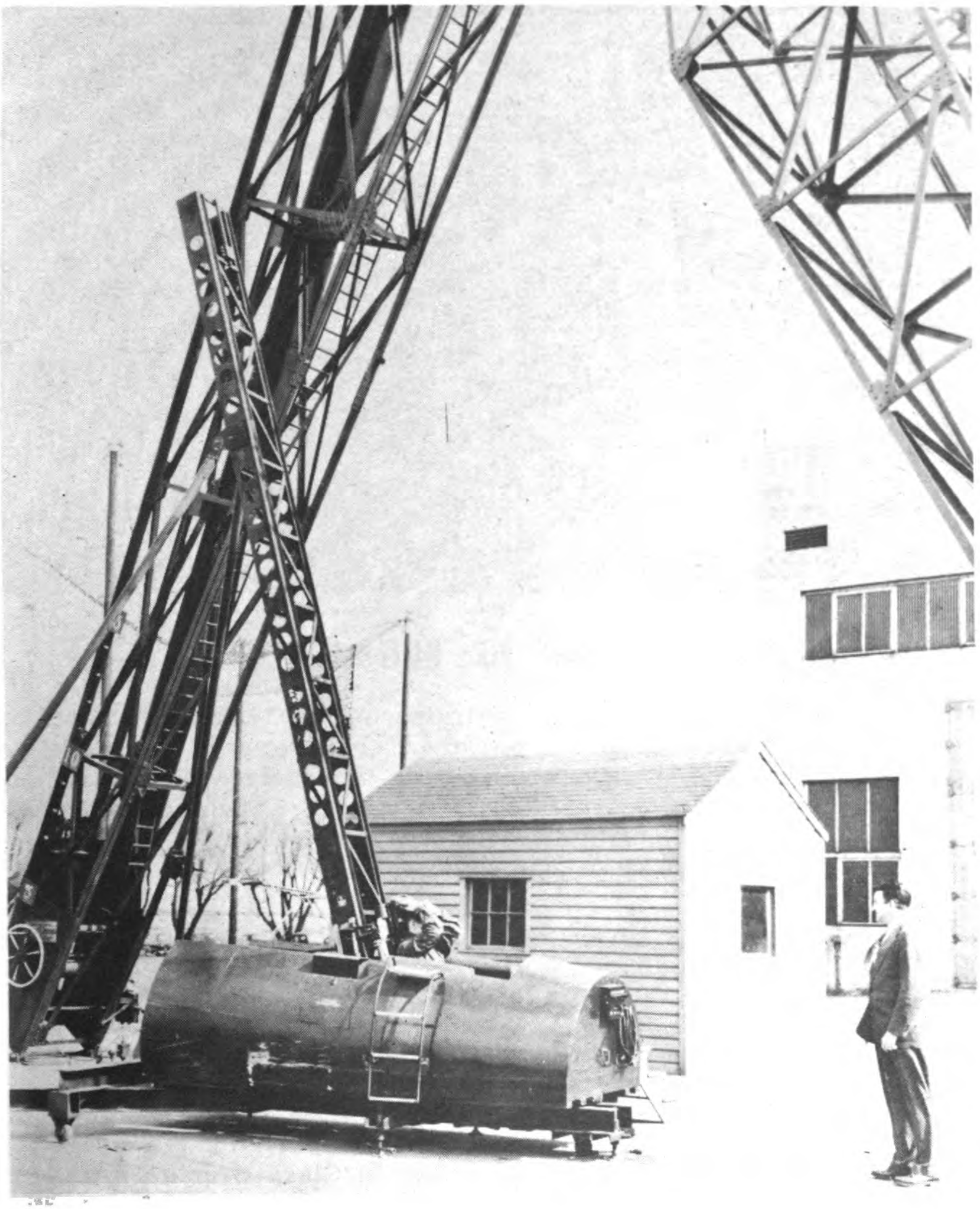
Largest training program is the one in aviation, in which trainers are used to simulate closely the operational characteristics of aircraft. Thus, pilot and crew may learn their jobs without the cost and danger of actually operating planes in hazardous situations.

Left: Instructor demonstrates operation of primary landing trainer. The small, self-powered plane in the foreground is controlled with stick, throttle, and pedals located in cockpit, where the instructor is sitting. The plane can be made to take off, climb, bank, dive and land.

