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RESEARCH REVIEWS

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DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: This Douglas Skyrocket, being released at an altitude of 35,000 feet from a B-29, may be the world's speediest plane; nevertheless it probably marks only the beginning of a new era in aviation. The Navy's Skyrocket has exceeded the speed of sound (exactly how fast it travels is a military secret) but tomorrow's research developments will probably enable the building of aircraft which will knock its records into the proverbial cocked hat. For more about such possibilities see "'Keeping Cool' at Mach 10" by Dr. Joseph Kaye, pp. 3-10.

Approved by the Bureau of the Budget, 14 February 1952

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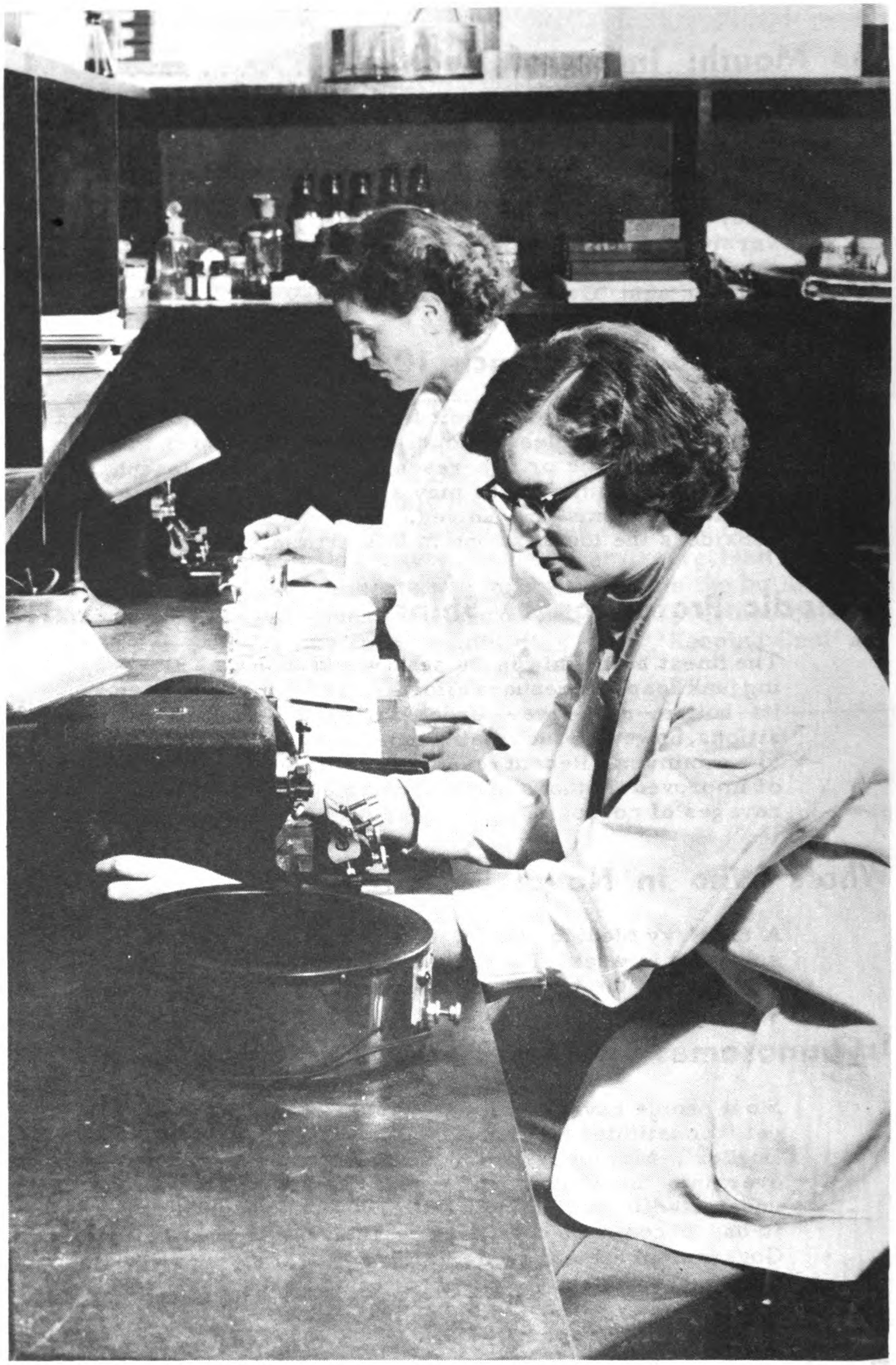

Technician trainees in the histological laboratory of the Department of Pathology, School of Dentistry, University of Pennsylvania. Here they are preparing material supplied by the Dental Department of the Naval Medical Research Institute. This type of work presents a real career opportunity for those interested in training courses offered.

The Mouth: Index of Health

by
Paul E. Boyle and Charles E. Wilde, Jr.
University of Pennsylvania

The old-fashioned family doctor supposedly learned a great deal about the health of his patient by telling him to open his mouth and say "ah". Nowadays this practice has fallen a bit into disuse and physicians at present are prone to regard the oral cavity merely as the gateway to the tonsils. Dentists, perhaps, concentrate too exclusively on the teeth and restrict their interest to problems of dental restoration such as fillings, bridges and dentures.

Among both professions, however, there is a growing realization of the importance of complete and thorough examination of mouth tissues. One of the most vital reasons for paying close attention to the whole mouth has been the frequent occurrence of cancers in the oral mucous membrane where they can be detected at an early and curable stage. But there has also been an increasing appreciation of the fact that many indications about the patient's general health can be found here.

The mouth contains large amounts of lymphoid tissue (especially in the tonsils and adenoids) as well as the salivary glands. The bony structures, muscles, nerves, blood vessels and lymphatics are similar to those found in other parts of the body. The gums and other tissues by which the teeth are attached to the jaws are a point of lowered resistance to bacterial infection. Periodontal disease (pyorrhea alveolaris) usually starts at the gingival crevice about the teeth and may be compared to infections about hair-shafts or about the fingernails.

There are a host of maladies which cause suspicious symptoms in the mouth. Characteristic signs of Vitamin B deficiency show up in the corners of the mouth; changes in the tongue are caused by pernicious anemia and nutritional lacks. And swellings of the gums with bleeding often give first warning of the fatal blood disease, leukemia.

What perhaps qualifies as the most modern of maladies, radiation illness, also shows up in the oral mucous membranes. People who survived the effects of atomic bombs for a week or two frequently complained of bleeding gums and loosened teeth. Ulcerations in the oral mucous membranes were also common. Similar effects have been produced in experimental animals exposed to ionizing radiations. It is believed that such results of ionizing radiations are due to the destruction of the white blood cells and of the centers in the bone marrow and

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Charles E. Wilde, Jr. (Ph.D. Princeton University) is a biologist who has been concerned with problems of growth, development and differentiation.

lymph nodes where these cells are formed. As a consequence, the tissues are susceptible to infection by disease-producing bacteria.

Medical researchers, as well as medical men, are also interested in the mouth—not only because of its value in diagnosis, but because many of the processes by which oral tissues form teeth are still only vaguely understood. At the University of Pennsylvania courses are being given to increase the number of trained technicians qualified to assist in this work.

Formation and mineralization of the teeth is a special problem of dental research, although it has many features in common with the formation and calcification of bone. Dental enamel is by far the hardest tissue in the body and the only calcified tissue formed by epithelial (cavity-lining) cells. During enamel formation an organic matrix is secreted which is deposited on the outer surface of the dentin. This enamel matrix is at first soft but ultimately becomes very highly mineralized. Mature enamel is composed in very large part of calcium salts (97 percent or more by weight). Subsequent arrested development (or hypoplasias) may be the result of some interference with, or failure of, enamel secretion, or of lack of mineralization.

In a tooth which is being shaped, four stages of activity of the enamel-forming cells may be recognized: 1) formation of new cells by mitotic divisions; 2) deposition of a matrix, when the enamel is constantly increasing in thickness because the cells are rapidly producing enamel substance; 3) mineralization, during which water is taken out of the matrix and mineral salts deposited in it; and 4) wasting away of the enamel-forming cells. The cells appear most susceptible to injury while they are actively secreting enamel matrix. Further research is necessary to ascertain the degree of effect on the enamel organ cells in the mitotic division phase.

Histological research is greatly aided by the availability of highly trained technicians. Since the calcified tissues of the teeth offer unusual difficulties in fixation, decalcification, sectioning and staining, training qualified personnel becomes a most important part, not only of this project but of all other projects in the field of dental research. The Dental School of the University of Pennsylvania, supported by ONR, has set up a laboratory for the training of technicians in the preparation of oral and dental tissues for histological examination. This is a one-year course, during which the processing of soft tissues is first mastered, followed by experience in the use of special staining methods and histochemical technics, and culminating in the use of slicing and grinding machines for the sectioning of the calcified dental tissues for histological examination. The students, four of whom are now in process of training, are under the supervision of an experienced chief technician. At the completion of their course they will be available as employees on other research projects. Their training will be such that they will be qualified for all histological technics. The material on which they are working is to be studied and reported on as a joint effort of the Dental Research Department of the National Naval Medical Center and the Department of Oral Pathology of the University of Pennsylvania.

These training courses present an opportunity for the physically handicapped, since the work can be done while the technician is sitting down. In particular disabled veterans may be interested and their applications for admittance to the courses will be given every consideration.

"Keeping Cool" at Mach 10

by
Joseph Kaye
Massachusetts Institute of Technology

Since modern planes have enabled man to fly faster than the speed of sound, a host of new problems has arisen. Just how fast can supersonic planes go? It seems likely that power plants may be designed capable of producing speeds five or ten times that of sound (Mach 5 or 10). But with present structural designs and materials a plane traveling this fast in the lower atmosphere would probably roast its crew and would itself be consumed like a flaming meteor because of the heat engendered by the tremendous friction between its surface and the air.

There are, of course, other difficulties in the way of attaining supersonic speeds of such magnitude. For example, the design and construction of new power plants will be required to furnish the much greater thrust or push needed. New aircraft structural forms, new and more rapid control systems and new methods of protecting personnel must also be devised if sustained supersonic flight is to become a reality. Nevertheless, the fact remains that the most important difficulties are caused by what I shall call thermal problems. They are important because until they are solved there is no possibility of flying for long periods at speeds greater than four or five times that of sound.

We do not intend to present here any exhaustive detailed discussion of these thermal problems. Instead we shall merely present a somewhat oversimplified explanation of their origin, some calculations of their effects on a simple diamond wing in supersonic flight and some suggestions for solving them by various cooling systems.

Thermal problems originate in what physicists call the "boundary layer", close to the surface of the plane. Between the surrounding air that flows freely around the aircraft and the actual surface of the craft is a thin envelope of air, slowed by friction, which is called the boundary layer. At the leading (i.e., forward) edge of the wing, the boundary layer may be very thin—of the order of hundredths of an inch— whereas at the downstream portion it may be several times as thick. The difference between the speed at which the air in this layer is moving, compared with the free air stream, is determined by frictional forces in the air. Its thickness is a rough measure of the disturbance created in the steady flow of air by the frictional forces on the surface of the wing. And the different velocites of the air within the boundary layer depend on whether it is laminar (smooth-flowing) or turbulent.

During supersonic flight there is a large temperature rise in the boundary layer. Hence the structural parts of the plane tend to get very

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hot, and this would lead, in turn, to a rise in the temperature of everything inside if no cooling were available. It is clear, then, that the need for cooling personnel, electronic equipment, electrical systems and the fuel system greatly increases the complexity of designing a supersonic aircraft.

What is the origin of the temperature rise in the boundary layer? A simple explanation will make this more comprehensible. It is well known that if air is trapped in a bicycle tire pump and then compressed, its temperature rises above that of the atmosphere. But in such a device the speed of the quantity of air involved is small compared with the speed of a supersonic aircraft. Hence, the rise in air temperature is, for all practical purposes, mainly dependent on the increase in pressure of a fixed quantity of air.

