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RESEARCH REVIEWS

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COVER PHOTO: This young lady is having her chewing ability tested by one of the devices constructed for that purpose by Dr. R. S. Manly, Director of Research at Tufts College Dental School. Dr. Manly, in the article "The Mechanics of Chewing" (pp. 4 to10) tells how his work may help the Navy in establishing more reliable dental standards for recruitment purposes.

Approved by Bureau of the Budget, 13 April 1948.

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For a long time metallurgists have been wondering exactly why the addition of a certain amount of chromium to steel would make it rust-resistant. Research by Dr. H. H. Uhlig of MIT promises to throw some light on the matter.

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In this article Dr. R. S. Manly of Tufts College delves into a subject that should interest everybody who likes to eat. Dr. Manly is trying to find out how the loss of certain teeth affects our ability to chew.

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In times of emergency like this everyone is aware of the vital importance of sound leadership. A timely contribution, therefore, is this article by Dr. L. F. Carter, who is trying to find out just what characteristics good leaders possess.

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Everyone who has ever handled a compass is aware of the practical applications of our knowledge of the earth's magnetic field. Now scientists are interested in finding other magnetic fields outside the earth. Drs. G. P. Kuiper and K. O. Kiepenheuer tell of the progress that has been made.

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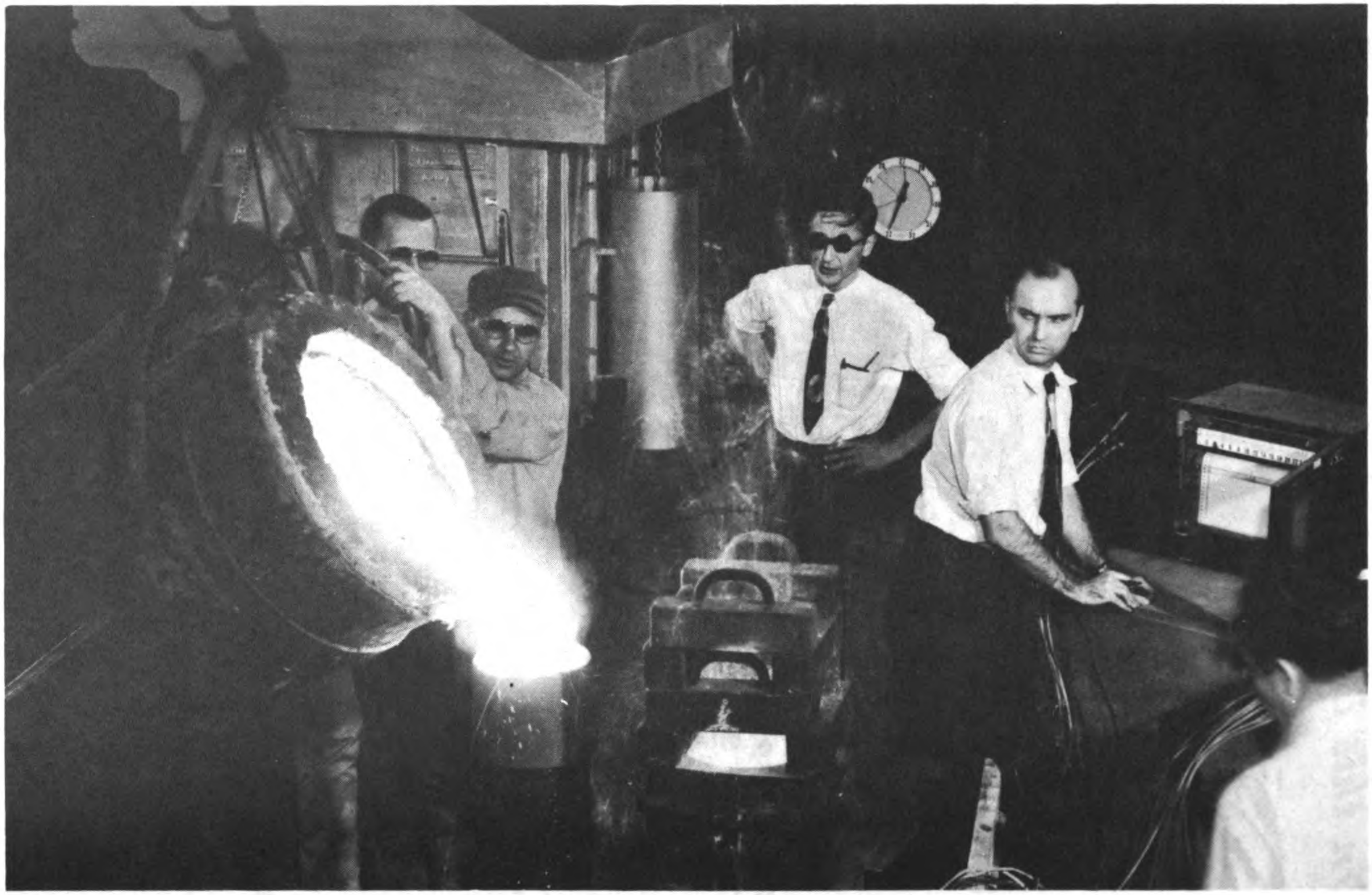
The vital topic of civil defense continues to absorb the interest of many units. News is coming in from groups throughout the Nation who are helping local authorities to prepare their communities for atomic warfare.



An important part of the Navy's research on steels is carried on at the Naval Research Laboratory. Here scientists in the Metal Processing Branch pour a steel ingot for experimental purposes.

Stainless Steels

by
Herbert H. Uhlig
Massachusetts Institute of Technology

Stainless steel is one of the important conveniences of our daily lives. It is often the only thing that will "fill the bill" when a fairly strong, rust-resistant alloy is needed. Cutlery, tableware and containers for corrosive liquids are only a few of the items which are composed of such steel. In fact it is so familiar to us that we are likely to make the mistake of assuming that there is one specific alloy to which the term "stainless steel" can be applied.

Actually, there are several alloys, each made for a particular purpose, to which the name is applicable. All are composed mainly of iron but contain at least 12 percent chromium and sometimes other metals. One type, called martensitic, contains 12-14 percent chromium and 0.15 percent carbon. Because it can be heat-treated to a strength almost as great as that of ordinary carbon steel, it is useful in turbine blades and cutlery. The so-called "ferritic" stainless steels, on the other hand, which contain 14-18 percent chromium and about 0.1 percent carbon, cannot be hardened appreciably by such treatment. They find their principal use in nitric acid equipment. The most popular of all stainless steels produced commercially, however, is austenitic steel. It contains, in addition to 18-20 percent chromium and less than 0.1 percent carbon, about 8-12 percent nickel. This alloy, the well-known "18-8", has a higher resistance to rust than the other two, and unlike them, it is nonmagnetic. Although it cannot be substantially improved by heat treatment, work hardening greatly increases its strength.

All the stainless steels achieve maximum rust resistance when they have been water-quenched from temperatures around 1800°F, and when they are used under oxidizing conditions. They are not, of course, stainless under all conditions, for there are a number of substances which corrode them. Although they are unharmed by nitric acid, sulfuric and hydrochloric acids are damaging. Solutions of sodium chloride cause the formation of deep narrow pits, making these steels unsatisfactory for carrying sea water. Even grime and soil have an adverse effect on them, for unless they are kept clean of these substances, pits form.

Herbert H. Uhlig, is Director of MIT's Corrosion Laboratory. After receiving degrees from Brown (Sc. B., 1929) and MIT (Ph. D., 1932) Dr. Uhlig worked for three years at Lever Bros., where he was assistant chief chemist. He then became a research associate at the MIT Corrosion Laboratory until 1940, when he returned to a position in industry with the General Electric Co. In 1946 he returned to MIT as Associate Professor of Metallurgy.