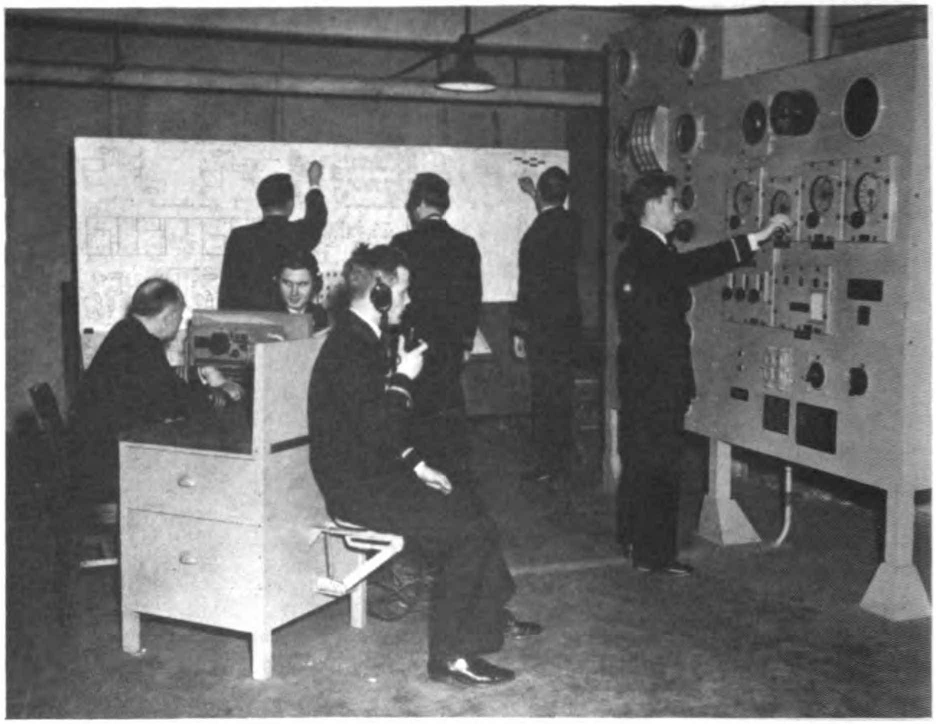


This instructor is showing students the working of the hydraulic systems of the PB4Y aircraft with the aid of a Naval Aircraft Maintenance Trainer on which are mounted working components of the system. This PB4Y hydraulic system trainer is only one in the series of aircraft maintenance trainers developed by the Center to teach personnel to care for aircraft.

A Pilot Practices for Supersonic Bailout

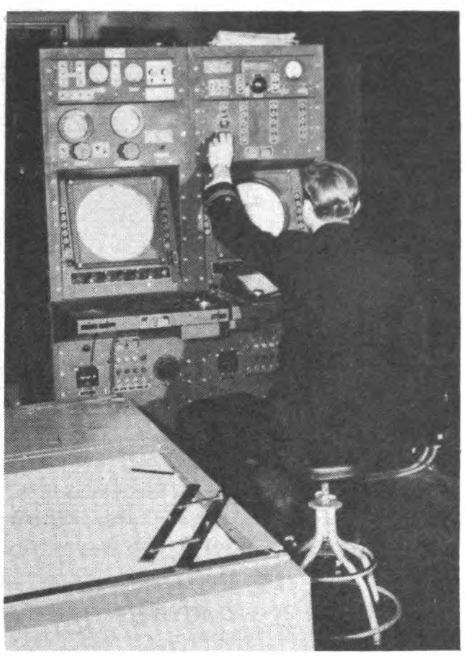


High speeds of modern aircraft have posed new problems in emergency bailout and have made necessary ejection gear that throws pilot and seat clear of the fast-traveling plane. In the ejection seat trainer, this pilot prepares to trigger the charge that will catapult him upward along the rails in a controlled simulation of an actual emergency escape.