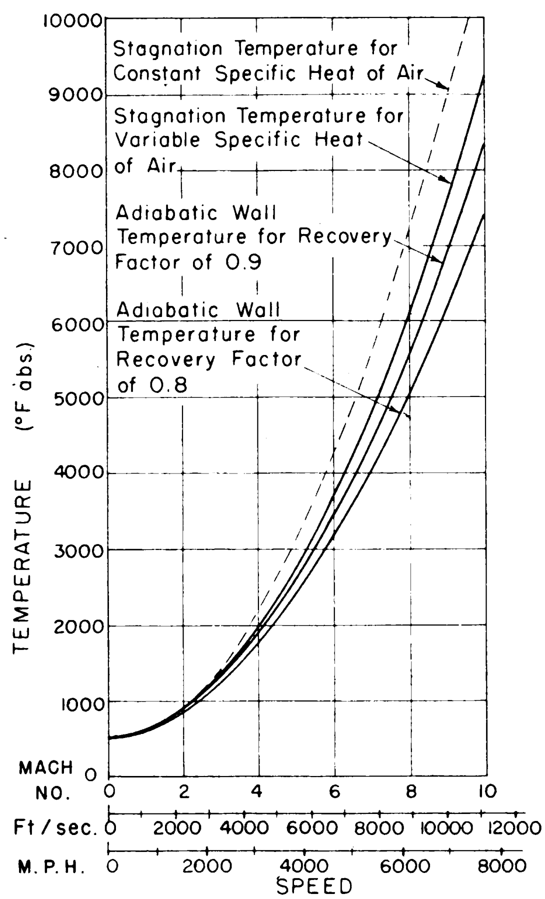

Figure 1. Stagnation and adiabatic wall temperatures for flight at constant speed in air at sea level. The two upper-most curves in Figures 1 and 2 represent the adiabatic wall temperatures for air for a recovery factor of unity and, hence, also the stagnation temperatures; the lower curves are for recovery factors of 0.9 and 0.8. The upper-most curve is calculated with a constant specific heat of air, while the other three are based on a variable specific heat.

How, then, does a high temperature originate in a supersonic plane? Clearly the answer lies in an examination of the compression process which occurs when a fluid in motion is brought to rest. If a moving quantity of air, for example, is brought to rest in a frictionless process, both its temperature and its pressure increase.

For a plane in steady flight, the approaching air is brought to rest in the boundary layer. At the surface of the plane the speed of the air is zero; with increasing distance from the surface the speed increases at a regular rate until it approaches the free-stream velocity. Within the boundary layer, temperatures are not uniform for the simple reason that air conducts heat, so heat flows from regions of higher temperature to regions of lower temperature in the boundary layer. Now suppose that the surface of the plane is insulated so that no heat can flow into it. We find that at subsonic speeds, the temperature of our insulated wall is not appreciably greater than the temperature of the free-stream.

At supersonic speeds, however, the temperature of our surface increases rapidly as the plane speed increases until, at about Mach 5, it becomes one of the most important factors to be considered in the design of high-speed vehicles. This increase in surface temperature is shown in Figures 1 and 2 for sea-level flight and in the isothermal atmosphere at altitudes from 35,000 to about 100,000 ft respectively.

It is obvious that if an aircraft is to fly steadily at an altitude of 50,000 ft and at a speed of 5,500 miles per hour (a Mach number of 8), the temperature of its surface would tend to a value of 4,000°F. Of course such a temperature might never be reached if the plane were made of materials that melted lower than this; obviously, however, this is not a solution to the problem!

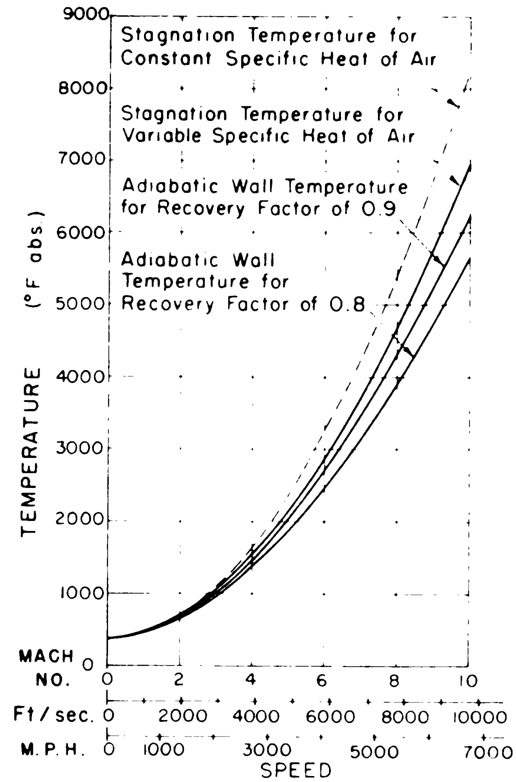

Figure 2. Stagnation and adiabatic wall temperatures for flight at constant speed in air at 50,000 feet. It is clear that at speeds much greater than that of sound surface temperature becomes crucial.

Let us examine more systematically the problems arising from aerodynamic heating on the design of a supersonic aircraft. Suppose a power plant is available, a structure has been designed to meet aerodynamic specifications, and only the effect of temperature rise on this structure remains to be investigated. Answers would be needed to the following questions:

1) For acceleration and steady flight of the aircraft, how does the surface temperature vary with time?

2) How is the heat engendered in flight distributed throughout the plane over a long period?

3) What are the thermal stresses introduced by nonuniform temperature distribution?

4) How do the temperature distribution and structural characteristics of the plane affect each other?

5) What materials are suitable for the high temperatures encountered?

6) What are the cooling requirements for safe operation of all parts of the aircraft, of the personnel, of the electronic equipment, etc.?

The answers to these questions depend on the rate of heat transfer from the supersonic stream (the air) to the solid body (the plane). Unfortunately data on rates of supersonic heat transfer were practically non-existent a decade ago and are being obtained but slowly at present. The main reason for this slow accumulation of data is that it is usually necessary to employ an extensive supersonic wind tunnel, which is expensive to build and operate. It is probable that in the next few years enough data will be obtained in various government-operated tunnels to enable the designer to predict rates of heat transfer for supersonic flows up to Mach 10 for a large variety of different geometric shapes.

Fortunately the rate of heat transfer between a supersonic stream and a solid wall can also be measured by forcing the flow to occur in a round pipe. Such a project, supported by ONR funds, has been under way for several years in the Department of Mechanical Engineering at MIT. The great advantage of this type of work at Mach numbers up to 3 has been the low cost of construction and operation; in comparison with wind tunnels, its expense is less by a large factor. The data obtained have been appearing in the engineering literature(2,3,4).

At the moment we are faced not only with a lack of extensive data on supersonic heat-transfer coefficients but also with a scarcity of information on the nature of the boundary layer, on the effects of transition, on the effects of a pressure gradient and on the effects of free stream turbulence. Nevertheless it has been possible to examine roughly on paper the effects of aerodynamic heating for a few simple wing geometries(1).

To bring home the effects of aerodynamic heating on a simple structure over a limited range of Mach numbers, a few of the results of Reference 1 will be given. Here the transient temperature distribution was calculated for a "diamond" or double wedge-shaped wing, accelerated at 1 g from an initial flight Mach number of 1.4 to a final flight Mach number of 6. The results are shown schematically in Figures 3 and 4. For the conditions calculated, the maximum temperature—about 2,200°F—occurs at the leading and trailing edges of the wing and is equal to the adiabatic wall temperature at a Mach number of 6. In addition, we note from Figure 4 that as the acceleration is continued from Mach 3 to 6, the temperature distribution is not uniform, and large thermal stresses appear in this wing, possibly causing the leading edge to buckle.

Since the initial temperature of this wing is roughly 80°F, it is evident from Figure 4 that its central portion is not much above 80°F when a Mach number of 6 is reached. If the wing were then flown steadily at this speed for a long time without cooling, the temperature distribution would be uniform at a value of about 2,200°F.

It is immediately apparent that for relatively short flights in supersonic missiles or aircraft, the transient characteristic of the heat flow at supersonic speeds is the important item. It is expected that in such cases relatively simple, light, and cheap means could be used to protect the aircraft—thermal-lag effects, non-cyclic refrigeration devices, etc. On the other hand, it is apparent that for sustained flight at supersonic speeds above Mach numbers of four or five the cooling devices needed to protect the aircraft and its contents probably would be larger, heavier, costlier and more complex.

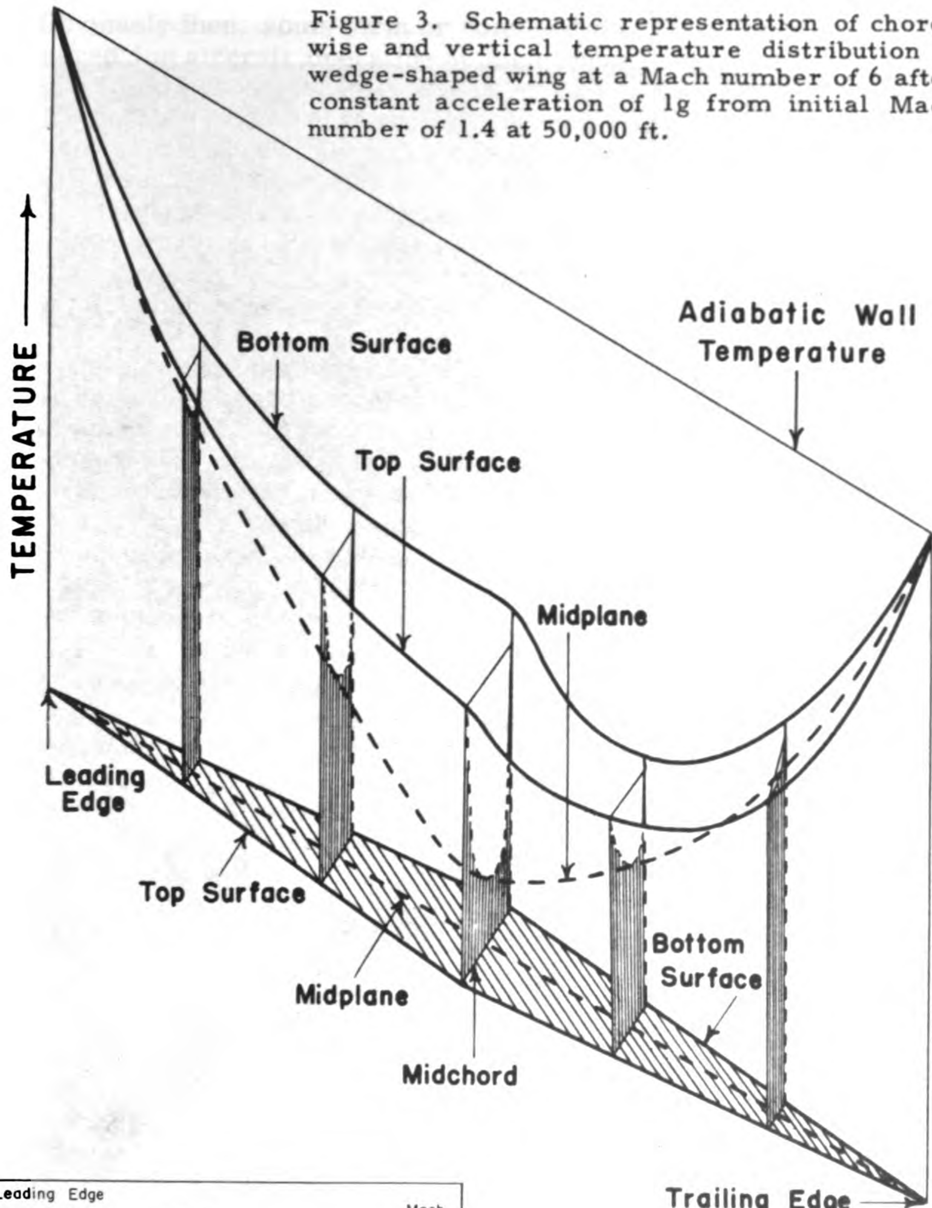

Figure 3. Schematic representation of chordwise and vertical temperature distribution in wedge-shaped wing at a Mach number of 6 after constant acceleration of 1g from initial Mach number of 1.4 at 50,000 ft.

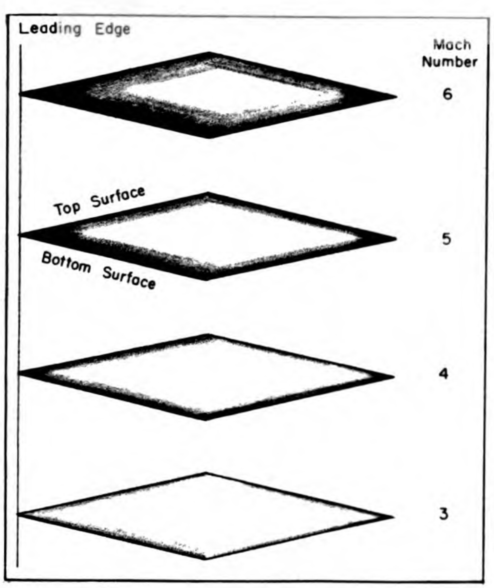

Figure 4. Schematic representation of temperature distribution in wedge-shaped wing at several mach numbers after constant acceleration of 1 g from initial Mach number of 1.4 at 50,000 feet. Darker areas indicate higher temperatures. Wing thickness is greatly exaggerated.