Dr. Uhlig is a member of several scientific organizations, including the Electrochemical Society, the Institute of Mining and Metallurgical Engineers and the Society of Metals. His special interests lie in the fields of corrosion, electrochemistry, physical metallurgy, stainless steels and gases in metals.

We are interested in discovering exactly why, in order to be stainless, a steel must contain a minimum of 12 percent chromium. To find an explanation we must first of all understand what mechanism actually keeps the alloy rust-free. And this is not, by any means, completely clear.

One theory is that when the steel contains at least this amount of chromium, a chromium-iron oxide forms on its surface. This layer of oxide supposedly protects the alloy from corrosion.

But recent work has indicated that this may not be the whole story. It has been found, for example, that the amount of oxygen taken up by a clean surface of austenitic steel is very small--corresponding at most to a few molecular layers of metal oxide. Such a thin layer probably would not suffice to protect the alloy. Because of this, and other evidence, a different theory has been suggested for explaining why steels are stainless.

It has been suggested that the oxygen makes the alloy resist corrosion not by physically isolating the metal from its environment, but by lessening its tendency to react. Oxygen atoms have a certain attraction for the metal, represented by chemical valence bonds, and, in the same manner, atoms on the surface of the metal exert a certain affinity for oxygen. When oxygen is adsorbed on the metal surface--that is, when it is attracted to the surface and occupies a position there--all these valences are satisfied, and neither the metal nor the oxygen thereafter has the same tendency to enter into chemical reaction. Because of this, the stainless steels are termed "passive" alloys.

With time, true metal oxides are formed slowly. These oxides, of course, remain attached to the metal and when they have become several hundred or thousand molecular layers thick, they actually do protect the metal by physically isolating it. Thus, they supplement its passivity, and are a secondary reason for the stainlessness of chromium steels. But the isolation of the metal is believed to be a less important reason for its resistance to corrosion than the satisfaction of the surface valences.

These, then, are the reactions which we believe are responsible for the "stainless" quality of steels containing at least 12 percent chromium. In alloys with less than this amount, oxygen, in the presence of moisture reacts, soon after exposure, to form iron oxides (rust). In other words, satisfaction of surface valences does not occur and the metal therefore is not passive. This seems to indicate that when steel contains at least 12 percent chromium it acts like the latter metal - which is rust-resistant. Below this concentration, however, the steel acts like iron, which rusts very easily. What we want to know, then, is the reason why this particular amount of chromium is so critical.

An explanation has been evolved which attributes this dual behavior to the structure of the chromium atom. This atom is known to have five electron vacancies in its third shell. These vacancies tend to fill with electrons supplied by alloyed iron atoms in the immediate neighborhood. There are logical reasons for assuming that the sharing of one electron per iron atom by chromium makes the iron passive, so that it behaves like passive chromium. Thus, one chromium atom with five electron vacancies can share a maximum of five electrons - that is, one from each of five iron atoms. Consequently, the alloy is made passive when chromium is present in a greater atomic ratio than 1 Cr to 5 Fe. This critical ratio turns out to be 16.7 atom percent chromium (1 Cr atom in a total of 6 atoms) or 15.7 weight percent chromium, which is in good agreement with the critical minimum amount of chromium found necessary for passivity in the stainless steels (12 percent).

Similar reasoning accounts for the rust-resistant qualities of many other alloys--for example, copper-nickel alloys which contain at least 40 percent nickel and molybdenum-iron alloys having a minimum molybdenum concentration of 55 percent. The theory also explains the effect of 2 to 3 percent molybdenum in 18-8 (Type 316) as a promoter of passivity, and also accounts for the empirical formula of Hastelloy A, a well known commercial corrosion-resistant alloy (20 percent Mo, 20 percent Fe, 60 percent Ni).

It is hoped that further studies along these lines will eventually lead to a science of alloying. We hope then to be better able to make proper use of alloys we already possess. We also hope to be able to produce improved materials, for the theory will indicate which elements and what proportions of each should be added to alloys of the future in order to make them resistant to specific substances and environments.

"Invisible Light" Helps Science to Progress in Many Fields

The picture facing page 22 of this month's issue shows research being conducted by means of what was popularly termed "invisible light" during World War II. This meant infrared, light waves which lie beyond the visible spectrum and which therefore cannot be seen by the naked eye.

During the last war infrared was invaluable in communications equipment, gunsights and other military devices. But the possibilities for its use had by no means been completely explored at that time. Because infrared offers so much promise for further applications, both scientific and military, ONR supports basic research in this field.

The picture on our back cover shows a war-surplus, 60-inch searchlight being used by a group at Johns Hopkins as a source of infrared in experiments aimed at determining elements present in the air. If this equipment were more portable it might be used to prospect for natural gas deposits.

According to Dr. John Strong, who heads this ONR-sponsored work at Johns Hopkins, this is only one of the many applications of infrared. It is also useful in the field of physics, to study a number of gases; in chemistry, to explore the structure of various molecules; and in astrophysics, to find out what type of radiations are being emitted by other planets. It is, in other words, one of the scientist's most valuable tools in the exploration of the unknown.

The Mechanics Of Chewing

by

R. S. Manly
Tufts College Dental School

The human body conducts a remarkable variety of activities. Among these, one of the least appreciated is a complex engineering feat that most people perform daily. It may involve the use of forces of more than a hundred pounds, by which pressures can be built up to more than 10,000 pounds per square inch. A hundred blows a minute are delivered for a half hour at a time. The blows are usually automatically controlled and precise to within a few hundredths of an inch, for a mis-timed stroke can cause intense pain. When chewing of food is viewed in this light, it seems surprising that it has been one of the least understood functions of the body.

We do not even know what harm--if any--results from chewing ability that is below par. Obviously many persons so handicapped manage to eat, even though they are unable to grind their food perfectly before swallowing it. It would seem, then, that poor chewing ability does not cause them any serious trouble. Yet everybody knows that corn-on-the-cob is often too much of a chore for the man with a complete set of false teeth; how, then, can we be sure that he will eat everything that he needs? He may tend to select foods unwisely because he can only chew softer ones. Or he may have digestive upsets because he swallows particles that are too coarse.

We have not yet determined if such bad effects do, in fact, result from poor chewing. We would like to find out, however, for such information would not only be of great interest to civilian dentists, but it would be highly useful to the Armed Forces. Often when recruits enter, the question arises as to which of those who have teeth missing will need dental appliances and which will not. Upon discharge, a means is needed to decide whether individuals have suffered a critical loss in their chewing ability during their service, and are, therefore, entitled to have dental appliances constructed for them. If such dentures are required, we need to know which are the least expensive and most efficient in restoring chewing ability. And finally when dentures have been constructed and the patient is dissatisfied with them, some method is needed to make sure that the complaints are justified.

R. S. Manly, Director of Research at the Dental School of Tufts College, received his B. S. degree from Antioch College and his M.A. from Oberlin. Subsequently he was awarded Corn Products and Rockefeller Fellowships at Rochester. After receiving his Ph. D. from that University in 1938, Dr. Manly served for six years as a research chemist with Proctor and Gamble Co. He has held his present post at Tufts since 1945. His special interests include carbohydrate metabolism, physical properties of the teeth, dental hygiene, and oral physiology. He is a member of the International Association of Dental Research.

The author gratefully acknowledges the assistance of Dr. Roy G. Hoskins in reviewing this manuscript.