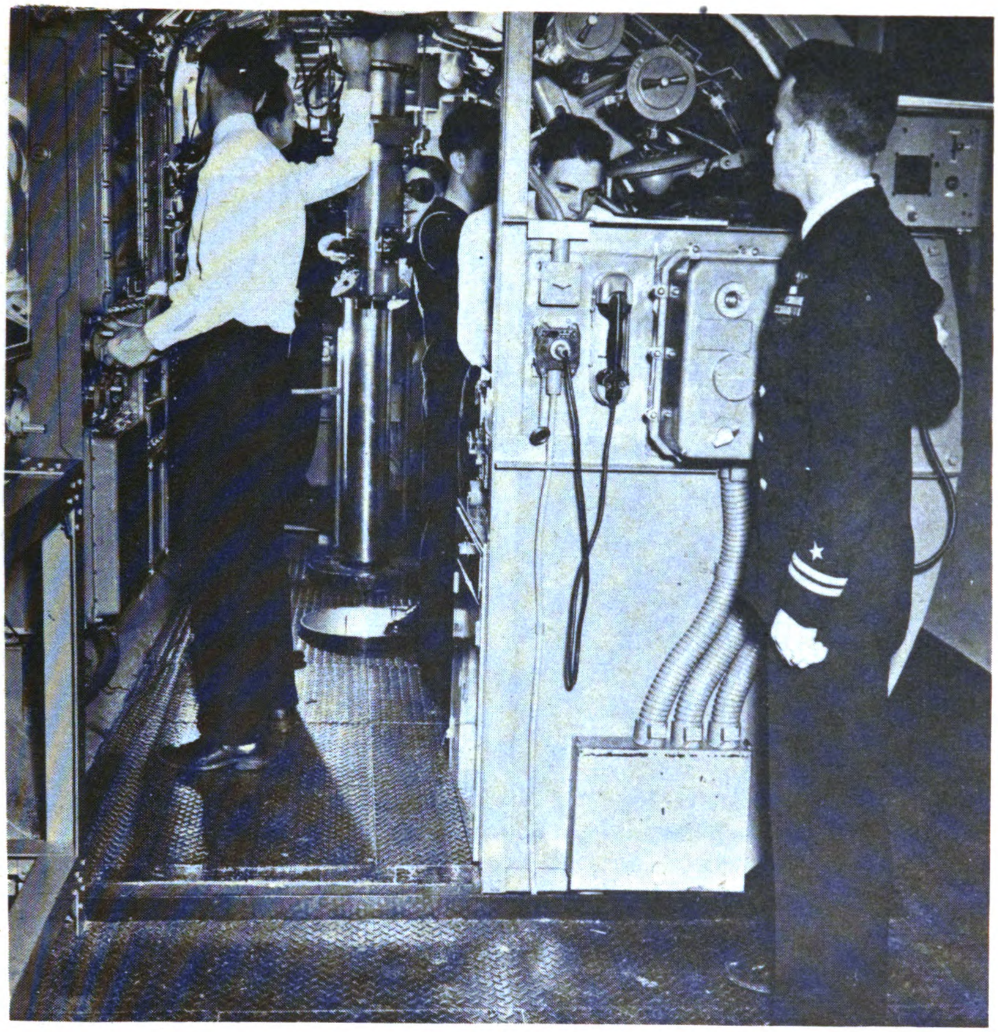


School for Skirmish

Our men fight their battles on trainers at SDC before they are exposed to the hazards of actual warfare. The pictures on these two pages show various devices which belong to modern combat situations and which have been incorporated into trainers. Meeting theoretical enemies in mock battle with these trainers is giving the Navy a big boost in combat efficiency.



Above, officer students at Navy Damage Control School learn to minimize effects of enemy action by working with the controls and charts of a mockup of the central control station of the CA-139 (Salem) Class Cruiser. At left a trainee works out a vectoring problem on the ground control intercept trainer used in teaching techniques of radar interception. On opposite page, above, a fire control party, working in an exact replica of the conning tower of a submarine, is being trained to approach and attack enemy vessels. Below sailors are shown in the SDC model shop making photographs which will be used to make slides for training personnel in aircraft identification.



Teaching Aids

Here are two aids which SDC technicians have devised to lighten the tedium of instruction--which, as any teacher knows, plays a big part in making learning easier. Above, instructor explains to college students basic physical applications with the aid of SDC's Mechanical Principles Demonstrator. Working parts mounted on the Demonstrator panels are operated to show effects of applied forces. At left sailor answers questions asked by an automatic rater. This device presents a question and several possible answers on a card that appears in the viewing window when the student presses a button. If proper answer-selection button is pressed, light flashes "correct" and score of 20 points is registered. Wrong answers flash "incorrect" light.

Helping The Navy Find The Right Man For The Job

(The following article, prepared by the editorial staff of Research Reviews, summarizes some of the results presented by Kenneth E. Clark of the University of Minnesota in Technical Reports Nos. 1 and 4 from Project NR-151-248, entitled "Interest Patterns of Naval Enlisted Personnel," under sponsorship of the Office of Naval Research.)

For a long time the Navy, in selecting men for various ratings, has been trying to avoid putting square pegs in round holes - that is, assigning recruits to billets for which they are completely unsuited. For the Navy, along with the other Armed Services, realizes that this results in wasting the manpower that is so important to us now. Yet the classification officer cannot tell merely by looking at a man or knowing generally about his background what assignment he will be able to carry out best. Will he, for example, make a good yeoman, or would he do better as a machinist's mate? Although the problem of finding out is a difficult one, the Navy is making progress in solving it, and the assessment of a recruit's interests is one contributing factor in this solution.

Most men who served during World War II are familiar with the use of aptitude tests to help solve this problem. These aptitude tests are designed to test a recruit's ability to do a certain task. For example, if a man scores high in the mechanical test, he presumably has at least part of the essentials to insure making good in a mechanical rating. This does not always prove to be true, however, because while ability is necessary, it is not sufficient in the absence of motivation to insure success. Frequently the schools established to train men in the fields where their greatest abilities lay complained that many highly capable students were not "interested" enough to be successful in the job for which they were supposed to be best fitted. It was apparent that an ability to do a certain task was not enough. A man had to like the work and want to accomplish the task. For this reason it seemed clear that some way of measuring a recruit's interests was needed - and this is not as simple as it may sound. To ask a new recruit what rating he would prefer is rather futile. First of all, such terms as "sonarman" or "aviation electronics technician" gives the new recruit only the haziest idea of the kind of work these ratings involve. Some men, on the other hand, might profess to like certain jobs which would prevent their assignment to combat duty.