Figure 5. Here the supersonic Douglas Skyrocket (see cover) takes off under its own power. It can do this only when a jet engine has been installed; normally it is powered by rockets. Its top speed is secret. The type of take-off shown here has the disadvantage of sharply limiting the range of the Skyrocket.

Obviously then, some form or combination of cooling devices will be required for aircraft operating at high supersonic speeds for long periods of time. It is not clear whether customary refrigeration units, which normally operate over a fairly narrow range of temperatures, can be used for aircraft. First, the temperature range is huge in the thermal problems considered here. Second, the performance of the normal refrigeration unit decreases rapidly as this temperature range increases. In addition, the weight and volume of the normal refrigerators would be extremely large to carry out safely the cooling requirements at the supersonic speeds involved.

It appears that the intensity of the thermal problems has created the need for an unbiased approach to the entire problem of cooling the supersonic aircraft. In fact, it no longer seems permissible to subdivide the design into parcels and hope they will work when combined by some compromise agreement. It is clear that another approach is to design a "power plant" which combines the over-all functions of propulsion, of heating, of cooling, and of auxiliary power production. Surely such a "centralized" power package would insure that the aircraft could safely sustain supersonic flight for a given duration.

The need for an unbiased approach to the problem is also seen on examination of the cooling requirements of some of the electronic and electrical gear. If there is heat dissipation in this equipment, there is usually an upper safe allowable temperature. The gear is usually kept below this maximum temperature by heat transfer to the cooler surrounding atmosphere. But at the high supersonic speeds, the ambient temperature may well exceed the safe limit, and so the gear must be cooled by a "refrigeration" device. The cooling requirements of the contents of the plane alone, then, may be considerable.

This situation may be alleviated in two ways. First the cooling requirements of the individual pieces of electrical gear can be incorporated into the scheme of a centralized power and cooling package. Secondly, a new concept of electrical equipment design will help: making the original design not only with the electrical requirements in mind but also with the aim of removing easily the heat to be dissipated electrically. This combined process may yield enormous premiums in the reduction of both weight and size of ordinary electrical gear. For example, it has been stated recently[1] that by proper application of cooling in the original design of electronic equipment, the weight and volume of systems and components have been reduced by a factor of three, while still permitting safe operation at high altitudes.

All these considerations mean that we have a long way to go before long flights at five or ten times the speed of sound will be within the realm of possibility. Even so we can at least feel encouraged that many of the problems are clearly defined and that further research promises to render some of them much less formidable. There is every reason to believe that the next few years will see great progress in the field of supersonic flight.

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[1]by Mr. L. Katz, at the January, 1952 Annual Meeting of the Institute of Aeronautical Sciences.

BIBLIOGRAPHY

1. Kaye, J., "The Transient Temperature Distribution in a Wing Flying at Supersonic Speeds", J. Aero. Sciences, 17, No. 12, 787-808 (1950)

2. Kaye, J., J. H. Keenan, and W. H. McAdams, "Report of Progress on Measurements of Friction Coefficients, Recovery Factors, and Heat Transfer Coefficients for Supersonic Flow of Air in a Pipe", Heat Transfer and Fluid Mechanics Institute, 147-164, June 1949

3. Kaye, J., J. H. Keenan, K. K. Klingensmith, G. M. Ketchum, and T. Y. Toong, "Measurement of Recovery Factors and Friction Coefficients for Supersonic Flow of Air in a Tube, Part I - Apparatus, Data and Results Based on a Simple One-Dimensional Flow Model", presented at Annual Meeting of ASME, Nov. 1951

4. Kaye, J., T. Y. Toong, and R. H. Shoulberg, "Measurement of Recovery Factors and Friction Coefficients for Supersonic Flow of Air in a Tube, Part II - Results Based on A Two-Dimensional Flow Model for Entrance Region", presented at Annual Meeting of ASME, Nov. 1951

Air Cannon More Effective as Result of NRL-Developed Lubrication System

Many an aviator flying in the dangerous air over Korea may owe his life eventually to a new lubrication system developed by the Naval Research Laboratory (of ONR). The new system will prevent jamming when it is necessary to fire 20-mm M3 automatic aircraft cannon in severely cold weather or at very high altitudes.

During the winter of 1950-51 these guns frequently jammed because the petroleum lubricants then in use solidified when the temperature dropped to -20° or lower. Even in summer, temperatures in this range are often encountered at altitudes above 30,000 ft.

Four synthetic lubricants make up the new system: (1) a light oil for the gun mechanism itself; (2) a lubricant for the ammunition; (3) a water-repellent lubricant for the electric trigger; and (4) a grease for the mechanism that automatically feeds the ammunition to the gun. Use of the "tailor-made" lubricants has permitted nearly constant rates of firing the cannon at temperatures from 150°F above zero to 70°F below (without the need for the auxiliary heater previously required).

Actually only two of the lubricants are required for periodic maintenance of the 20-mm cannon: the light oil for the gun mechanism and the lubricant for the ammunition. A few drops of lubricant on the electric trigger and a single greasing of the automatic feeder are normally good for the lifetime of the gun. In addition to providing improved lubrication and simplified maintenance, the new lubricant system will stand up better in storage—another important military advantage.

Although the new lubricant system was developed specifically for military application, the light oil in particular is believed to have excellent potentialities for use in sportsmen's rifles and guns.

Once NRL scientists got started on the problem, it took them only six months to perfect the new lubricant system to a point where it could be used in Korea. The development was under the direction of Dr. W. A. Zisman, Head of the Lubrication Branch of NRL's Chemistry Division.

Cathodic Protection of Ships

A Staff-written Article[1]

Ever since the builders of ocean-going ships began using metal sheathing below the water line, they have been aware of an annoying type of corrosion. Even copper, which won't "rust" in fresh water or air, deteriorated on salt-water vessels. When iron hulls came into use—particularly steamships with bronze propellers—corrosion became a critical problem. Back about 125 years ago Sir Humphry Davy analyzed the difficulty as "electrolytic" corrosion: The floating ships were acting as giant storage batteries and the corrosion was a result of galvanic action.

Anyone with a knowledge of elementary physics knows that if two electrically connected metals are immersed in an electrolyte, the more reactive metal becomes the anode and the less reactive metal the cathode of a voltaic cell. If the difference in electrical potential is great enough, current flows and is accompanied by electrochemical reactions at the electrodes: oxidation at the anode, and reduction at the cathode. The oxidation at the anode usually results in the dissolution of the anode metal. On ships, corrosion is usually most evident around the stern, on the propeller shafts and struts, and on the rudder; i.e., on the parts nearest the bronze propellers. In this case the propeller is the cathode and the steel ship's parts form the anodes; the salt water is, of course, the electrolyte.

Although the problem of electrolytic corrosion of ships has been recognized for many years, it has acquired some new angles since the beginning of the last war. The necessity for operating whole fleets for months and even years at vast distances from docking facilities, the operation of long-range snorkel submarines which can stay under water for weeks on transoceanic forays, and now the problem of taking care of thousands of "mothball" ships in floating storage have pointed out to the Navy that the subject of anticorrosion must be tackled with new emphasis and greater discernment. Ideally, one would like a single system capable of preventing corrosion of ships both in floating storage and in motion, so that "mothballed ships" would be ready for activation at all times without need for costly and time-consuming drydockings to overhaul corroded bottoms.

There are two classic approaches to the prevention of electrolytic corrosion of ships. The one originated by Sir Humphry Davy is to use one or more "sacrificial anodes." These are plates or strips of a metal (zinc, commonly) that corrodes more readily than other hull or appendage material, bolted or riveted to the hull at places where corrosion is most likely to occur. The idea is that these plates will then become the anodes, and the hull or shafting will become the cathode of an electrolytic cell. The anodes corrode and the cathode is protected—hence the term "cathodic protection" (see Figures 1 and 2). A more modern use

[1]The material contained in this article was previously published as a report of the Metallurgy Division, Naval Research Laboratory.

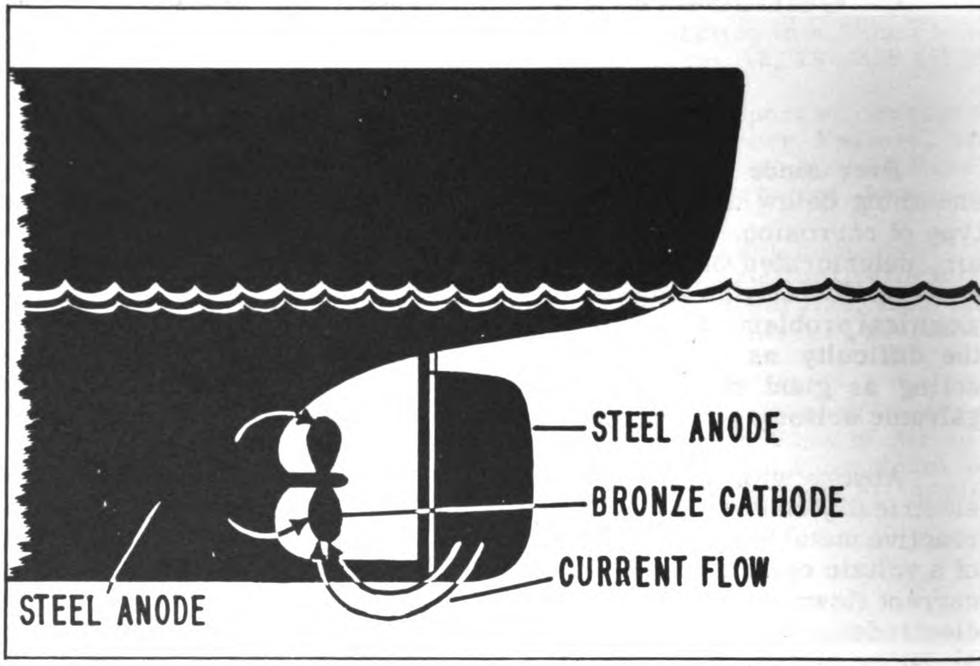


Figure 1. Current flow on unprotected ship; steel anodes corrode.

of the same principle is to suspend electrodes in the sea-water and to make the ship a cathode by impressing current between the electrode and the ship with a battery or some other appropriate direct-current source (Figure 3).

The other approach has been to try to insulate the ship's hull and appendages from the electrolyte—that is, to cover the underbody with a waterproof and nonconducting coating such as paint.

Before World War II very little attention was given to the improvement of cathodic protection systems, although work on the improvement of coating systems was vigorously pursued. By 1943, however, it became obvious that every possible step must be taken to lengthen the period between drydockings, so the Bureau of Ships asked the Naval Research Laboratory to investigate cathodic protection. The work there aroused considerable doubt as to whether the zinc systems then in use were really much good.

It must be realized that the electrolytic cell previously described depends on anode and cathode being in effective contact with the electrolyte, in this case sea water. It was found that the zinc anodes in use at that time tended to acquire insulating films by reaction with sea water, thus destroying their protective action. Sometimes the same undesirable effect resulted from painting of the zinc by uninformed dockyard workers. What can happen to supposedly protected ships is graphically illustrated by Figure 4.