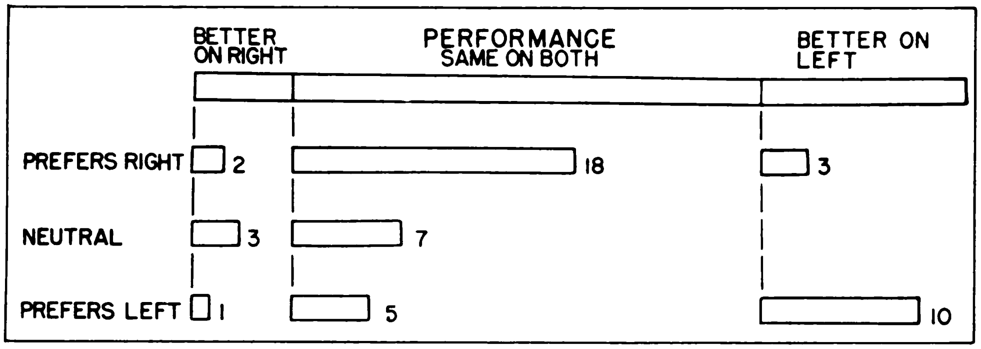


Figure 1. This chart indicates that the more efficient side of the mouth is usually preferred in chewing.

Before any of these specific problems could be tackled, some basic things had to be learned about the way we chew food. First of all, we actually needed a measure of the grinding ability of the teeth. Study showed that the coarser particles are pulverized in the mouth more quickly than the fine ones. Since the change in size of the large particles was more obvious, ability to grind them seemed to provide the best basis for a simple, dependable test. The question then arose as to the best foods to use for these studies. Investigations of 35 varieties showed that some were definitely unsuitable. For example, since we found that nearly everyone could pulverize salami to the same extent, it seemed clear that this food would be useless as a basis for comparison. It was also clear that either very hard or very soft foods would not provide good criteria--mashed potatoes need no chewing, whereas some over-age steaks defy one's best efforts. Finally roasted peanuts were found to be representative of the softer foods, while raw carrots exemplified tougher parts of the diet. Both are cheap, uniform and liked by enough persons to be good for testing. Naturally, either one could be used for persons with their own teeth, for they could chew both equally well. Both proved to be necessary in testing persons who had artificial teeth, for some of these could grind soft stuff well but flunked the test with a tough food. Consequently these studies gave us an accurate measure of the ability to chew a variety of foods.

Next we had to find out whether the mouth is a single or a double organ for chewing. It obviously acts as a unit in such functions as speaking, or biting a piece of apple, but dentists generally believe that each chewing stroke must be aimed at food on only one side of the mouth. This is because the jaw must be swung slightly to the left or right to make the best contact between teeth on that side. Furthermore, the two sides are organized separately--i.e., each has a distinct and complete nerve supply. If an anesthetized animal has the two parts of his jaw separated by surgery, each functions independently of the other, clamping down when the teeth are gently stroked and opening when a painful force is applied to teeth or gums. In view of these facts, it was reasonable to assume that food would be chewed on first one side of the mouth and then the other. But what if teeth are missing on one side? Would the person realize his handicap and use only the more efficient side? To answer this question chewing ability was determined on both sides of the mouths of 50 persons (Figure 1). In most instances the superior side was preferred and used whenever there was a definite difference between the two. Whenever both were about equal, the right side was usually

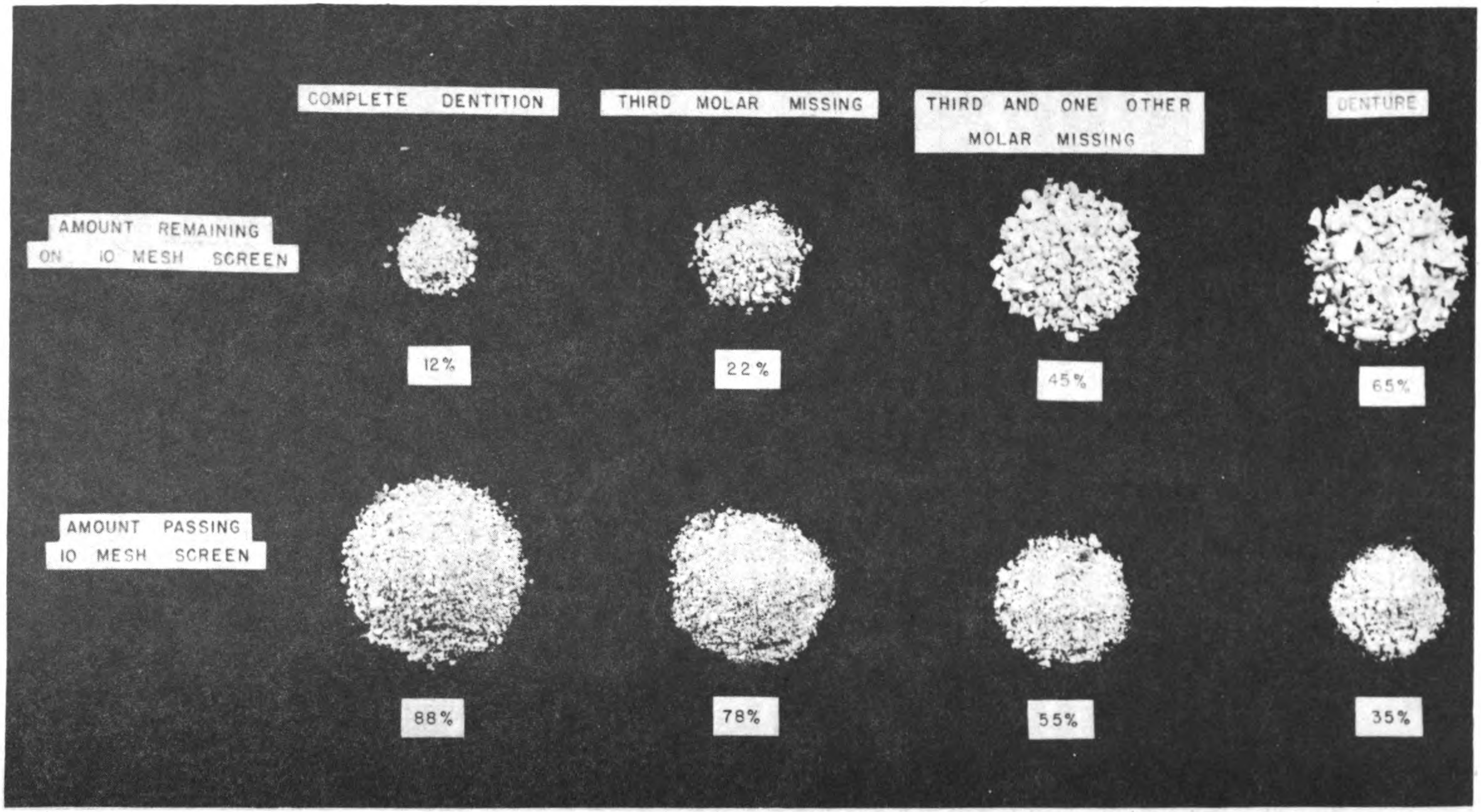


Figure 2. The size of the piles of peanuts indicates the extent to which loss of teeth affects chewing ability.

favored, probably for the same reason that most people use their right hand for writing or their right eye in aiming. In addition to these tests the chewing ability of ten subjects was determined for both sides separately; then the subjects were given another test without any instruction as to where they should chew the food. On the average the performance without instructions was the same as that of the best side. This rule indicates that dental standards for induction at the beginning of World War II were not well founded. Personnel were required to have three pairs of molars (upper and lower teeth) which could bite together, and two premolar pairs could count as one molar pair. This criterion was unsatisfactory because it did not specify where these tooth pairs might be located in the mouth. According to the rule we have formulated, if all the tooth pairs were on the same side, the person would usually have normal chewing ability; if they were divided evenly between the two sides, mastication would be below normal.