To devise a means of finding out where the genuine interests of each man lay, the Office of Naval Research undertook the support of a research program aimed at the measurement of interest of skilled-trades groups, proposed by Dr. Kenneth E. Clark at the University of Minnesota.

Dr. Clark devised a questionnaire containing 570 items, all describing various activities connected with doing certain jobs. These items were arranged in three's, and the person completing the inventory is required to select, from each group, the activity he would like most and the one he would like least. Here is how the questionnaire looks:

Directions

On the following pages you will find many activities listed. They are arranged in blocks of three. You must make a choice in each block of the one thing you like to do most and the one thing you like to do least.

Mark the thing you like to do most with a plus sign (+)

Mark the thing you like to do least with a minus sign (-)

That leaves one of three items blank.

Example: ( ) a. Write letters.

(+) b. Fix a leaky faucet.

(-) c. Interview someone for a newspaper story.

Now turn the page and begin. Be sure to fill out all the pages.

None of the groups of three is aimed at any particular occupation, but each provides choices of the sort that a person makes almost every day on the basis of his "interests." Thus, widely differing activities like learning calculus and chopping wood are not combined, since such choices are not realistic.

The questionnaire has been administered to about 3300 successful employed workers in the skilled trades. These included groups of electricians, milk wagon drivers, painters, plasterers, bakers, sheet metal workers, printers and plumbers. Prof. Clark points out that the results of the early administration of the interest inventory are somewhat biased, since everyone who answered the questionnaire came from the same locality (St. Paul, Minn.) and belonged to the same union (AFL). Another drawback was that all the members of a particular union to whom the questionnaire was submitted did not fill it out. In analyzing the results, the response of each member of these various trade groups to each item was computed on a percentage basis. Then these percentages were averaged to give an estimate of how the groups of tradesmen-in-general (as opposed to any particular occupational group) would reply to each item.

It was then necessary to find out how the response of the separate groups to the questionnaire distinguished them from each other. A comparison was made (on a percentage basis) between the way the tradesmen-in-general answered each item and how the members of one certain occupational group answered it. For example, the response of electricians to the following item was compared to that of the average of the whole group of skilled tradesmen:

Item 18	Percentage Responses of "Like" Made by:	
	Tradesmen-in-general	Electricians
a. Be an electrical engineer	61%	90%
b. Be an aeronautical engineer	20%	5%
c. Be a surgeon	19%	5%

Obviously, electricians have a greater desire to be electrical engineers than do tradesmen-in-general. The way a man answered this question, then, helped to indicate whether or not he would make a good electrician. For this reason, this group of items was put on the "key" or scoring standard for electricians. Items for the keys for other occupations were chosen in the same way. In order for an item to be placed on a "key," however, the answers of a certain occupational group had to differ from the tradesmen-in-general by at least 15 percent.

When questionnaires were scored in this way it was found that differences of interest really did distinguish one trade group from another. Some occupational keys, however, turned out to be better than others. The painters' key, for example, seemed to do the best job of distinguishing these workers from other groups, for not even workers in similar trades, such as plastering, would make high scores on the painters' key.

One interesting discovery was that workers in certain related trades seemed to have similar interests. For instance, those in three unions connected with the building trades (electricians, plumbers and sheet metal workers) would make good scores on each other's keys. But they differ markedly from workers in two other building trades - painting and plastering. And, as we would be more inclined to expect, they also differ markedly from two service occupations - milk wagon drivers and bakers. On the whole, there seem to be indications that skilled-trades groups may be divided into families of occupations with rather similar interests. For this reason it may not be necessary to distinguish between closely related jobs in guiding young people in their choice of work. For example, a person who would make a good electrician probably would also do a fairly good job as a sheet metal worker, for the two have somewhat similar interests.

This type of questionnaire has been administered on men in seven Navy rates: yeomen, fire controlmen, gunners' mates, aviation ordnancemen, aviation structural mechanics, aviation machinists' mates, and aviation electronics technicians. The men studied were essentially those who had achieved success in their rate, as indicated either by advanced pay grade or by attendance in advanced technical schools. After they had made choices from each group of three items, as described above, the percentage of choices of the most liked and least liked items were computed for each of the seven Navy groups. The percentages were then compared with those of the tradesmen-in-general to determine which items were important in distinguishing men in one Navy rate from those in another.