The current cathodic-protection program includes both the sacrificial-anode principle and the use of impressed-current anodes. The first may prove the more desirable in some instances because of

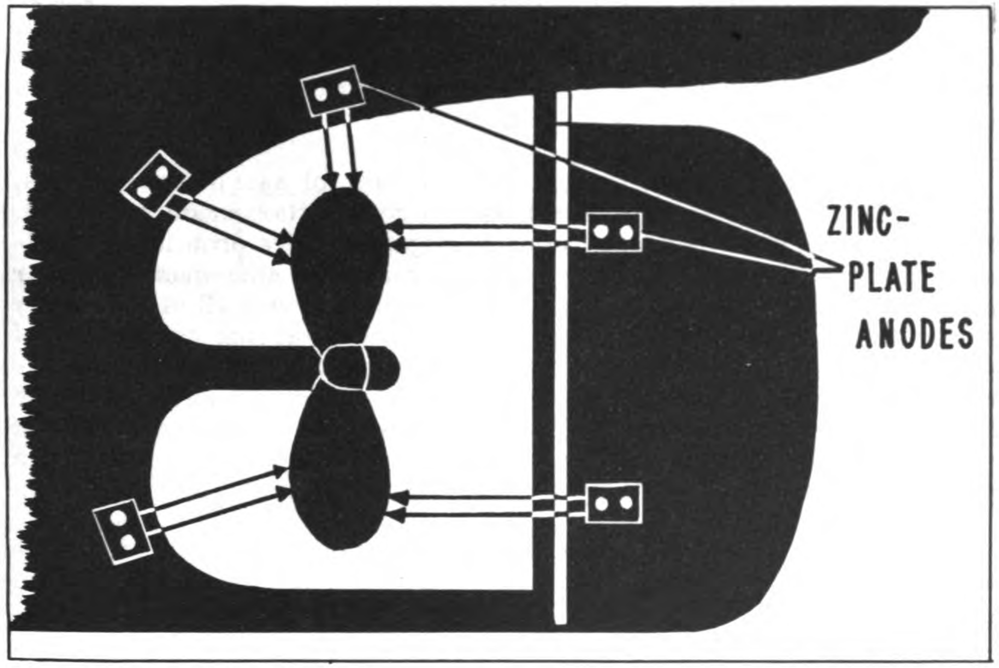


Figure 2. Current flow from sacrificial anodes; steel is unharmed.

its simplicity; the second, due to its flexibility, may be so effective (and possibly less expensive for large vessels) that its widespread use will be indicated. To gain a greater insight into each method—perhaps to erase many of the question marks that are now in the literature—the Naval Research Laboratory has set up a comprehensive schedule of projects, some of which are already in progress. The research workers have been promised the wholehearted support of the Bureau of Ships and the Bureau of Yards and Docks. The two bureaus are already providing Reserve Fleet ships, dock space and the use of yard facilities and personnel.

Modern corrosion theory indicates that the key to effective cathodic protection is the maintenance of a critical potential difference between metal and solution, the value of which depends upon the nature of the metal and the character of the solution. Tests by corrosion engineers have indicated that the maintenance of this critical potential will halt corrosion in sea water. Under ideal conditions, i.e., water of sufficient salinity, hull paint in good shape, low ship speed, and electrodes free of insulating films, commercial-quality zinc does the trick for a short space of time by simple galvanic action. Under the varying conditions of ship operation however, or over periods of greater than 6 to 8 weeks, zinc seems to lose its effectiveness. In some cases the water may have

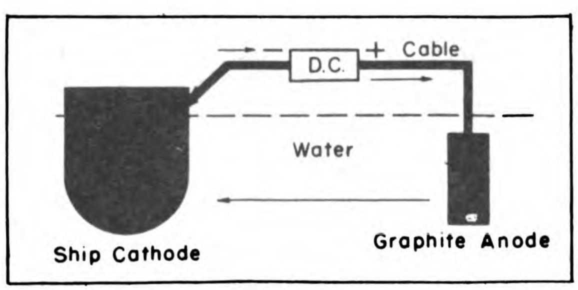
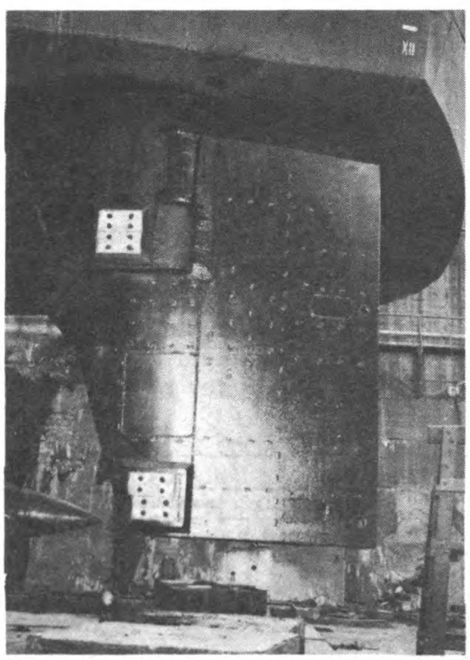


Figure 3. Impressed-current anode principle.

too high an electrical resistivity because it is only brackish and not truly saline, resulting in a decrease in protective current from anode to ship and adversely affecting the maintenance of the desired potential. High speed not only tends to scale away paint and other protective coatings but also adversely increases (by churning action) the oxygen content of the water near the propellers.

In applying cathodic protection by means of sacrificial anodes, one of the first lines of research is to find a better anode material. Special high-purity zincs have been investigated. More promising, however, is magnesium, which—being more reactive than zinc—has a greater potential difference in relation to steel or bronze. When all of the likely materials have been exhaustively tested under varying conditions of water salinity and against different structural metals, perhaps the optimum anode material can be determined. The study also must include the best distribution of anodes on shipboard, and the efficacy of different varieties of bottom paints to be used in conjunction with the cathodic protection system (Figure 5).

In the case of impressed current anodes particularly, the possibilities of control are such that ideal corrosion protection can be the goal. With an automatic control on the direct-current generator-rectifier, or other source of impressed current it should be possible to maintain the optimum hull potential. Such control is critical, for a lower potential reduces the effectiveness of the protection, while higher potentials might give currents which would tend to peel or strip away the bottom paint. The control should also, if possible, be able to compensate for any random electrical potentials present in the water (due to grounded electrical circuits, etc.) or for changes in the resistivity of



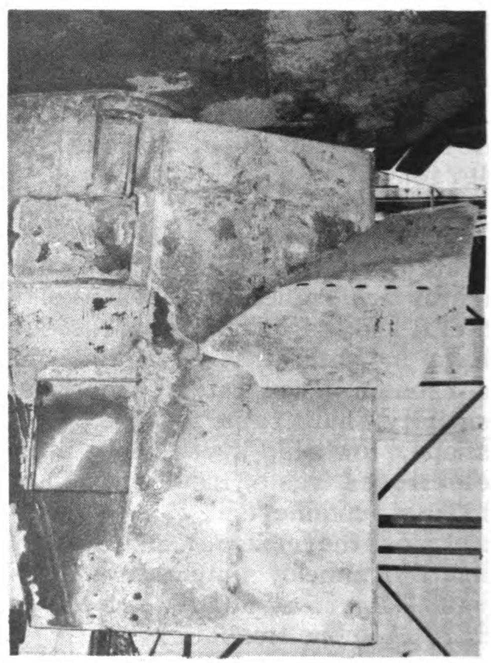


Figure 4. "Before and after" photographs of destroyer rudders supposedly protected by zinc plates. Note the torn ship-plating and the complete loss of the zinc anodes. The time of immersion was about two years.

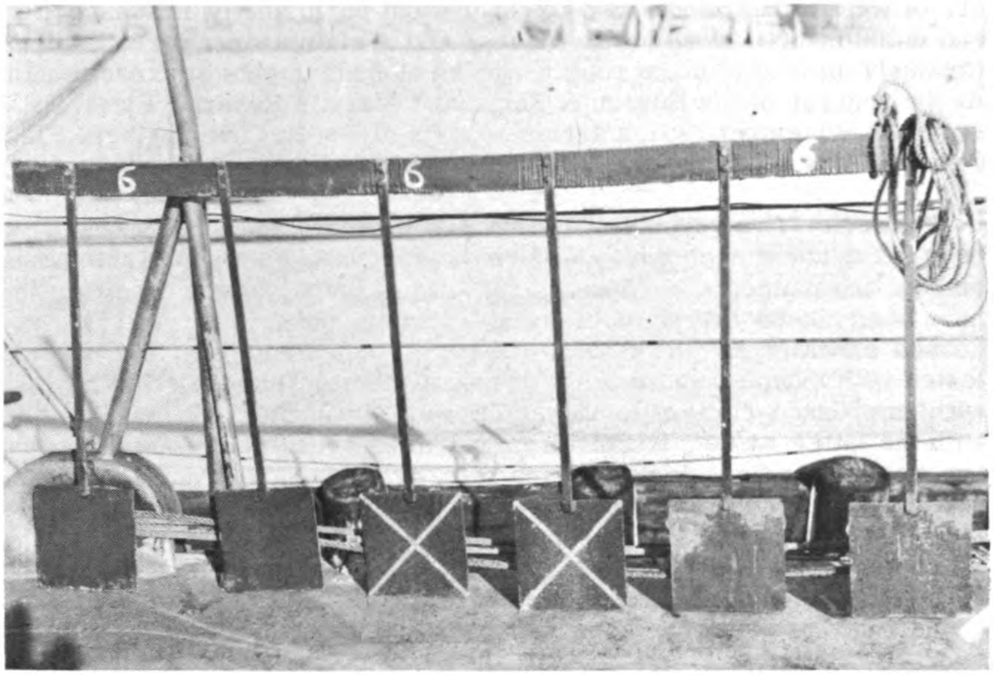


Figure 5. Test panels: left pair painted; middle pair painted, except for cross; right pair unpainted.

the water. Despite the rather elaborate equipment which may be required for obtaining such exact potential control, a system of this type would appear to offer great promise. Impressed current systems have been successfully used by oil companies for the protection of underground pipelines and the Canadians have recently tested an impressed current system—with apparent success—on some experimental ocean-going vessels.

The problems which must be considered in connection with impressed current anodes for cathodic protection are many. What is the best material for use as anodes? Where should the anodes be located in relation to the hull for (a) ships anchored in reserve, and (b) ships in actual operation? What is the optimum potential and current for any particular ship? How will the necessary dc supply be operated and controlled? What effect will a ship's speed have on optimum potential and current requirements?

Before either of the two methods of cathodic protection can be recommended, a number of practical answers must be given. Which of the two would be better in terms of economical installation or long life? (For instance, the galvanic anodes now in use are much simpler to install but they last only a year or two as opposed to about seven years for the available graphite anodes.) What effect will these systems have on the bottom paints now used, and what effect will they have, if any, on the inhibition of marine fouling? How much of the hull will be protected and how long will the protection be effective; i.e., will it lengthen the time between required drydockings?

The existence of a large number of immobilized vessels—the "mothball fleet"—provides a choice opportunity for full-scale field tests.

These ships are dispersed to many harbors and inlets, offering a variety of water conditions; they are hauled out periodically for inspection and maintenance at nearby drydocks, and a maintenance force is continuously on hand to make routine checks of instruments or experiments. At the request of the Bureau of Ships and Atlantic Reserve Fleet, NRL began, in September 1951, a series of tests at Green Cove Springs, Fla., Orange, Texas, Charleston, S. C., and Norfolk, Va.

Four or five vessels, varying in size from LSM's to APA's have been set aside at each site. All have been drydocked; some were sandblasted and painted; others are being used in their present condition; all have been placed low on mobilization-priority lists. They will be drydocked annually for inspection. Of the 18 selected ships, 5 are being tested with magnesium anodes (galvanic protection) and the remaining 13 with impressed-current anodes. The larger number are being tested with the latter system because several different methods of emplacing the steel and graphite anodes are being tried, and because the water-conductivity is so low at some fleet sites that use of magnesium anodes is not feasible. In most cases, the hulls are berthed singly with the anodes suspended just clear of the hull, or buried in the mud under the ships. However, at Orange, Texas, four ATF's are being tested as a group with the anodes laid on the harbor bottom, 400 feet away from the ships.

Ordinarily, the impressed-current anodes are 60-inch graphite rods 3 inches in diameter. In some cases steel cable is being used as an anode, largely because a sufficient quantity of scrap cable is available at the test site. The power supply is either from the ship's lighting circuit or from a shore source, rectified to a dc output that is variable over the range of voltages needed. In preliminary work, the ship-to-water potential is being manually controlled (Figure 6 and back cover).