Pain causes the most important exception to this rule. Probably everyone has bitten his tongue or cheek, and noticed how the closing muscles suddenly were checked and the jaw involuntarily jerked open. Pain acts in much the same way when teeth are sensitive, and the more comfortable side is used even though it is less efficient.

Naturally we were most interested in finding out exactly why one half of the mouth is more efficient than the other. Of course everybody knows that the loss of a tooth generally decreases the chewing ability of that side. What we are trying to find out is exactly how great an effect the loss of a certain tooth actually has. Figure 2 offers some data on this question. The upper four piles of peanuts show the average amount of food which will be held back by a ten-mesh screen after 100 chews. The lower four piles indicate how much has been ground finely enough to pass through. It is easy to see that in the tests illustrated, a complete set of natural teeth performed best, while a complete denture gave the worst service. Even when a natural set of teeth lacked one wisdom tooth and another molar on the same side, the picture shows that it performed better than a whole set of false teeth. When only one wisdom tooth was missing, performance was even more satisfactory. In fact, in a study of 100 cases of the latter type, we found that 90 of the subjects could grind peanuts well enough to cause 69 percent to pass the ten-mesh screen. This represents adequate chewing ability and provides a standard for normal mastication. Certainly anyone who can grind his food this well does not need dental treatment--and some people with nine molars missing could pass muster!

As a matter of fact, the ability to chew cannot be predicted merely from the number of missing teeth. The more there are lacking, the harder it is to guess how well the remaining ones will function. To illustrate: Twenty-five people with complete sets were able to chew food so that 75 to 97 percent of it could pass a ten-mesh screen. Yet this range was from 20 to 83 percent for 25 others who each lacked two molars on one side.

When artificial dental appliances are necessary to replace missing teeth, we need to know what types will be most effective. If the teeth have been lost because of dental disease, it is often impossible for the dentist to restore the loss completely. Neighboring teeth must be used to support the chewing forces which fall on the artificial tooth. Either

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the grinding area or the cutting action of the replacement must be inferior. It seemed wise to learn which factor would contribute more to chewing ability, in order to be able to advise the dentist what compromise to make.

In the case of persons with natural teeth, the most important factor proved to be the grinding area on the best side of the mouth. This area was measured by having the person bite on a specially prepared piece of dark wax. Where the teeth made contact, the wax was squeezed away, making the area translucent. Its size was estimated from the amount of light it would transmit. As shown by Figure 3, this measure of grinding area ran hand-in-hand with the ability to chew. Here was an index of chewing ability which was rational enough to be used for screening purposes. If the area on the best side of the mouth is high enough, the chewing ability can be called normal; if the area is low the person should be subjected to a performance test.

We can also compare chewing ability of different types of restorations. On an average the artificial denture wearer needs four times as many chews as a person with a normal set of teeth; therefore, his efficiency would be only 25 percent. The average means little, however, for denture wearers differ greatly. Some may have normal chewing ability and others only 10 percent of normal.

It was felt that the change to false teeth might not only affect chewing but might also blunt certain sensations and handicap certain functions of the mouth. For example, it is known that many people lose their enjoyment of ice cream as soon as they have to use a denture, because the layer of plastic on the roof of the mouth dulls the cool sensations. To investigate such effects, we decided to study touch sensations and size and hardness judgments.

Everyone knows that the soft tissues of the tongue and lips are acute organs of touch, but the teeth are not usually considered to be sense organs. Yet certain teeth can detect a touch of 0.1 gram and even a molar can distinguish 5 grams, the weight of a five-cent piece. The same molar may be able to exert a force 10,000 times as great. Loss of supporting tissues surrounding the teeth was found to cause the force tolerance to decrease, but did not affect the touch sense. Another common and important use of teeth as sense organs is to determine the size of food morsels so that the individual gets a cue when he should swallow. A series of discs of different thicknesses were held out before a person who was asked to bite upon each and judge whether it was one of the thicker or thinner members of the series. From the number of errors we learned the smallest difference that he could distinguish. It was surprising to discover that the average person could sense as little difference between discs as 0.15 mm, the thickness of a playing card. Furthermore, artificial dentures were no handicap to the acuity of this sense, indicating it apparently depends upon sense organs in the muscles or joints rather than those near the teeth.

The hardness judgment was also very acute. This faculty is well known to rubber technologists, who often bite on rubber sheets when they wish to get a quick comparison of their hardness. The hardness judgments also proved to be uninfluenced by the transition to complete artificial dentures, except when the rubber discs were hard. Then the

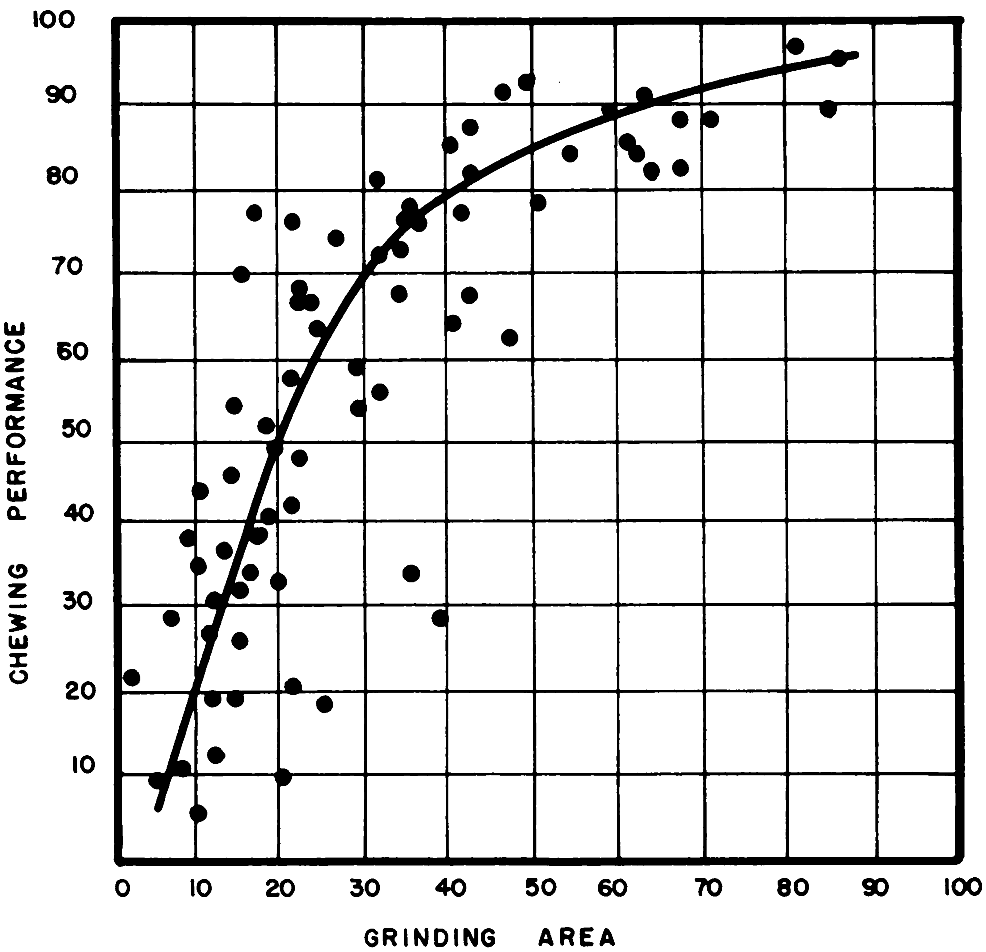

Figure 3. Chewing ability compared to grinding area

rigidity of natural teeth enabled the person to "sense" hardness much more accurately than the denture wearer could. Perhaps hardness judgments could be used as one measure of denture "fit."