An examination of the results showed that men in Navy rates can be differentiated on the basis of interests just as well as can civilian workers. The yeoman's key definitely did the best job of separating this group of men from other rates, indicating, perhaps, that the interests of yeomen are quite different from those of men in other ratings. The key for aviation ordnancemen, on the other hand, was the least effective. Too many other ratings seemed to share the interests of this group. Probably the most satisfactory result of the tests is the fact that groups doing similar tasks (fire controlmen, aviation electronics, technicians, aviation structural mechanics, and aviation machinists' mates) shared similar interests. Conversely, on the ratings which involved markedly different tasks (for example, yeomen compared to machinists' mates) there was very little in common. Oddly enough, no general pattern of aviation interests emerged for the men in these four groups.

One problem that Dr. Clark has been interested in is the relationship between Navy and civilian specialties, for in case of mobilization, it would be a great asset to know the rating in which a painter, for example, would give the Navy the best service. The results indicated that yeomen, the only "office work" occupation in the seven Navy rates, shared many interests with shipping and stock clerks, with printers and with warehousemen. They also showed some similarity to milk wagon drivers, bakers, and plasterers.

One very gratifying result of the tests was the similarity between the interests of sheet metal workers and aviation structural mechanics. Since the duties of these two groups would presumably have much in common, these results seem to confirm the validity of the interest inventory.

It is interesting to note that men in some civilian trades have more interests in common with Navy men than do Navy men in other ratings. That is, the highest relations between occupational groups often cut across Navy-civilian lines. In the scores on the electricians' key, for example, civilian electricians naturally score the highest. Yet the next two highest scores are made <u>not</u> by civilians in other trades, but by fire controlmen and aviation electronics technicians. This suggests that being in or out of the Navy does not matter much in interpreting the scores made by a particular individual. This, of course, increases the applicability of the questionnaire.

Our summary has, of course, presented only the highlights of Dr. Clark's work and has omitted many important details of the way in which the research was carried out. There are naturally many problems involved in the development of the scoring keys and these have not, by any means, been completely solved. In addition, improvements need to be made on the results obtained from the criterion group, the tradesmen-in-general, and a wider variety of keys more representative of rates in the whole Navy needs to be developed. Moreover, we must not jump to conclusions about the validity of the tests, for until now they have been given only to skilled workers in the various trades and rates. Long practice as an electrician, for example, might cause a man to give answers that would indicate he would make a good electrical engineer. His experience, in other words, and not his inherent preferences, may be the determining factor in his score. To check this possibility, future plans involve testing green recruits and then following their subsequent careers to see if results are really valid.

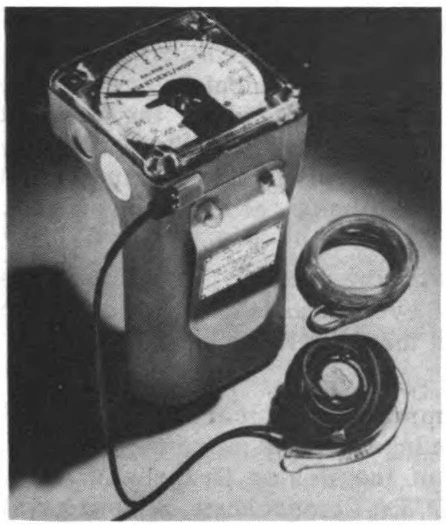
At present the adoption of the questionnaire for Navy use to a limited extent is under consideration. Its use, in conjunction with ability tests would be something along these lines: First the Navy classification battery would be used to discover the <u>abilities</u> of the recruit; then the interest tests would determine how best to utilize these abilities. Another possible use of the questionnaire is in determining whether or not a man should change to another rate. If his interest patterns are the same as those of men in a different rate, his chances for successful adaptation to the duties of the new rate would support the change. In a like manner, the inventory might be used as an index for determining the direction of his further advancement.

At the present time the idea is not to use the inventory as a predictor of success in school or in a rate, for there has not been enough positive evidence to indicate that the inventory would be reliable for such purposes. However, when the questionnaires have been further developed and when more adequate means of scoring them have been provided, it is hoped that they will enable the Navy to make improvements in its use of manpower.

Navy's New Radiation Indicator

Pictured below is the latest thing in radiation indicators--a pocket-sized precision radiation survey instrument developed for military personnel by Navy scientists. A similar type of instrument is being developed by the Atomic Energy Commission for non-military applications. While neither instrument is available as yet in production quantities, the Navy's Bureau of Ships has completed tests on developmental models of its device.

Push-button operated, and easily maintained, the new simplified instrument will instantly indicate values of atomic radiation intensities over a wide range, all the way from a "safe" level to a maximum dose of 500 roentgens per hour, which would be fatal if exposure were continued for that period of time. Readings are readily obtained from the 270-



This is the new Navy-developed radiation indicator. The device not only gives visual information on the presence of radioactivity, but at lower dosages it also gives an audible warning--by ticking.

degree scale. Two ordinary flashlight batteries operate the two-pound instrument, which is housed in a protective shock-proof and waterproof plastic case.