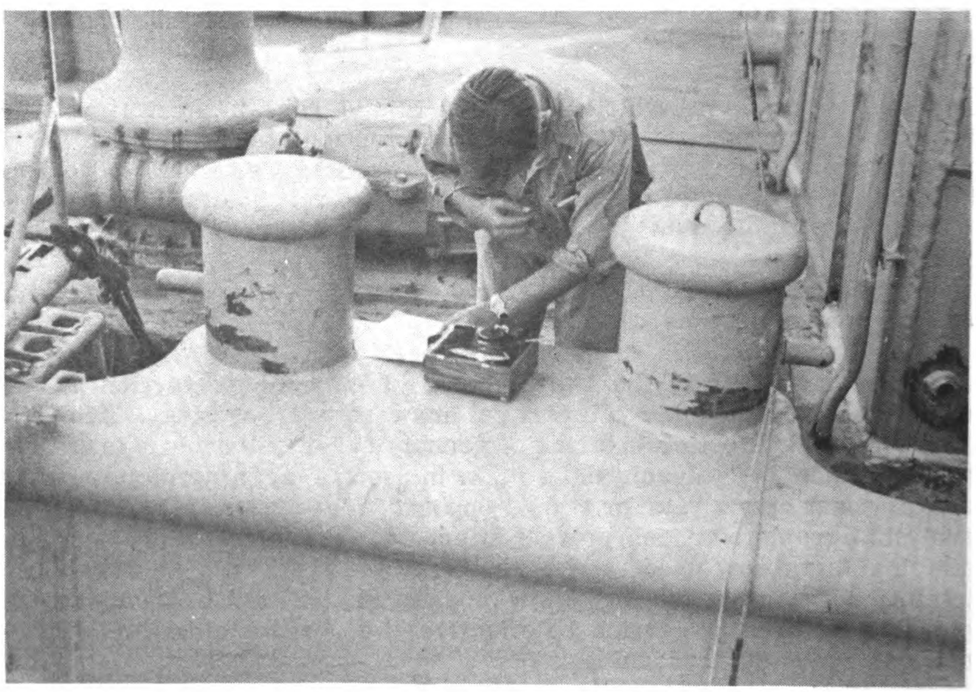


Figure 6. Taking potential difference measurements at Orange, Tex.

Figure 7. Attaching electrical cables to impressed-current electrodes. These graphite rods will be buried in the mud some 400 ft from the ship.

The information which will be gained by the Reserve Fleet program is insufficient for the specification of adequate systems on moving vessels for the following reasons: (1) protective systems for moving vessels must avoid mechanical hindrance of the ship's motion, and (2) movement of the ship and its accompanying effects induce potential changes between the ship and the water which are not completely understood, and which must be considered in the design of the protective system. Preliminary tests on a division of destroyers have raised a number of questions regarding requirements for cathodic protection on moving ships. A program of study designed to clarify the effects of ship motion upon potential distribution and consequent demands upon cathodic systems is now under way. The Coast Guard has provided a small vessel which will be equipped with flexible cathodic protection systems and measuring devices for such studies.

Additional special problems regarding the protection of submarines and tankers are also to be investigated.

The present Reserve Fleet phase of the research, including field tests, is programmed to cover a space of three years. From this limited project, it is expected that a system can be evolved that will provide protection for the whole Reserve Fleet. Meanwhile, a concurrent laboratory project is directed toward the protection of operational ships. The whole program, it is hoped, will confirm existing theories to the extent of providing an optimum single system which will protect a ship at anchor or in active service.

More effective anticorrosion protection is immediately translatable into dollars and cents. It costs approximately $30,000 just to drydock and sandblast a medium-sized vessel. In contrast, the expense for initial installation of impressed-current anodes, for instance, has been estimated at about $100 per ship and the annual consumption of current is negligible—say about $10. If the interval between necessary drydockings can be extended even for one year, the saving for the hundreds of government-maintained vessels will be enormous.

ONR Research Results in New Use of Underwater Sound in Search and Rescue Work

A natural channel deep in the ocean which allows underwater sounds to be picked up more than 3,000 miles away may provide the Navy with a "private line" for use in locating ships, planes and people in distress on the seas. The Navy recently acquired basic patent rights to the new development (an outgrowth of work by Dr. Maurice Ewing, ONR investigator at Columbia) which is called SOFAR, initials for "sound fixing and ranging".

If SOFAR is adopted for search and rescue work liferafts and aircraft will be equipped with small bombs. Dropped overboard, these bombs will sink to proper water depths and explode. Sound waves thus released will be picked up by Navy SOFAR stations and positions of craft will be determined by triangulation.

Dr. Ewing discovered the possibility of adapting SOFAR to these purposes while working on submarine detecting methods under a Navy contract at the Woods Hole Oceanographic Institution. He developed the principles and equipment used after discovering the existence of a natural sound channel located some 4,200 ft below the surface of the Atlantic and somewhat higher in the Pacific.

The reasons for the existence of such a channel are fairly simple. Sound waves bend toward the region where they have the lowest velocity. Under water this velocity is affected by both temperature and pressure (the higher the temperature and pressure, the faster sound travels). At depths above 4,200 ft in the Atlantic the temperature factor is dominant. Thus, sound waves in that area bend downward toward the lower temperatures, where they will travel more slowly. At depths below 4,200 ft the pressure factor is dominant and sound waves at these depths bend upward. Thus, at 4,200 ft the pressure and temperature factors create a region of minimum sound velocity. A large part of any sound originating at this depth is therefore carried along the channel for great distances without hitting the ocean surface or bottom. It thus avoids high losses due to reflection, absorption and scattering.

Tests are under way in the Pacific to test the practicality of using SOFAR in search and rescue operations. By June the Navy should know whether or not it has one more valuable tool to use in salvaging endangered men and equipment.

Who's Who in Naval Research

There is probably no such thing as an "indispensable" man but CAPT Charles Wesley Shilling's contribution to Navy medicine and research has been such that the word seems disconcertingly appropriate. Perhaps that is why he is now assigned to two highly essential posts—that of Special Assistant for the Bio Sciences at ONR and Director of the Research Division, Bureau of Medicine and Surgery.

Each job might be considered full-time in itself, but CAPT Shilling, with a twinkle in his eye says, "Oh it's not so bad; it's really just a matter of making decisions." Actually a huge amount of work and responsibility are involved in making these decisions, for they guide the Navy's whole program of biological and psychological research which, in turn, affects the health and security of countless Americans, both in and out of the Armed Forces.

When CAPT Shilling started out he thought he was going to be a civilian doctor. After graduating from Taylor University (where his father was acting President and his mother still resides), CAPT Shilling obtained his medical degree at the University of Michigan. But his fine record enabled him to win a commissioned internship at the Naval Hospital in Chelsea, Mass. And by the time he had finished this apprenticeship he had decided to make the Naval service his career, a road that has, in the intervening years, brought him to the top in Navy Medicine.

At the outset his tours were routine enough—a session at the Harvard School of Public Health and ship's-doctor billets at the Boston Navy Yard and in the CAMDEN—but then he got into a specialty that is unique even in these days of specialization: submarine rescue work. The first assignment was medical officer for the experimental submarine S-4, a detail that was mostly research on safety, salvage and escape equipment. Then he was designated medical officer in charge of escape training at the New London submarine base. For six months, in addition to other duties, he made a close and detailed study of all reported submarine accidents. This so interested the Navy that he was sent back to Harvard to continue his research at the School of Public Health.

CAPT Shilling's next tour involved adventure of a rather unusual sort of which, incidentally, he is rather proud: he was attached to the Experimental Diving Unit at the Washington Navy Yard and graduated from the Deep Sea Diving School. This was, in fact, practically a necessity for the satisfactory discharge of his duties, which included research on diving tables and "lung" training techniques in connection with submarine escape. By this time CAPT Shilling was well on his way to being a top authority on submarine medicine and the clincher was added when his next duty took him to Coca Sola, C. Z., where he rode the submarines and cared for their personnel. He was soon back in a laboratory, however, again at the Submarine Base in New London Conn., where, as medical officer, he initiated and organized an extensive research program which became officially the Medical Research Laboratory.

The Captain's unique knowledge was put to dramatic use in 1940 when he served as Senior Medical Officer in the rescue of the crew of the stricken submarine USS SQUALUS. He stood by while 33 men were snatched from a 40-fathom bottom, keeping an expert eye on their health and that of the divers bringing them up. In this connection the words of RADM Lamont Pugh are very illuminating: "....when a submarine is lying on the bottom of the ocean with a crew of human beings aboard the kind of expert knowledge on which their salvation may well depend is possessed by an extremely small number of doctors". That Captain Shilling was the kind of doctor Admiral Pugh was referring to is documented by Nat A. Barrows who wrote the Story of the Squalus under the title "Blow All Ballast" and who autographed the book to Captain Shilling with the remarks: "To one who helped to make the Squalus rescue a success - both long before it happened and at the Isles of Shoal, Lieutenant Commander C. W. Shilling (MC) USN, whose research and experiments have added such great benefits to the science of deep sea diving."

This, then, was the record of the officer who, in 1947, came to the Office of Naval Research to direct research in the Biological Sciences Division. Later he became Special Assistant for the Bio Sciences and last fall took on the additional duties of directing BuMed's Research Division, which has cognizance of all naval medical research laboratories under the management of the Bureau. As a result, CAPT Shilling's day is now crowded with interviews with everybody from high-ranking military men from all the Armed Forces to civilian scientists and industrial representatives, while his evenings of late, he admits, have seen him burning the midnight oil. All this obviously adds up to plenty of headaches but so far no one has heard the Captain yelling for the aspirin. Actually he is well equipped temperamentally for such a schedule. In addition to plenty of vitality and enthusiasm for his work, he combines a talent for plain speaking with unpretentious friendliness that does much to expedite work involving constant personal contacts.

With this type of schedule it seems ridiculous to speculate about what CAPT Shilling does with his "spare" time. It turns out, however, that though he has cut down on his favorite outdoor hobby, gardening, he has managed such diverse activities as service on the Board of Stewards of the Mt. Olivet Methodist Church (where he sings tenor in the choir), collecting coins, and membership in the Cosmos Club. These activities plus his family (besides his wife he has a married daughter and a medical student son) just about account for the Captain's out-of-the-office time. All in all, it sounds like a busy life, and certainly to the Navy, a very useful one.

Trypanosomes in Test Tubes

by

E. R. Noble, W. L. McRary and Elsye Tondevold
Santa Barbara College, University of California

A large blood-sucking bug is responsible for a major health menace in central South America and southern Mexico. This insect, known as the "Kissing" or, a bit more appropriately, as the "Assassin" bug (Figure 1A) transmits from one human being to another a dangerous, frequently fatal malady known as "Chagas' Disease". When the creature sucks a meal of human blood it defecates on the skin. This drop of feces may contain infective stages of a microscopic parasite called a trypanosome (Figure 1B) which is generally rubbed into the tiny wound made by the bug's mouth by the act of brushing him away.

Once in the skin the parasites begin to multiply and are quickly carried to all parts of the body by the circulatory system. In such organs as the spleen, liver, and heart muscle the trypanosomes reproduce themselves in great numbers at the expense of the host cells. Then they migrate into the blood and may be seen in blood smears obtained from a punctured ear lobe or finger tip.[1]

Chagas' Disease cannot be controlled by drugs because no remedy has been discovered which will consistently cure it. The disease is frequently fatal in a short time as a result of damage to internal organs or it may continue as a chronic condition for years before death. It is particularly common in children, who are relatively more susceptible to infection (Figure 2).

One way to attack the problem of control is simply to test patients with a selection of drugs in the hope that one of them may, by chance, be the answer. Another way is to grow the trypanosomes in test tubes or in flasks and then to try the drugs directly on the parasites. Yet even if the parasites are killed by a certain drug in a test tube they are not necessarily killed by that same drug in the body of a patient. Evaluation of a drug that works in the test tube has to be made in experimental animals and later in infected human beings.

Elmer R. Noble (Ph.D. University of California) is Professor of Zoology and Dean of the Division of Liberal Arts at Santa Barbara College.

Willard L. McRary (Ph.D. California Institute of Technology) is Associate Professor of Chemistry at Santa Barbara College. Previously he was Associate Physiologist, Bureau of Plant Industry, United States Department of Agriculture.

Elsye L. Tondevold (A.B. in Bacteriology, University of California at Los Angeles) is a research assistant under O.N.R. contract.

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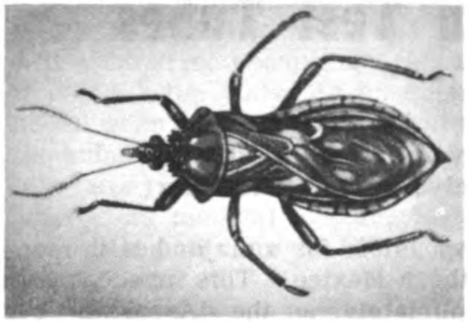
[1] The organisms are named Trypanosoma cruzi after Oswaldo Cruz, the scientist who first observed them in the blood of infected Brazilian natives.