Since teeth are important load-bearing structures, we wanted to find out how much pressure was ordinarily used to chew food. It was known that forces as high as 250 pounds could be carried by a single tooth and that forces over 100 pounds were easily obtained in the mouth. But it was also known that loads this large are probably not necessary in eating modern foods. To determine exactly what forces were commonly employed, a pressure-sensitive element was fitted into a subject's mouth in the space left by a missing tooth (see cover). With this apparatus plus suitable electronic equipment, we found that he used only one to five pounds in chewing many foods and never employed more than 27 pounds. This finding helped to explain another fact we had observed: Some persons have a high and others a low force tolerance, but little difference exists in their ability to chew. The reason is that the force needed is well within the capacities of both groups.

Our studies have shown that the "simple" act of chewing is deceptively complex. It is affected by a number of habits and preferences and governed by decisions which the person makes without thinking. Its efficiency becomes blunted when teeth are lost from the "grinding mill." At present we are well on the way to finding out how much of a handicap each of us can tolerate to our "grinding mills" before such damage is reflected in our health and well-being. We are in a better position to do this now that we have found ways to determine for sure when chewing is poor. Soon we hope to be able to supply some of the answers to problems faced by the Armed Forces in deciding how much dental work they should supply for their active personnel and for retired veterans.

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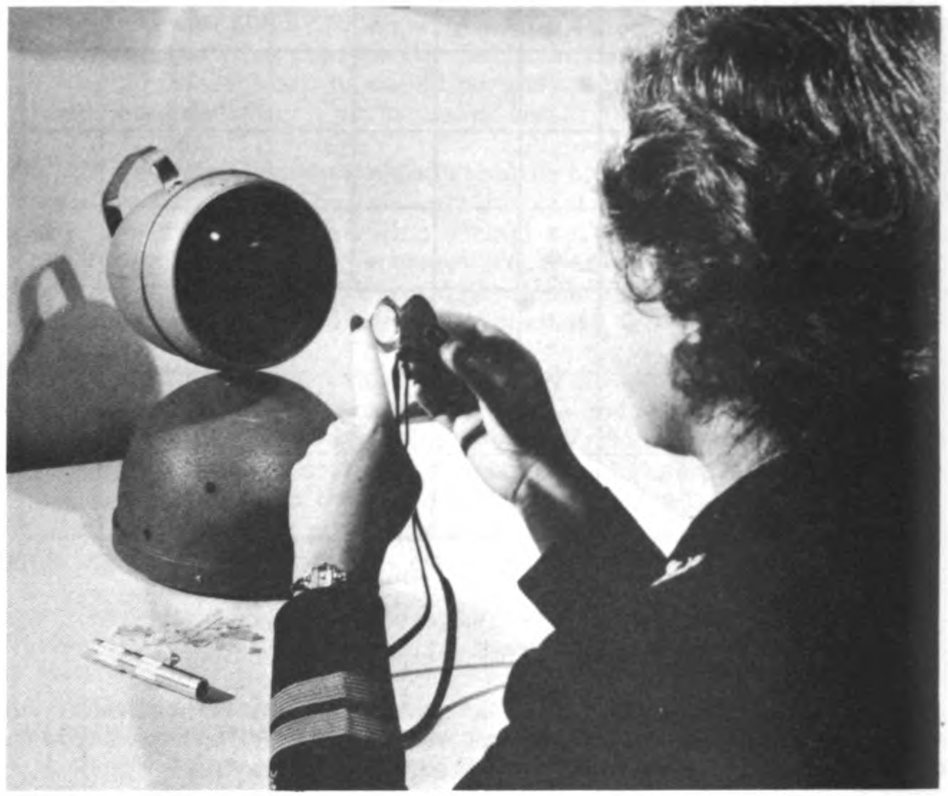
Navy's Two New Radiation Detectors



LT Rosemary **Lafferty** is holding one of the two types of radiation "dog tags" developed recently by the Naval Research Laboratory for the protection of personnel. The oblong object on the table is the other type.

The dosimeter LT **Lafferty** is holding would be most useful in situations where a danger of panic exists, for it cannot be read by the person wearing it. After the wearer has been in an area where radioactivity is a hazard, the device is subjected to ultraviolet light. If the glass in it turns orange, this is proof that it has been exposed to radiation--and the darker the color the greater the dose.

The other dosimeter, which is shown lying on the table, contains normally transparent salts which are turned blue by radiation. This detector is easily read by the wearer.

Both devices are simple, rugged and inexpensive. They were produced under the sponsorship of the Bureau of Ships. (Official Department of Defense Photograph)

Leadership In Small Groups

by
Launor F. Carter
University of Rochester

Daily we hear the call for better leadership. Some feel a need for more effective government, some for more dynamic military planning, some merely for a new officer to get their club going again! Considering the great demand for better leadership, surprisingly little sound scientific knowledge is available to guide us in attaining it. There are many reasons for this lack. First of all, the problem itself is complicated, and the social sciences which should help to solve it are a new endeavor. Furthermore, although we lack basic understanding of the behavior of people in groups and the interaction between groups, many have faith that human relations and leadership are "just common sense". Recently, however, there has been renewed effort to investigate leadership and group phenomena systematically.

On the surface it seems that there should be certain characteristics which are typical of leaders. For years psychologists have been trying to identify such traits. But it has usually been found that while leaders are often dependable, alert, intelligent, and persistent, the relationship between good leadership ability and these characteristics is fairly small. There are also many exceptions to any general statement regarding the traits of a good leader. Stogdill, who has recently summarized over 100 studies on this question, concludes, "A person does not become a leader by virtue of the possession of some combination of traits, but the pattern of personal characteristics of the leader must bear some relevant relationship to the characteristics, activities, and goals of the followers."

Since the approach through traits has proven less fruitful than hoped, increased attention has been given to the particular situation in which the leader performs. The person who is effective in leading one group may be unsuccessful in another group made up of markedly different personalities. Likewise even though the membership of a group may remain the same, its problem may change and some member who has the skills required by the new situation may take the reins. A minister who is an effective leader of his congregation might not make a very good boss of a group of racketeers. As an extreme statement of this view it has been suggested that each situation calls for its own type of leader. A more moderate view is that while there are undoubtedly unique requirements in each situation there are also common elements running through many. This indicates that persons who are successful leaders in one situation will also be adequate in other situations of that same general type. One of the problems of this investigation is the

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Launor F. Carter, now Assistant Professor of Psychology at the University of Rochester, has had extensive experience in Government personnel work. From 1937 to 1939 he served as Chief Examiner for the State Department of Social Security in Washington State. Following this he held positions as assistant personnel technician for the Social Security Board, and later for the Adjutant General's office. During the war he was a major in the U.S.A.F., and immediately following this served as research psychologist in the Aeronautical Medical Laboratory at Wright Field.

Figure 1. This group is planning a task, unaware that it is being observed through the "mirrors" (one-way observation windows) visible at the top of the picture.

identification of those situations which have common characteristics and require similar abilities.

To help solve this problem, an increasing number of studies have been made of small groups. Some studies are based on natural groups and some on "artificial" groups brought together in the laboratory. Our own studies have been made on the latter type. In our laboratory a large work room and a smaller observation room are connected by one-way vision mirrors and communication systems (Figure 1). Usually a group of from two to eight subjects is brought into the work room and given a task. No leader is designated by the experimenter. Thus, the spontaneous emergence of leadership can be studied. Unseen by the subjects, observers in the other room record the interaction between the group members as they work. Figure 2 shows a typical group working on a mechanical assembly task. In one experiment the membership of each group was held constant while the subjects worked on six different kinds of tasks: a reasoning problem, an intellectual construction, a clerical job, a discussion, a muscular cooperation, and a mechanical assembly task.