The light weight and simple operation of the new device are made possible through the use of two subminiature tubes, which represent the culmination of ten years of research work by scientists at ONR's Naval Research Laboratory and by Naval contractors. One of these is a gas-type Geiger counter tube, which is noted for its long life, and which has sufficient current output to permit the instrument to operate without the addition of any electronic devices or tubes. The second component, called a corona voltage regulator tube, provides a stable source of high voltage for operating the Geiger tube, using the two flashlight batteries as the only source of power. The equipment and tubes, developed in their present improved form for the Navy by the Anton Electronic Laboratories, were based upon the early investigations by Dr. H. Friedman, Dr. S. H. Liebson, and their associates in the Electron Optics Section of the Naval Research Laboratory. Each of the tubes used is smaller than an ordinary cigarette.

On the Naval Research Reserve

RADM T. A. Solberg Guest Speaker at VNRRU 1-1's Second Birthday Party

RADM T. A. Solberg, Chief of Naval Research, was on hand for the festivities that marked the second birthday of VNRRU 1-1, Boston, Mass. last month. A cocktail party and banquet plus a speech by the Admiral were combined to make the meeting one of the most successful ever held.

RADM Solberg reviewed the history of the Office of Naval Research and outlined its present policy in the light of the critical international situation. He traced the development of the Research Reserve Program to its present size of nearly 100 units, with a membership of more than 3,000 officers. In particular he stressed the value of the Research Reserve group to the whole Navy--not only to ONR but to the Bureaus as well. He cited a number of examples of worthwhile contributions which the units are making to the research program and pointed out the fact that ten active-duty billets which ONR has had available have been filled by officers volunteering from VNRRU 1-1. He also told how individual members of units can make valuable contributions to the research picture.

RADM Solberg prefaced his talk with the remark that this was the largest meeting of a unit which he had ever attended. Practically the whole unit--130 officers and 37 enlisted men--were on hand.

CAPT Louis M. Smith, USNR, Commanding Officer of VNRRU 1-1 was Master-of-Ceremonies for the evening. Guests were CAPT A. L. Pleasants, USN, Commanding Officer of the Boston Branch, Office of Naval Research; CAPT P. D. Gold, Jr., USN, Commandant, Boston Naval Shipyard; Colonel LeRoy M. Hersum, AUS, Commanding Officer of the Army Research and Development Unit in Boston; and LCDR H. Wray Rohrman, USNR, Reserve Program Officer for the First Naval District.

The Committee on Arrangements for the dinner meeting was made up of CDR B. Altman, LCDRs A. H. Healy, T. J. McLaughlin, A. H. Rosen, and LTs T. B. Dowd, E. L. Cook, and L. W. Brown. The Committee was warmly applauded for a well planned and executed evening.

CAN YOU TOP THIS?

VNRRU 1-7, Dartmouth College, Hanover, New Hampshire, believes that it holds the record for an officer's travel to attend meetings. LT Carol J. Korzeniewski lives in Exeter, New Hampshire and attends meetings regularly in Hanover, New Hampshire--a distance of 222 miles for the round trip! He states "The meetings are so interesting I wouldn't miss one of them."

Age Limits For Recall
of Reserve Officers to Active Duty

Here are the age limits which have been established to govern the recall of reserve officers to active duty.

RANK	VOLUNTARY	INVOLUNTARY-LINE	INVOLUNTARY-EDO-SDO
ENS or LTJG	36	28	38
LT	38	32	42
LCDR	40	35	45
CDR	45	45	51
CAPT	50	--	--

Civil Defense News

VNRRU 12-4, FRESNO, CALIF.

"Science in Civil Defense" is the name of a course being offered by members of Unit 12-4 at Fresno State College this semester. The course, which will be repeated next fall, is open to students and other members of the community who wish to enroll.

VNRRU W-5, BETHESDA, MD.

A device called an "A-bomb Scale" has recently been designed by this unit, and is believed to be of great potential value to civil defense trainees. It will be used to familiarize defense workers with effective damage areas following an aerial atomic explosion over any region covered by an operational map of known scale.

The device consists of a transparent plastic sector radius arm, the center of which may be pin-pointed at an arbitrary target center on a map of suitable scale. By rotation about this center the sector arm may be made to indicate the extent of lethal and dangerous radiations. In this way information will be available on the severity of injury and blast damage which is to be expected from the explosion of a "standard" atomic bomb.

Data for the device were taken from the tables and formulae in the text of "Effects of Atomic Weapons".

VNRRU 9-13, DES MOINES, IOWA

Members set up the city's civil defense exhibit at a home show held there recently. Previously the unit, though not formally engaged in a civil defense project, had been able to assist local authorities by nominating members of the chemical and radiological groups in the city's defense set-up.

LTS E. S. Churchill and J. C. W. West are New VNRRU Program Officers

The last few weeks have seen some important personnel changes in the VNRRU organization. Two program officers--CDR R. W. Mayhew, USNR, Program Officer of ONR-Chicago and LT E. I. Estep, Program Officer Southeastern Area--have been assigned to new billets. Their successors are LTS E. S. Churchill and James C. W. West.