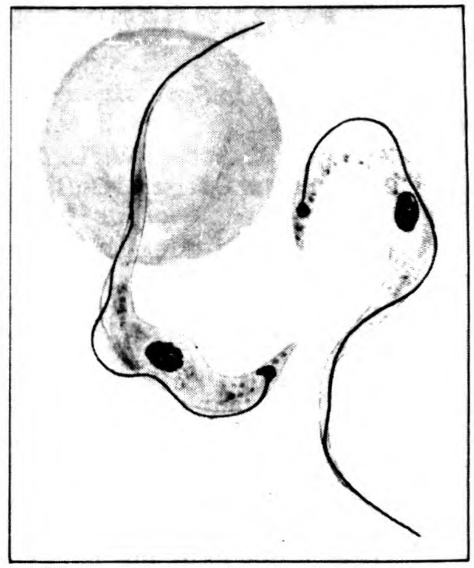


Figure 1A (above): The so-called "Assassin" bug, which usually attacks victims about the face at night. The pointed beak is folded vertically when insect is at rest, and is moved vertically when a meal of blood is taken. During the daytime they frequently hide in native huts. 1B (right): Two mature Trypanosoma cruzi, as found in the circulating blood of man. Red blood cell is added for comparison. (Figures 1A and 2 are reprinted from the Sharpe and Dohme, Inc., Seminar by special permission.)

Another approach to the problem is through a study of the nutritional requirements of the parasites. Such a study is more fundamental than the other two mentioned above. If we could know exactly what is needed to support their growth, we would have a sound basis on which to determine the conditions or substances necessary to stop their growth, and thereby to eliminate them and cure the disease. We are able to grow the trypanosomes very easily in a test tube containing, in addition to certain basal nutrients, a small amount of whole blood from rabbits or man. By elimination, it has been established that hemoglobin appears to be the only one of the numerous blood components essential for the growth of the parasites in the presence of sugar, salt, and meat digest. Furthermore, hemoglobin in its native state is not quite suitable, but is rendered active simply by being heated to the point of coagulation. The nature of the subtle physico-chemical changes induced by the heating process is not well understood. In the body of the host animal, blood serum, instead of heating, may activate the hemoglobin. Vitamin C also gives some evidence of being capable of doing the same thing in test tube experiments. Some common factor doubtless underlies these seemingly unrelated observations, the clarification of which will throw light on the metabolism of the parasite, and possibly even give clues to fundamental life processes.

Figure 2. Characteristic clinical appearance of patient ill of Chagas' Disease. Note facial swelling, particularly puffiness of eyelids and associated conjunctivitis.

Related to the hemoglobin problem is another aspect of the nutrition of trypanosomes, namely the question of additional food requirements supplied by the meat digest used in the culture medium. Progress along these lines has been made and is being continued by various investigators. This study takes the form of numerous trials of salts, amino acids, vitamins, and other biochemicals important in cellular metabolism. Each mixture of up to 50 separate components must, before its promise can be assessed, be subjected to trials which may require months. Eventually it is hoped to obtain a completely synthetic medium which will support growth of the parasites as well as does the meat extract.

Knowledge gained from the use of such culture media could be applied to problems pertaining to related parasites which cause African Sleeping Sickness, Oriental Sore, Kala Azar, and similar diseases. Such knowledge is also of value for its own sake, for it adds to our information on the physiology of living cells, and on the relations between a parasite and its host.

We mentioned above the possibility of subjecting parasites in test tubes to drugs. The many recently discovered antibiotics seemed to us a promising field for investigation, especially since one or two other workers had already made a hopeful start in this direction. Accordingly, we obtained several antibiotics[2] and administered them in varying concentrations to test tube cultures of our trypanosomes. Of the biologicals tested only prodigiosin showed promise. It was effective at exceedingly low concentrations, such as one part in 100,000. This antibiotic thus appears worthy of further study to determine if it is also effective against the disease in experimental animals and in man.

Our investigations represent a double-barreled attack, fundamental and applied, on a disease of great potential importance not only to civilians of the Western Hemisphere but to the U. S. Navy as well. In the Southwestern United States, for example, the area of our own country where the "Kissing" bug is found, military personnel on bivouac should take precautions against infection. Scientists believe that improved diagnostic techniques would reveal numerous cases of Chagas' Disease there, for conditions are right for spread of the malady. Eventually we hope that studies like those we are carrying on at Santa Barbara will disclose an effective point of attack on this dangerous illness and thus bring one more human affliction under control.

[2]Terramycin, bacitracin, subtilin, aureomycin, chloromycetin, prodigiosin, polymixin B and E, fumagillin and neomycin were used.

Correction on "Noise Deafness"

An error occurred in numbering the illustrations for "Noise and Deafness", an article by Drs. W. D. Neff and S. E. Lindquist which appeared in April. The editors renumbered the figures which accompanied the manuscript, and did not make corresponding alterations in the text. Thus, the graphs referred to in the text as 3 and 4 actually appeared as 2a and 2b; those referred to as 5 and 6 appeared as 4 and 5; and the photographs which, in the article, are called Figure 7 appear as Figure 6 (there is no Figure 7). The editors regret the error, which was their mistake and not the fault of the authors. A corrected reprint is available.

On the Naval Research Reserve

VNRRU 1-1's Activities Last Summer Recommended as Model for Other units

Now that summer is in sight, many reserve units may want to emulate the civil defense program carried on last year during the warm weather by VNRRU 1-1 in Boston. The unit's usual activities—regular drills at MIT and lectures by guest speakers from universities in the area—were feasible only during the academic year. When summer came, instead of slackening up, members of the group resolved to follow the suggestion of the Chief of Naval Research and find means of cooperating with the local civil defense set-up. They decided that a series of trips to see the city's facilities for dealing with emergencies would help them acquire a better understanding of the problems involved and the means for solving them.

In setting up this program, the interests and backgrounds of the research reservists were kept in mind. For example, they are interested in communications of all types, so arrangements were made to visit the Boston Fire Alarm Headquarters, the Boston Police Headquarters, the New England Telephone and Telegraph Company and an electrical substation of the Metropolitan Transit Authority. The visits were scheduled to commence at seven P.M. so that the two-hour drill could be completed before darkness.

On the first visit, to the Boston Fire Alarm Headquarters, the group learned that Boston had the first such alarm system in the United States. It was a mechanical set-up and was established in Boston City Hall just one hundred years ago. The present headquarters at 59 the Fenway was established in 1925. The Fire Department has kept abreast of changes in communications and has a very up-to-date and efficient alarm system.

The operation of this facility reminds a navy man of operations in a Combat Information Center or a Damage Control Center aboard ship. Fire alarms, either phoned in or received on the alarm system, initiate a very complex process, one entirely unknown to the average citizen. When a fire box is pulled, a relay for it is activated in headquarters, setting off an alarm similar to General Quarters aboard ship. Since hundreds of these box relays are located in this station, the relays are arranged in banks, and when a relay is activated, a light on the top of the bank flashes signalling the duty operators. The attendant checks the bank, calls out the number of the box, and the relay is reset. The number is then placed on the system and department radio to notify all department stations and vehicles. The apparatus responds to various box numbers according to a prearranged procedure. In the case of an alarm that is phoned in, the telephone operator notes the location of the fire, and the number of the box closest to it is then sent out on the system and radio, and the stations respond as if to a regular alarm.

After the alarm is sent out, a red disc is placed on a large map which has the location and number of all fire boxes in metropolitan Boston. One can find at a glance the boxes that have been activated or

ONR - Washington Seminar Scheduled 8-21 June

A fourteen-day Research Reserve Seminar will open early next month in Washington, D. C. This seminar will provide an opportunity for selected volunteer reservists to study the plans, objectives and functions of the Office of Naval Research, with emphasis on their own part in the organization. In addition, opportunities will be afforded to observe other research and development activities in the area of Washington, D. C.

Officers selected for this seminar should be ordered to report to the Chief of Naval Research at the U.S. Naval Receiving Station, BOQ, Anacostia, D. C. prior to 1800 on 8 June 1952.

are out for repairs. All events are carefully logged, with notes of the action taken, the time the first apparatus arrives at the scene, etc. If a phone call or a radio message is missed, there is a tape recorder that can replay it; the tape is automatically wiped every five minutes.

When the engines arrive at the scene of the fire, a report is sent back to Headquarters stating that the apparatus at the scene is adequate or that more is needed (as in the case of a two-alarm or a three-alarm fire). This information is transmitted to Headquarters either by radio or by a telegrapher's key over the fire box system. After this report is received, another alarm may be sent out.

All vehicles of the chief and district chiefs are equipped with two-way radios and the Department is equipping other apparatus at least with receivers. The members of the unit were impressed with the communications equipment and the caliber of the personnel operating and maintaining it.

The visit to the Boston Police Headquarters showed that the radio system used by the police is similar to the Fire Alarm System. Information is received by phone through telephone operators, transmitted to a dispatcher, displayed on a map and then radio police cars or ambulances are dispatched to the scene. Ordinarily the telephone operators write out the calls and pass them to the dispatcher. If an emergency arises, however, the dispatcher can be placed directly on the line with the individual who is calling. All conversations and actions are recorded and stored—a procedure that has proved very valuable, for recordings are studied and restudied to detect loopholes in police procedure which may allow a criminal to escape from the scene of crime.

Visits to the Telephone Company and Metropolitan Transit Authority proved to be equally interesting. In both instances, two different types of communication or transmission systems were in operation and personnel were on duty to forestall any interruptions in service. Discussions were given on the over-all systems, the procedures used to forestall trouble and the system of checks and double checks used to locate trouble.

After these visits, the Unit invited Mr. F. B. Sanborn, Deputy Fire Chief and Director of Civilian Defense for Boston, to lecture on civilian defense. The visits and Chief Sanborn's talk gave the members of the unit a very clear picture of the civilian side of "total war".

Officially Activated

Volunteer Research Reserve Units

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
1-1	1930, 1st & 3rd Mon. Rm. 4-370, M.I.T. 77 Mass. Ave. Cambridge, Mass.	CAPT L.M. SMITH, USNR 34 Parkland Ave. Lynn, Mass.
1-2	1930, 2nd & 4th Tues. USNROTC Bldg. Brown University Providence, R.I.	LT Charles E. FRANKLIN, USNR 27 Cherry Rd. Edgewood 5, R.I.
1-2 Sub-Unit	1600, 1st & 3rd Tues. Rm. 305, Ranger Hall Rhode Island State College Kingston, R.I.	LTJG Eugene C. WINSLOW, USNR Narragansett Marine Laboratory Kingston, R.I.
1-2 Sub-Unit	2000, 1st & 3rd Tues. Woods Hole, Mass. Oceanographic Institute	LCDR Mary SEARS, USNR Glendon Rd. Woods Hole, Mass.
1-3	1900, 1st & 3rd Tues. University of Mass. Amherst, Mass.	LCDR George R. RICHASON, USNR 41 Fairfield St. Amherst, Mass.
1-5	2000, 1st & 3rd Mon. Stratton Hall Worcester Poly. Inst. Worcester, Mass.	CDR Emerson A. WIGGIN, USNR 25 Bay State Rd. Worcester 6, Mass.
1-7	2000, 1st & 3rd Tues. Wentworth Hall Dartmouth College Hanover, N.H.	LCDR Martin E. HEFFERNAN, USNR 6 Brockway Rd. Hanover, N.H.
3-1	1915 Alt. Thurs. Auditorium Cornell Univ. Med. Coll. New York 21, N.Y.	CAPT Robert H. GRIFFIN, USNR 105 Pennsylvania Ave. Tuckahoe 7, N.Y.
3-2	1930, 2nd & 4th Mon. Special Devices Center Engineering Bldg. Port Washington Long Island, N.Y.	CDR A. A. CHESTER, USNR Navigation Training Section Special Devices Center Port Washington Long Island, N.Y.
3-3	2000, 1st & 3rd Mon. USNRTC & MCRTC 3 Porter Ave. Buffalo, N.Y.	CDR Morris BEERMAN, USNR 479 Eggert Rd. Buffalo, N.Y.
3-4	1930, 1st & 3rd Tues. Harkness Hall University of Rochester Rochester, N.Y.	CDR Henry C. SHEVE, USNR USNRTC & MCRTC 900 East Main St. Rochester 7, N.Y.