At the completion of each task the observer made ratings of the leadership performance of each subject. It was found that from task to task different individuals emerged as leaders. On the reasoning task individual A might be the leader but on other tasks he would become a follower and someone else would take over. However, a statistical examination of the consistency of leadership in different types of tasks indicated that some subjects seemed to be effective leaders in "intellectual"

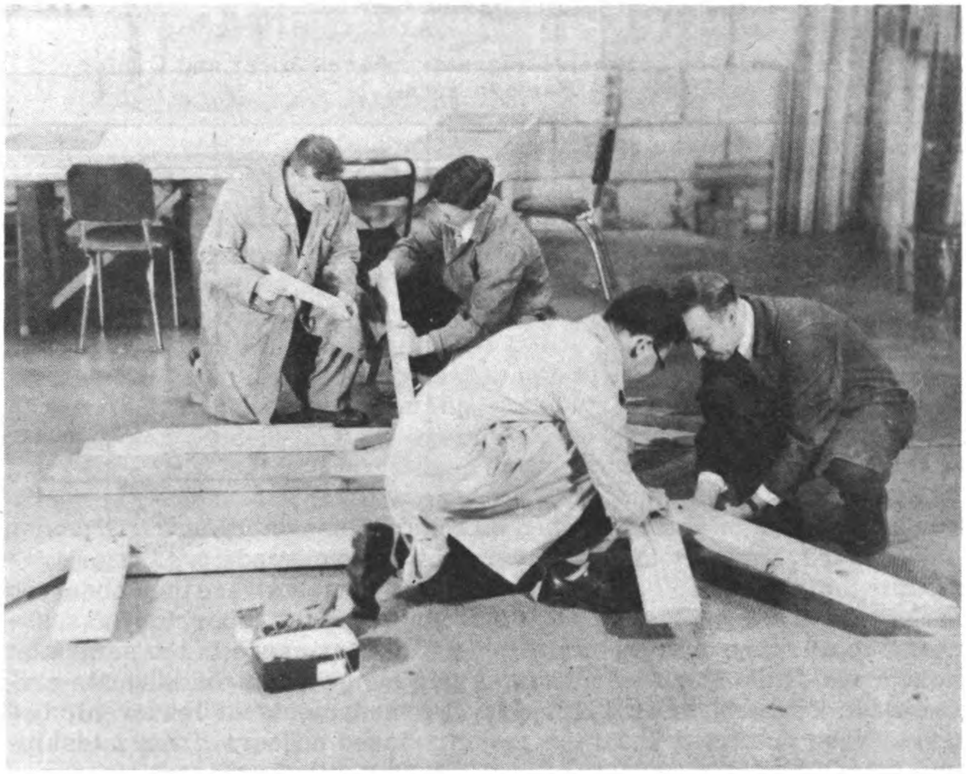

Figure 2. Here the group works on the mechanical assembly task that it was planning. From a rough line sketch, the subjects are assembling lumber to make a bridge.

situations and others seemed to be effective in "doing-things-with-one's-hands" situations. In other words, our six specific situations seem to break down into two basic groups in terms of leadership requirements. Thus one person might be outstanding for one family of situations but some other person would be more effective in another family of situations.

Conclusions like this are limited because of the nature of the members of the groups, the situations employed, and the criteria used in identifying and measuring leadership. The latter problem has many aspects. Since judgments made in laboratory situations may be too artificial, other criteria of leadership have been used. Subjects have been asked to make nominations for leadership after the group has worked together for some time. These nominees were rated by their friends and by faculty members for leadership potential. Records were also available from which the number of leadership positions previously held could be determined. Thus five different types of measures of leadership potential or performance were available: Performance in laboratory situations, nominations by other members of the experimental work groups, friends' ratings, faculty assessments, and previous performance. While all of these could be called criteria of leadership, the degree of agreement between the different types was quite low. As a result, studies based on any one criterion may have only limited generality.

During the winter of 1949-50, 40 NROTC students were observed while working in the laboratory situation. Many combinations of

Table I

Correspondence between Laboratory Assessment and Cruise Performance

Comparison of Laboratory Assessments and those made by:	Other Midshipmen	Commissioned Officers	Over-all Cruise Rating*
Number similarly classified	18	17	22
Number dissimilarly classified	8	9	9
Tetrachoric correlation	.60	.52	.60

*Including 5 marine trainees

subjects worked on the reasoning, mechanical assembly, and discussion tasks. Our laboratory staff, after watching them, made predictions regarding their leadership. Twenty-six of the students were then observed on their summer cruises in an attempt to see if the laboratory assessments would agree with the midshipmen's performance in the somewhat more "real-life" cruise situation. Again the problem of adequate criterion for judgment caused difficulty. Assessments of leadership behavior were collected from the commissioned officers, from midshipmen from other universities, from the final over-all cruise ratings, and from our own staff, who had gone on the cruises. Once again, the agreement between these different sources was not as high as would be desirable. There was considerable correspondence between our staff assessments and the evaluations made by other midshipmen ($r = .72$) but the other relationships were considerably lower (ranging from .14 to .57). Even with this lack of agreement between criteria there was some relationship between the laboratory assessments and judged performance on the cruise. Table I presents relationships between laboratory assessments and cruise assessments of the 26 midshipmen.

From this table it will be observed that when our laboratory evaluations were used as a basis for picking a top and bottom group, and when the ratings given by the other midshipmen on the cruise were similarly used to divide the group, there was agreement in 18 cases and disagreement in eight cases. Similar results were obtained for the other criteria. Of course the number of subjects is extremely small and definite conclusions should not be drawn. The results, however, are encouraging to the belief that there may be a relationship between laboratory assessments and those derived from more real-life performances. Additional data is now being gathered to see if this relationship can be verified.

Many investigators are now working on problems in the area of group behavior and leadership. The application of such work in the selection of individuals for special training is obvious. Efforts are now being made to match bomber crews through techniques developed in similar research. It is reasonable to expect that the day is not far distant when we will have considerable valid knowledge regarding leadership.

Solar Magnetic Fields

by

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The existence of a magnetic field for the Earth has stimulated astronomers to look for magnetic fields elsewhere in the Universe. Modern explanations of the Earth's magnetic field involve slow convection currents (the motion of electrically charged particles) in the liquid core, which occupies the inner-most half as measured along the Earth's diameter. Such currents, which are caused by the rotation of the earth, have accounted for the variable part of our magnetic field. The popular concept that the interior of the Earth has a huge iron magnet inside it (a belief strengthened by the knowledge that the core of the Earth is composed of iron) is wrong. For one thing the interior is too hot. The temperature is above the Curie point, where all ferromagnetism ceases to exist.

If the earth's magnetism depends on slow convection currents, there is good reason to expect that the Sun and other stars also possess magnetic fields. Most stars possess some rotation; the Sun, for example, has a rotation period of 26 days. Other stars revolve much faster and have periods less than one day. In fact a few are known which whirl around so fast that they shed gas streams from their equatorial regions, like a fast spinning wet wheel throwing off bits of water. Since it is well-known that the rotation of such stars cannot be uniform, a current system must be superimposed upon the general rotation. For this reason we might anticipate that some stationary or variable magnetic effects arise from these currents. It is obvious that the first test of such ideas should be made on our nearest star, the Sun.