LT James West, the new Southeastern Area Program Officer, comes to active duty in the Navy from the Virginia Polytechnic Institute, where he was Professor of French and English. His educational background includes degrees in the romance languages from Randolph Macon College and Syracuse University.

LT West's career, however, has not by any means been confined to strictly academic matters, but has included plenty of practical Navy training and experience. During the war he served on the USS Sacramento, a communications guard ship between San Francisco and Pearl Harbor. Later he was on the USS PC 793, a sub patrol operating out of Adak, Alaska. His Navy schooling included courses at the Harvard School of Communication and the Ft. Schuyler Advanced Training School. He also attended the Miami Sub-Chaser Training Center.

LT Churchill, who has taken over as Program Officer in Chicago, has behind him a splendid record as Commanding Officer of VNRRU 9-16 in Lansing, Mich. He headed this unit from its activation in August 1949 until January 1951, and during this period the unit grew in membership from 16 to 46. Before taking over as Program Officer he had two weeks of training in the Chicago Office and two weeks in the ONR Washington Office. He is therefore thoroughly familiar with the problems and purposes of the Research Reserve.

Armed Forces Day, May 19, is the occasion when our country salutes the united military might of our Army, Navy, and Air Force. It serves to remind us that in these hours of emergency, we must husband every resource to keep the Nation strong. A resource that the Navy is proud to have helped to develop is the scientific potential of our country. Today's guns, planes, ships (even the Mighty Mo ploughing through the waves, opposite) will one day be obsolete. The newly designed equipment of the future will be the result of labors of men like the ones pictured here, who are gathering the fundamental knowledge that is so vital to practical developments. That is one reason why basic research programs, like the extensive one supported by ONR, must be considered one of the vital links between the critical present and a secure future.