Desig-nation	Time and Place of Meeting	Commanding Officer and Mail Address
3-5	1930, 2nd & 4th Thurs. USNRTC Fort Nathan Hale Park New Haven, Conn.	CDR D. S. ROWELL, USNR USNRTC Fort Nathan Hale Park New Haven, Conn.
3-6	2000, 2nd & 4th Mon. USNRTC Syracuse (Liverpool), N.Y.	LCDR Henry W. ISLEIB, USNR 10 Maxwell Court, Mains Ave. Syracuse 6, N.Y.
3-7	2000, 2nd & 4th Thurs. USNRTC Scotia, N.Y.	LCDR Harold L. SHAMBACH, USNR 1826 Nott St. Schenectady 8, N.Y.
3-8	1930, 2nd & 4th Tues. 250 Park Ave. New York City, N.Y.	CDR Alfred WEEKS, USNR Rm. 1205, 247 Park Ave. New York, N.Y.
3-9	2000, 1st & 3rd Wed. Brookhaven National Lab. Upton, Long Island, N.Y.	CDR John S. MEDD, USNR Brookhaven National Lab. Upton, Long Island, N.Y.
4-1	2000, 1st & 3rd Wed. Nassau Tavern Princeton, N.J.	CDR Harry G. HART, USNR 21 Lilac Lane Princeton, N.J.
4-2	1930, Alt. Thurs. Franklin Institute 20th St. & Parkway Philadelphia, Pa.	CDR John H. NEHER, USNR Philadelphia Electric Co. 1000 Chestnut St. Philadelphia, Pa.
4-3	2000, 2nd & 4th Thurs. Rm. 1112 Science Bldg. Carnegie Inst. of Tech. Pittsburgh, Pa.	CDR Neil D. COLE, USNR 303 Thaw Hall, Univ. of Pittsburgh Pittsburgh, Pa.
4-4	1900, 1st & 3rd Wed. Rm. 200, Engineering "E" Pennsylvania State College College Station, Pa.	LCDR Paul F. NORTON, USNR 749 West Hamilton Ave. State College, Pa.
4-5	2000, Alt. Mon. USNRTC Foot of Madison St. Wilmington, Del.	CDR Donald MacCREARY, USNR USNRTC Foot of Madison St. Wilmington, Del.
4-6	1930, 2nd & 4th Wed. USNRTC Bethlehem, Pa.	LCDR Lynn S. BEEDLE, USNR Fritz Engineering Lab. Lehigh University Bethlehem, Pa.
4-7	1930, 2nd & 4th Tues. Rm. 107, Old Armory Ohio State University Columbus, Ohio	LCDR Louis J. NOWACKI, USNR 846 Grandon Ave. Columbus 9, Ohio
4-8	2000, 1st & 3rd Mon. USNRTC 1089 E. Ninth St. Cleveland, Ohio	LCDR Viktor SCHRECKENGOST, USNR 2366 Noble Rd. Cleveland 21, Ohio

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
4-9	1930, 2nd & 4th Mon. USNRTC Dayton, Ohio	LCDR Edward J. O'TOOLE, USNR 314 W. Hudson Ave. Dayton 6, Ohio
W-Battalion	2000, 3rd Thurs., last month of quarter Auditorium, Interior Dept. Washington, D.C.	CAPT Fred C. WIESNER, USNR Rm. 2714, Navy Bldg. T-3 LI-5-6700, X-65755 Washington, D.C.
W-1	2000, 1st & 3rd Thurs. Natl. Academy of Sciences Washington, D.C.	CDR Urner LIDDEL, USNR Atomic Energy Commission Washington, D.C.
W-2	1900, 1st & 3rd Thurs. NRL Auditorium, Bldg. 8 Washington, D.C.	LCDR Bruce G. Bingham, USNR Code 3260, NRL Washington, D.C.
W-5	2000, 2nd & 5th Tues. Conference Rm. NMRI Bethesda, Md.	CDR Barry G. KING, USNR 5617 Wood Way Circle, Sumner Washington 16, Md.
5-2	2000, 1st & 3rd Mon. Virginia Poly. Inst. Rm. 208, Price Hall Blacksburg, Va.	LT Frank D. HANSING, USNR 204 Turner St. Blacksburg, Va.
5-3	2000, each Tues. Camp Detrick Frederick, Md.	LT Riley D. HOUSEWRIGHT, USNR Camp Detrick Frederick, Md.
5-4	2000, 1st & 3rd Thurs. Rm. 202, Maryland Hall Johns Hopkins University Baltimore, Md.	LT Alan T. OSSERMANN 1809 Chelsea Rd. Baltimore 16, Md.
5-5	1700-1900, 2nd & 4th Mon. Medical College of Virginia Richmond, Va.	CAPT Roscoe D. HUGHES, USNR Medical College of Virginia Richmond, Va.
6-1	2000, Alt. Thurs. Rm. 103, Physics Bldg. Ga. Institute of Tech. Atlanta, Ga.	CDR J. E. BOYD, USNR Physics Bldg. Ga. Institute of Tech. Atlanta, Ga.
6-2	1915, 1st & 3rd Mon. Rm. 318 Ross Lab. Alabama Poly. Inst. Auburn, Ala.	LT J. E. LAND, USNR Dept. of Chemistry Alabama Poly. Inst. Auburn, Ala.
6-3	2nd & 4th Wed. O.R.I.N.S. Medical Div. Oak Ridge, Tenn.	LCDR Edward I. WYATT, USNR 110 Gordon Rd. Oak Ridge, Tenn.
6-4	1930, 1st and 3rd Tues. Engineering Bldg. University of Florida Gainesville, Fla.	LCDR Chester L. EGGERT, USNR College of Education University of Florida Gainesville, Fla.
6-5	2000, 1st & 3rd Thurs. USNRTC Gulfport, Miss.	LCDR Robert L. STOBAUGH, USNR 2701 Kelly Ave. Gulfport, Miss.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
6-6	1945, 2nd & 3rd Wed. USNROTC Armory Univ. of North Carolina Chapel Hill, N.C.	LCDR Robert F. SCHENKKAN, USNR Communications Center Univ. of North Carolina Chapel Hill, N.C.
6-6 Sub-Unit		LTJG Ralph F. TRAMBARULO, USNR Dept. of Physics Duke University Durham, N.C.
6-6 Sub-Unit		LT Sidney H. USRY, USNR Dept. of Engineering State College Raleigh, N.C.
6-8	2000, 1st & 3rd Mon. Underwater Sound Ref. Lab. Orlando, Fla.	LCDR D. T. HAWLEY, USNR 1027 Guernsey Ave. Orlando, Fla.
6-9	1930, 2nd & 4th Tues. Rm. 101, Baldwin Hall University of Georgia Athens, Ga.	LCDR A. R. ROBERTSON, USNR 390 South Pope St. Athens, Ga.
6-10	2000, 1st & 3rd Wed. Rm. S-110, Memorial Classroom University of Miami Coral Gables, Fla.	LCDR John S. McANALLY, USNR Medical Research Unit V.A. Hospital Coral Gables, Fla.
6-10 Sub-Unit	2000, 1st & 3rd Wed. 151 South County Rd. West Palm Beach, Fla.	LTJG John H. COLEMAN, USNR c/o Radiation Research Corp. Box 8126 West Palm Beach, Fla.
8-1	1930, 1st & 3rd Tues. USNROTC Bldg. Tulane University New Orleans, La.	LCDR John M. SCOTT, USNR Dept. of Chemistry Tulane University New Orleans, La.
8-2	2000, 1st & 3rd Wed. Rm. 221, Coates Laboratory La. State University Baton Rouge, La.	LT John A. ALFORD, USNR Dept. of Bacteriology La. State University Baton Rouge, La.
8-3	1930, 2nd & 4th Mon. PMA Bldg. or Bolton Hall Texas A & M College College Station, Tex.	CDR Norman F. RODE, USNR Dept. of Elec. Engineering Texas A & M College College Station, Tex.
8-4	1930, Alt. Wed. USNROTC Bldg. The Rice Institute Houston, Tex.	LCDR L. J. CASTELLANOS, USNR 6513 Rutgers St. Houston, Tex.
8-5	2000, Alt. Tues. & Wed. Rm. 15, Chemistry Bldg. University of Texas Austin, Tex.	LCDR G. H. AYRES, USNR Dept. of Chemistry University of Texas Austin, Tex.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
8-6	1930, Last Mon. USNRTC Galveston, Tex.	LT Lauro GUTIERREZ-VELA, USNR Galveston Laboratories 305½ 22nd St. Galveston, Tex.
8-7	2000, 1st & 3rd Wed. USNRTC 1805 S. Yale Ave. Albuquerque, N.M.	LCDR Howard V. MATHANY, USNR Office of the Dean of Men University of New Mexico Albuquerque, N.M.
8-8	2nd & 4th Wed. Senior High School Bartlesville, Okla.	LT Robert G. NISLE, USNR P.O. Box 583 Bartlesville, Okla.
8-8 Sub-Unit	1930, 2nd, 3rd & 4th Thurs. Oklahoma A & M College Stillwater, Okla.	LCDR Dariel E. HOWELL, USNR 1408 Lewis St. Stillwater, Okla.
8-9	1705, 1st & 3rd Tues. Rm. B-117 Los Alamos Scientific Lab. Los Alamos, N.M.	CDR Henry HEYMAN, USNR 1072-48th St. Los Alamos, N.M.
8-11	1930, 2nd & 4th Thurs. USNRTC Orange, Tex.	LCDR Hugh F. SMITH, USNR c/o DuPont Co. Orange, Tex.
8-12	2000, 2nd & 4th Tues. Rm. 127, Fondren Science Bldg. Southern Methodist University Dallas, Tex.	LT James A. BOWMAN, USNR 1810 Argentia Drive Dallas 16, Tex.
9-1	1900, 2nd & 4th Tues. Navy Pier Campus University of Illinois Chicago, Ill.	LCDR Walter E. PETERSON, USNR 411 South 15th Ave. Maywood, Ill.
9-2	1930, 1st & 3rd Mon. Rm. 319, Gregory Hall University of Illinois Urbana, Ill.	CAPT Chauncy M. LOUTTIT, USNR Dept. of Psychology University of Illinois Urbana, Ill.
9-2 Sub-Unit	1930, 2nd & 4th Tues. Library Northern Regional Research Lab. Peoria, Ill.	LT R. G. DWORSCHACK, USNR 1503 N. Sheridan Rd. Peoria 5, Ill.
9-3	1930, Alt. Mon. Rm. 18, Angell Hall University of Michigan Ann Arbor, Mich.	LT James E. BEVER, USNR 1443 University Terrace Ann Arbor, Mich.
9-3 Sub-Unit	Houghton, Mich.	LCDR Roy W. DRIER, USNR 715 Pine St. Calumet, Mich.
9-5	1930, 1st & 3rd Wed. USNROTC Bldg. Iowa State College Ames, Iowa	LCDR J. A. GREENLEE, USNR 307 Ash Ave. Ames, Iowa