The presence of the magnetic field on the Earth may be detected by a magnetized needle. No such measurements, of course, can be made for the Sun. We must rely on natural phenomena which disclose the presence of a magnetic field. The observable phenomenon most directly dependent on the presence of a magnetic field is the Zeeman effect. Zeeman discovered in the laboratory that certain atomic lines in the spectrum became double or multiple when the emitting source was placed in a strong magnetic field. The "Zeeman splitting" was found to be proportional to the strength of the field and could therefore be used to measure this strength. It is, of course, immaterial whether the source

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K. O. Kiepenheuer, well-known expert on solar research, came to the United States from the Fraunhofer Institute in Freiberg, Germany, where he had been working under French occupation authorities. He had been responsible for the development of several new instruments and methods of investigation in this field of research.

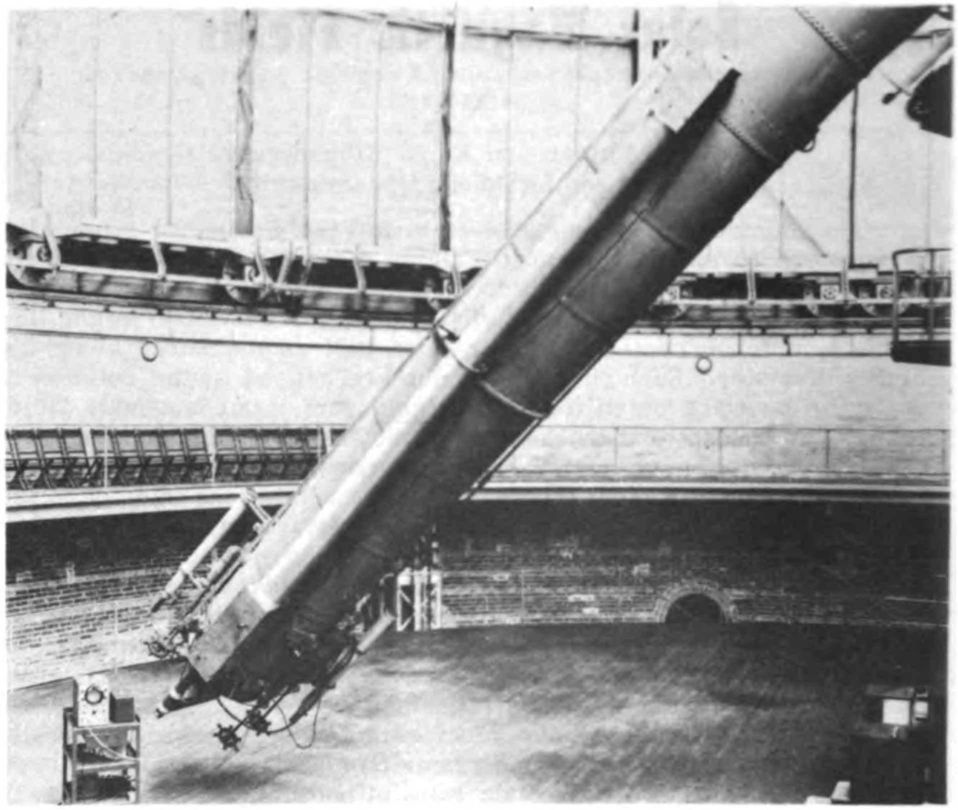

Figure 1. Here the 25-foot solar spectrograph is shown attached to the side of the 40-inch refractor.

is in the laboratory, 93 million miles away as is true for the Sun, or, one million times as far away as the Sun itself, provided that the source is bright enough so that we can use a spectrograph of sufficient resolution to test the presence of the Zeeman splitting.

Certain refinements in technique may be made which permit the observer to detect magnetic fields too small to produce true Zeeman splittings; it must be remembered that spectral lines are never completely sharp and that therefore the Zeeman components will partly overlap when the fields are small. The refinements consist of making use of the different polarization properties which the different component-lines possess. By using the proper analyzers we can eliminate alternately one or the other components of the Zeeman pattern and thus produce small shifts in the blend, which then can be measured.

Another, quite recent method gets information about magnetic fields by observing the polarization of solar radiation in the meter-wave band. Also, particles observed as cosmic rays or geomagnetic effects caused by such particles can give us estimates on the structure and the strength of interstellar or interplanetary fields.

A current ONR project here at Yerkes Observatory is designed to give information on the magnetic fields on the Sun. It has been known since the time of G. E. Hale that sunspots are very powerful magnets with field strengths sometimes in excess of 3,000 gauss. Outside the local fields associated with the spots, a more general field seems to exist which supposedly corresponds to the field we observe on the surface of the Earth. It is, at best, very weak and therefore gives at most only minute displacements of solar absorption lines. Indeed, these displacements are so small that the results of different astronomers have been contradictory, especially when based on the older methods of spectroscopy. A decision as to whether there really is a general solar field has still not been reached, but at present both observation and theory support the existence of a variable field. A definite observational result would be of a great importance, not only for a better understanding of the interior of the sun, but also for the interpretation and prediction of the Sun's emission of cosmic rays, corpuscular beams, and electromagnetic radiation in the range of 10 to 300 Mc.

The method in use at Yerkes Observatory is a combination of high-resolving spectroscope (concave grating, spectrograph of 21-foot radius and interferometer) and modern electronic procedures. The displacement of a line in the solar spectrum is transformed into an intensity variation of light which is measured by a photomultiplier. A rotating optical device takes care that any Zeeman effect observable in a solar line gives rise to a vibration of this line and therefore to an a-c signal of known and fixed frequency. This signal is then amplified by a tuned narrow-bank audio-amplifier to such an extent that the signal can still be detected even if it is one thousand times smaller than the noise level. The noise is a direct consequence of the quantum structure of light and of the photoelectric effect. Although the sun is such a brilliant light source and the 40-inch refractor has such a great light-gathering power, there are only about 10,000 photons/sec available to give the information desired.

The accuracy of the method has closely approached the theoretical limit. This limit is set by the fundamental properties of light and by the optical properties of our atmosphere.

The preliminary results which have been obtained in the short period since the instrument was completed are not yet in finished form, but they already show some interesting and unexpected features. The full potentialities of the method will not become available until the measures have been extended systematically over several years, i.e. a good fraction of the solar cycle of eleven years. It will also be necessary to make comparisons with similar data obtained at one or two other observatories now active in this field for the measurements are among the most difficult made in physical science.

The attachment of the 25-foot solar spectrograph to the side of the 40-inch refractor is shown in Figure 1. The 40-inch tube is 63 feet long. It supports the 40-inch doublet in the upper end of the tube, outside the picture, while the image is formed at the bottom end of the tube. The solar image is eight inches in diameter and has a resolution of about one second of arc. Two right-angle reflections throw the image onto the first slit of the solar-spectrograph. The 21-foot grating is placed in the upper end of the spectrograph tube; the spectrum and analyzing slit as well as the interferometer and the revolving polarizing devices are contained in the box-like lower end of the spectrograph. The record is observed on the oscilloscope placed on the observing platform.

On The Naval Research Reserve

Special Devices Seminar Planned

The Chief of Naval Personnel has approved a fourteen-day Naval Research Reserve Seminar for Volunteer Reserve Officers, to be held at the Special Devices Center, Port Washington, New York, during the period 21 April to 4 May 1951.

The seminar will provide an opportunity for selected Reservists to familiarize themselves with the special devices program. It is planned to include field trips to activities where special devices are in use in current training programs. A complete schedule will be announced in the near future.