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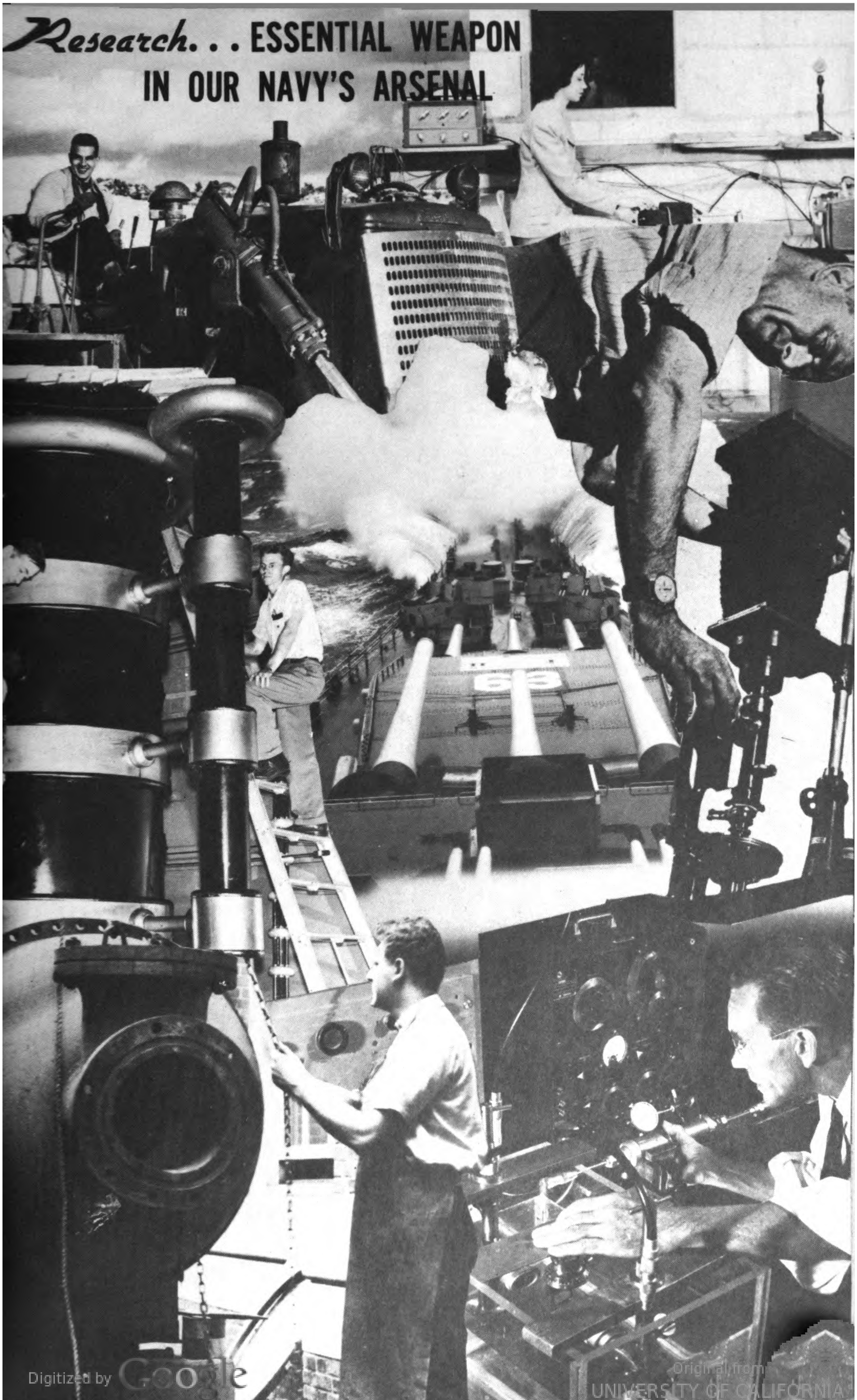
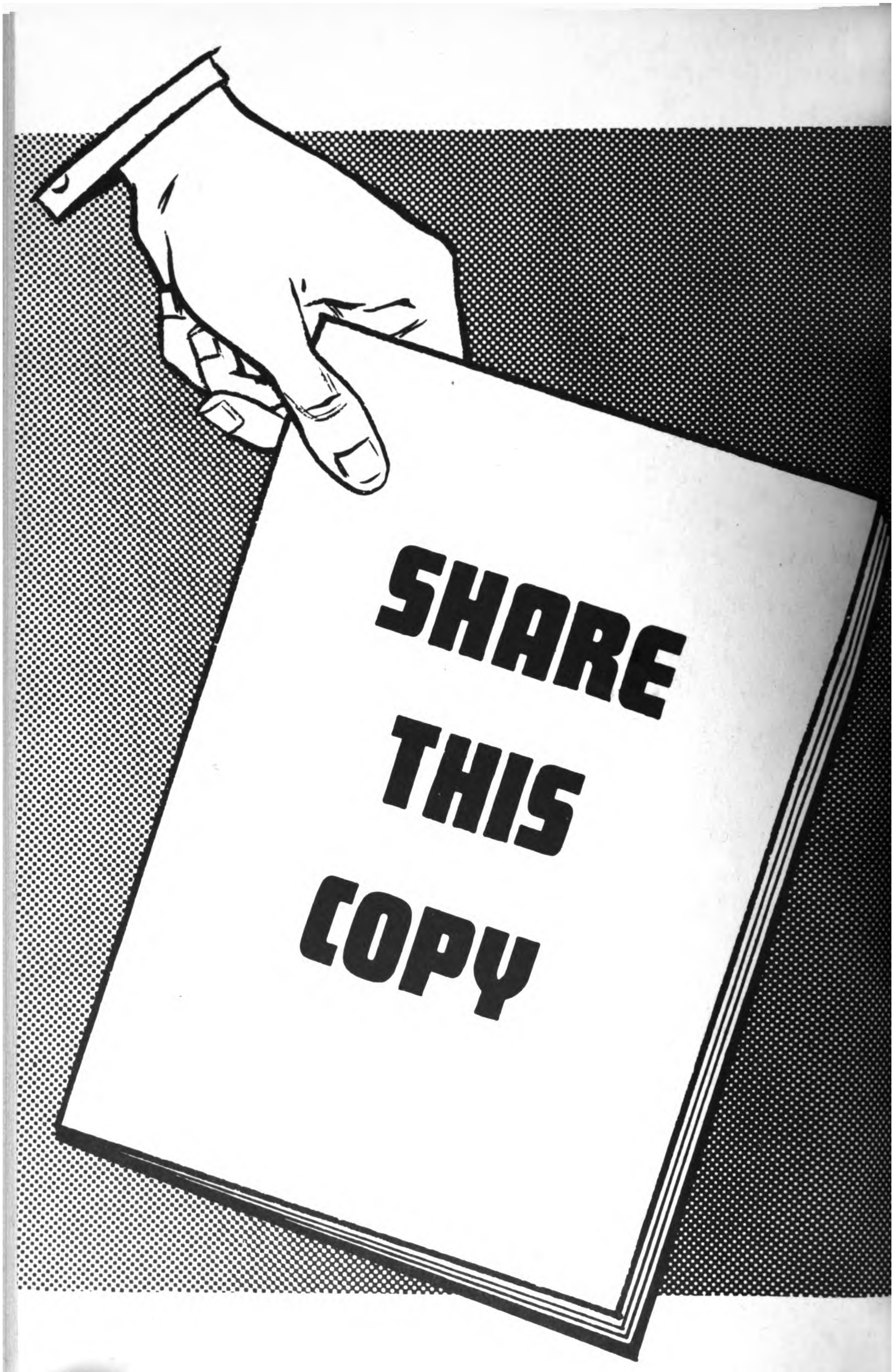
Research. . . ESSENTIAL WEAPON IN OUR NAVY'S ARSENAL

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