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
9-6	1930, 1st & 3rd Mon. Rm. 4, Mech. Eng. Bldg. University of Minnesota Minneapolis, Minn.	LCDR J. A. WISE, USNR 222 Aeronautical Eng. Bldg. University of Minnesota Minneapolis, Minn.
9-6 Sub-Unit	2000, 2nd & 4th Wed. ROTC Armory Smith College Brookings, S.D.	LT Gerald B. SPAWN, USNR So. Dakota State College Entomology-Zoology Dept. Brookings, S.D.
9-7	1930, 2nd & 4th Thurs. Rm. 111, Coulter Hall Purdue University Lafayette, Ind.	LT L. N. BAKER, USNR Dept. of Psychology Purdue University Lafayette, Ind.
9-8	2000, 1st & 3rd Thurs. Rm. 101, Crew Hall Washington University St. Louis, Mo.	LCDR John Hayes CARTER, USNR Rm. 1118 915 Olive St. St. Louis, Mo.
9-8 Sub-Unit	Louisiana, Mo.	LCDR Tracey P. MOORE, USNR Bureau of Mines Louisiana, Mo.
9-9	1930, 1st & 3rd Thurs. Rm. 204, Mechanics Hall Missouri School of Mines and Metallurgy Rolla, Mo.	LCDR Robert ELGIN, USNR P. O. Box 194 St. James, Mo.
9-12	1930, 2nd & 4th Tues. Rm. 2, Botany Bldg. Annex Colorado A & M College Fort Collins, Colo.	LT W. D. THOMAS, USNR Botany & Plant Pathology Dept. Colorado A & M College Fort Collins, Colo.
9-12 Sub-Unit	1900, 1st & 3rd Fri. Boulder, Colo.	LTJG John R. ZIMMERMAN, USNR 1080 7th Ave. Boulder, Colo.
9-12 Sub-Unit	1930, 1st & 3rd Mon. Rm. 103, Eng. Bldg. University of Wyoming Laramie, Wyo.	LCDR Verne J. VARINEAU, USNR Dept. of Mathematics University of Wyoming Laramie, Wyo.
9-13	1930, 1st & 3rd Thurs. USNRTC Des Moines Still College Des Moines, Iowa	LCDR J. R. MALONEY, USNR 2920 48th St. Des Moines, Iowa
9-14	1930, Wed. or Thurs (2/MO) USNRTC University of Wisconsin Madison, Wis.	LT Richard M. SHACKELFORD, USNR Dept. of Genetics University of Wisconsin Madison, Wis.
9-14 Sub-Unit	1930, 1st & 3rd Tues. Lecture Rm. Institute of Paper Chemistry Appleton, Wis.	LT Edward G. SNYDER, USNR Institute of Paper Chemistry Appleton, Wis.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
9-15	1900, 2nd & 4th Thurs. Conference Rm. Dow Chem. Co. Pers. Bldg. Midland, Mich.	LTJG John L. SCHICK, USNR 1173 West Midland Rd. Auburn, Mich.
9-16	1900, 1st & 3rd Mon. USNRTC 1620 E. Saginaw St. Michigan State College East Lansing, Mich.	LCDR Ira B. BACCUS, USNR 407 Marshall St. East Lansing, Mich.
9-19	1945, 3rd Thurs. Senate Chamber, Old Capitol University of Iowa Iowa City, Iowa	LT John L. DAVIES, USNR East Hall Iowa City, Iowa
9-20	2000, 1st & 3rd Mon. Naval Science Bldg. University of Kansas Lawrence, Kans.	LT Russell C. MILLS, USNR Dept. of Biochemistry University of Kansas Lawrence, Kans.
9-21	1700, 2nd & 4th Wed. General Motors Research Lab. 485 W. Milwaukee Detroit, Mich.	LCDR Ralph A. RICHARDSON, USNR General Motors Research Lab. 485 W. Milwaukee Detroit, Mich.
9-22	1930, 1st & 3rd Wed. Military & Naval Science Bldg. University of Nebraska Lincoln, Neb.	LCDR Lloyd W. HURLBUT, USNR 2640 Colonial Dr. Lincoln 2, Neb.
9-22 Sub-Unit		LT Benedict J. JASKOSKI, USNR Rm. D13, Creighton Dental Bldg. Omaha 2, Neb.
9-23	1800, 2nd Thurs. Argonne Natl. Lab. DuPage County Site, Ill.	LT W. A. LAMBERTSON, USNR Box 5207, Argonne National Lab. Chicago 80, Ill.
11-1	2000, 1st & 3rd Tues. 1030 E. Green St. Pasadena 1, Calif.	LCDR Silas E. JOHNSON, USNR 48 Annandale Rd. Pasadena 2, Calif.
11-2	2000, Alt. Thurs. USNRTC Pasadena, Calif.	LCDR Albert P. KELSO, USNR 1015 Cynthia Ave. Pasadena 8, Calif.
11-3	2000, 2nd & 4th Mon. USNRTC & MCRTC 851 Chavez Ravine Rd. Los Angeles, Calif.	CDR Louis J. CURRAN, USNR 758 North Orange Dr. Hollywood 38, Calif.
11-4	2000, 1st & 3rd Wed. USNRTC San Pedro, Calif.	LCDR Philip B. WILSON, USNR 2633 E. 7th St. Long Beach 4, Calif.
11-5	1930, 2nd, 3rd & Last Tues. USNRTC San Diego, Calif.	LCDR Winfred R. GODDARD, Jr., USNR 750 San Fernando St. San Diego, Calif.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
11-6	2000, 2nd & 4th Thurs. USNRTC Phoenix, Ariz.	LCDR Milton B. MORSE, USNR 522 West Virginia Ave. Phoenix, Ariz.
11-7	1st & 3rd Thurs. USNRTC & MCRTC 1100 So. Alvernon Way Tucson, Ariz.	LT John W. STULL, USNR 1435 East 5th St. Tucson, Ariz.
12-1	2000, 2nd & 4th Mon. 1000 Geary St. San Francisco, Calif.	CDR R. M. FINCHER, USNR ONR Branch Office 100 Geary St. San Francisco, Calif.
12-2	1945, 2nd & 4th Mon. Rm. 201, Donner Lab. University of Calif. Berkeley, Calif.	LT Howard K. SCHACHMAN, USNR 7705 Ricardo Court El Cerrito 8, Calif.
12-3	2000, 2nd & 4th Wed. Rm. 268, Engineering Corner Stanford University Stanford, Calif.	CDR L. S. JACOBSEN, USNR Dept. of Mech. Eng. Stanford University Stanford, Calif.
12-4	2000, 2nd & 4th Thurs. Rm. N103 McLane Hall Fresno State College Fresno, Calif.	LCDR Ennis B. WOMACK, USNR 138 Bellaire Way Fresno, Calif.
12-5	1930, 2nd & 4th Wed. Rm. 208, LeConte Hall University of California Berkeley, Calif.	CDR John M. DUNDON, USNR 316 Pacific Ave. Piedmont, Calif.
12-6	2000, 1st Tues. 1200 & 1630 3rd Tues. Tower Rm. Animal Sci. Bldg. University of California Davis, Calif.	LCDR Lawrence L. CLAYPOOL, USNR Division of Pomology University of California Davis, Calif.
12-7	2000, 2nd & 4th Mon. USNRTC Fort Douglas Salt Lake City, Utah	LCDR Donald DAVIS, USNR 2579 E. 2940 South Salt Lake City 1, Utah
12-8		CAPT George J. HIGGINS, USNR U. S. Naval Postgraduate School Monterey, Calif.
13-1	1930, 2nd & 4th Mon. Rm. A-223, Anatomy Bldg. University of Washington Seattle, Wash.	CDR H. S. BENNETT, USNR Dept. of Anatomy University of Washington Seattle, Wash.
13-2	1900, 2nd & 4th Tues. American Legion Hall Richland, Wash.	LCDR Donald R. GUSTAVSON, USNR 1510 Cottonwood Dr. Richland, Wash.
13-3	1930, 2nd & 4th Mon. Rm. 39, Holland Library Pullman, Wash.	LCDR W. G. GNAEDINGER, USNR 601 High St. Pullman, Wash.

Desig-nation	Time and Place of Meeting	Commanding Officer and Mail Adress
13-4	2000, 2nd & 4th Tues. USNRTC Swan Island Portland, Ore.	LCDR Danny C. MARQUEZ, USNR 830 N. E. Holliday St. Portland, Ore.
13-5	1930, 2nd & 4th Mon. Rm. 104, Chemistry Bldg. Oregon State College Corvallis, Ore.	CDR Albert V. LOGAN, USNR Dept. of Chemistry Oregon State College Corvallis, Ore.
13-6	1930, 1st & 3rd Thurs. National Guard Naval Reserve Armory Tautphaus Park Idaho Falls, Idaho	LCDR Wm. L. MORRIS, USNR 725 Northrup Ave. Idaho Falls, Idaho.

NOTE: If any changes are made please notify:

CDR F. L. Edmondson
ONR Code 233, Bldg. T-3
17th and Constitution Ave., N. W.
Washington, D. C.

Reservists Briefed on U.S. Mineral Resources

One of our country's most essential resources, both in peace and war—its mineral deposits—were the subject of a talk given before Unit 5-2 (Blacksburg, Va.) by Dr. R. V. Dietrich. Dr. Dietrich is on the faculty of the Geology Department of the Virginia Polytechnic Institute.

Dr. Dietrich pointed out the importance of minerals in world history: "In the past industrial Nations developed coincidentally with utilization of their mineral resources, and mineral resource deficiencies prompted voyages of discovery and subsequent colonization; at present minerals, the very foundation of modern civilization, have gained a dominant role in national economy and in international policy making. Distribution, ownership, and international transfer of minerals are of paramount importance, because industrial strength is based on them and because an adequate supply is essential to peaceful economic development."

An alarming consumption of mineral resources has taken place in recent years, Dr. Dietrich said. For example, more minerals have been mined and consumed within the period embracing two world wars than in all previous history. Consequently our mineral resources have been drastically depleted and some are near exhaustion. To assure continued industrial development, either substitutes for or new supplies of these minerals must be found.

Dr. Dietrich emphasized that it is now the job of the geologist, with his knowledge of the occurrence, distribution and origin of mineral deposits to help fill in some of the present deficiencies. He pointed out that the day of the old-time prospector is practically over in this country and that scientific methods will have to take the place of intuition if we are to be successful in finding new ore bodies and in maintaining adequate mineral reserves.

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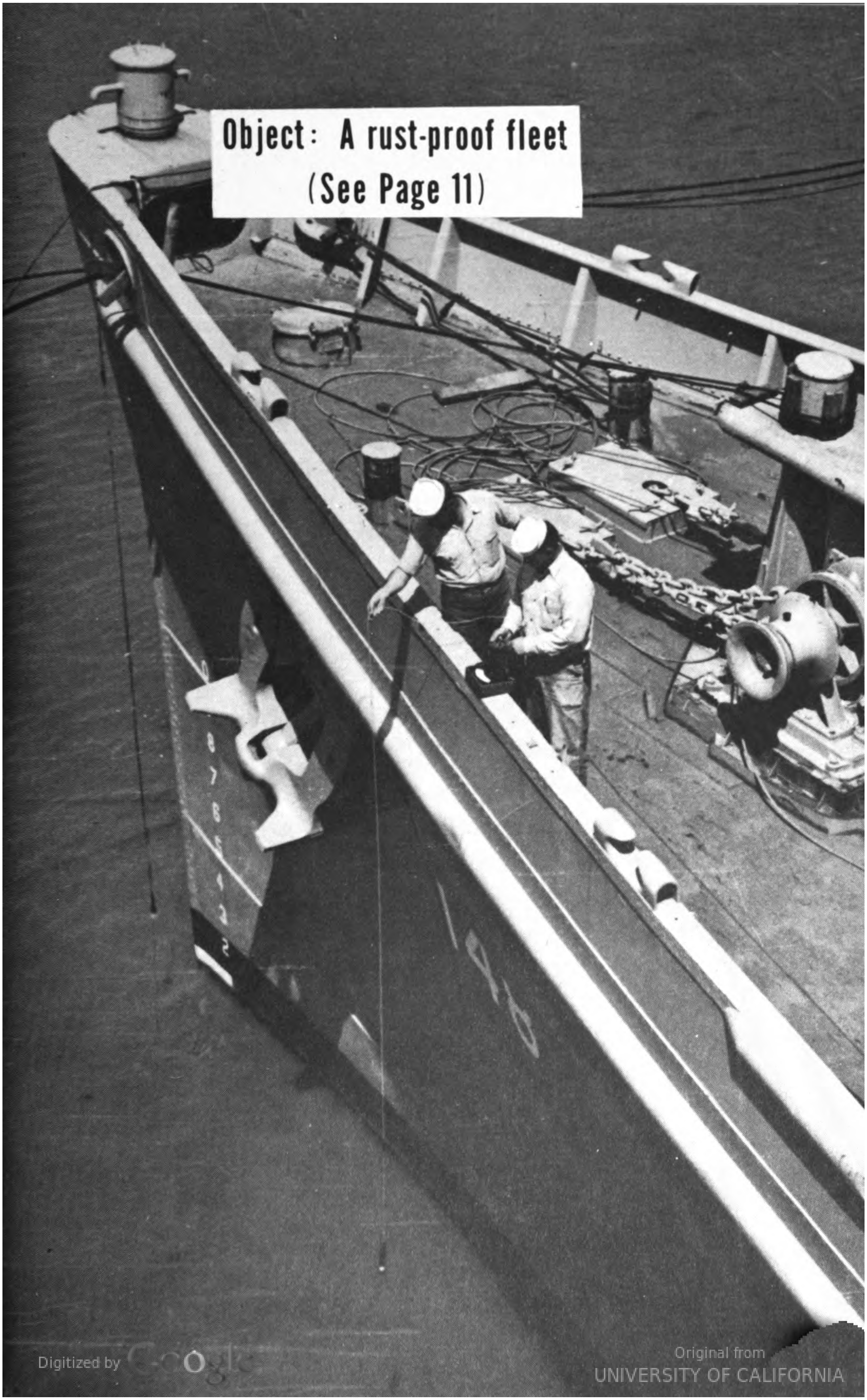

Object: A rust-proof fleet

(See Page 11)


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