Limited quotas for the seminar have been assigned to District Commandants. Priority will be given to members of Volunteer Research Reserve Units who are special devices officers. An application should be forwarded in quadruplicate to the cognizant District Commandant, via appropriate channels, including the Commanding Officer and Director, Special Devices Center (Code 720). Proper "via" addresses for members of Volunteer Research Reserve Units are: (1) Commanding Officer of the unit; (2) Commanding Officer of the cognizant ONR Branch Office (Research Reserve Program Officer), or, for the Southeastern Area, where there is no ONR Branch Office, the Chief of Naval Research (Code 230, Research Reserve Program Officer, Southeastern Area); and (3) Commanding Officer and Director, Special Devices Center (Code 720).

Officers ordered to this seminar from the 11th, 12th, and 13th Naval Districts will be required to perform travel at no expense to the government.

Civil Defense News

VNRRU 5-4, Glen Burnie, Md.

This unit is taking an active part in the training of civilian defense personnel in the State of Maryland, but members are not committed to the extent that the program would suffer if they were mobilized. Lt. Col. David G. McIntosh, USAR, Maryland State Director of Civil Defense has requested that the group train civilians in the use of radiation detection devices. This work will be undertaken as soon as the personnel are selected and the material is available. Members of the unit would like information from other civil defense groups on the steps they have taken to further the program in their localities.

VNRRU 13-2, Richland, Wash.

The basic qualifications and experience of the majority of the members of this unit are considered excellent for participation in the civil defense program which the group has undertaken. Most of these reservists are employed as scientists and engineers at the Hanford Works of the Atomic Energy Commission. A number have completed the course in radiological safety at the Damage Control Center on Treasure Island, San Francisco, and a few have been trained in the theory and use of health instruments designed to protect humans from destructive radioactivity. Their program has the dual purpose of serving those civilian agencies which need the Navy's scientific advice in problems of atomic defense and of increasing the specialized knowledge of members of the unit. According to present plans, six months will be spent in educating reservists in all aspects of atomic warfare and defense measures. Then the services of these men will be available to civilian defense groups on a consultant basis.

VNRRU 9-16, Lansing, Mich.

Members of this group felt that the most critical need was for some medium to bring to key civilian leaders in the community the magnitude of atomic warfare. For this reason three movies were shown to a number of civil and military groups. These films, obtained through the Ninth Naval Branch Office of ONR, were: "Able and Baker Day Tests at Bikini", "Medical Effects of the Atomic Bomb", and "Medical Aspects of Atomic Bombing".

During the past three weeks, a lecture team has been operating at the request of the Lansing Civilian Defense Chairman. These lecturers have been attending local civic meetings in pairs. The first speaker gives a description of a theoretical atomic bombing of an undefended city, pointing out the limits of destruction in terms of known landmarks and approximate numbers of casualties. Then a second speaker outlines what the city should do to protect itself against such a disaster.

The participation of the unit in civil defense plans has been welcomed by local authorities. The most noticeable effect in the community has been an increased interest in the organization of defense groups.

LETTER FROM SECRETARY MATTHEWS

The following letter was received by Federal Civil Defense Administrator Caldwell from Secretary of the Navy Francis P. Matthews:

My dear Mr. Caldwell:

It would seem appropriate to inform the Civil Defense Administration of the efforts being made by the Office of Naval Research to aid the Civil Defense Program throughout the Nation and of the potential benefits to many local Civil Defense authorities in utilizing the advisory talents of the Naval Research Reserve Units.

The Office of Naval Research sponsors a Naval Research Reserve program which comprises some 90 units and 3100 Naval Reserve officers. The majority of these units are located on university campuses and the membership is composed of Naval Reserve officers who are principally engaged in research or some other scientific endeavor. The roster of these units is attached.

It is considered that these units are well qualified to assist the local defense effort in a consultant capacity relative to the simplification of the scientific aspects of radiological defense. They were encouraged to offer their services in such a capacity by letter of 20 July 1950, a copy of which is attached. Several examples of this cooperation are given in other attached enclosures.

At the Oak Ridge Seminar mentioned in Secy. Matthews' letter, LT Price and LCDRs Robertson, Simon and Peterson watch the effect of the electrostatic high-voltage generator on LTJG Laug. Though his body is at a potential of thousands of volts, he is in no danger because of the generator's low current.

From 29 November to 12 December, 1950, the Office of Naval Research sponsored a Radiological Defense Seminar at Oak Ridge, Tennessee, conducted by Naval Research Reserve Unit 6-3, which is located at Oak Ridge. Attending this Seminar were some 50 officers from the various Research Reserve units throughout the country, as well as the representatives of several Naval District Commandants.

Incidentally, the Chief of Naval Research has expressed his appreciation for the cooperation of Admiral G. L. Schuyler, USN (Ret.), Consultant, Civil Defense Research, National Security Resources Board, who addressed this Seminar on 30 November.

It should be understood that neither the Research Reserve Units nor individual members of these units can participate in the Civil Defense program to the extent of being members of disaster teams etc., since they are all available for recall to active duty in case of general mobilization. However, the services of the Office of Naval Research and the Research Reserve are available to Civil Defense Administration in the formative and training stages of your program. Information on procedures desired should be referred to the Director, Naval Research Reserve, Office of Naval Research, who may be contacted on government code 131 or LIberty 5-6700, Extension 6-5812.

Sincerely,

/S/ FRANCIS P. MATTHEWS

LTJG's Brockington, Parker and Moss look on as LTJG Keniston places a dime in a large lead box containing a source of neutrons which, by bombarding the silver atoms in the coin, will make it slightly radioactive. This device is at the Oak Ridge Museum of Atomic Energy.

At the Oak Ridge Institute of Nuclear Studies, this group is working with Geiger Counters and Scaling **Circuits.**

Mobilization Billets

The following letter, reprinted from The Naval Reservist, contains information which is of interest to VNRR members.

Sir: I would like to know the type of duty a Reserve officer with an AL classification would normally perform on active duty. As an engineer I would like to know if I might be able to apply my background in engineering if I should be called to active duty. As an AL officer should I include information regarding my engineering experience when I fill out my annual qualification questionnaire?--A. J. S., Ensign, USNR, New York City.

The old-style officer "classifications" (including your classification of "AL") are now obsolete, having been replaced recently by the numerical "designator." For example, the classification AL is now replaced by the designator 1355, which means "an unrestricted line officer who is a member of the naval aeronautic organization not on duty involving flying."

Like the old-style classification, the new type designators are designed primarily to identify officers as being in the Line or Staff Corps, and to categorize them further into general groups within those branches. They do NOT determine your mobilization billet. For information on the changeover to designators, see the June 1950 issue of The Naval Reservist (pages 4 and 5).

Your specific civilian and military skills, training, and experiences have been analyzed from data in your records and are recorded in your "qualification codes," which are used primarily in determining MOBILIZATION assignments.

"Qualification codes" are six-digit numbers, and as many as five different significant "qualification codes" are maintained for each officer. Cards containing your "qual codes" and other pertinent data are filed for each Reserve officer. In the event the Navy desires a particular individual with special qualifications, it can run thousands of these cards through electric IBM machines. The machines will select the cards of those persons who have the necessary qualifications, and an assignment officer can then make his final selection after studying the complete records of the individuals whose cards have been picked by the machine.

In your particular case, as you are a general service man, it cannot be determined in advance the type of particular duty to which you would be assigned, since billets are determined by (1) your qualifications, and (2) the needs of the naval service.

It is suggested that you include all experience, training, education, and special qualifications when making out your personnel qualification questionnaire.--Ed.

Promotion Boards to Convene

Promotion boards will convene in March to select reservists for promotion to CAPT and CDR; in April to select from all officers on active duty candidates for the ranks of LT and LCDR; and in May to select reservists on inactive duty for the ranks of LT and LCDR.

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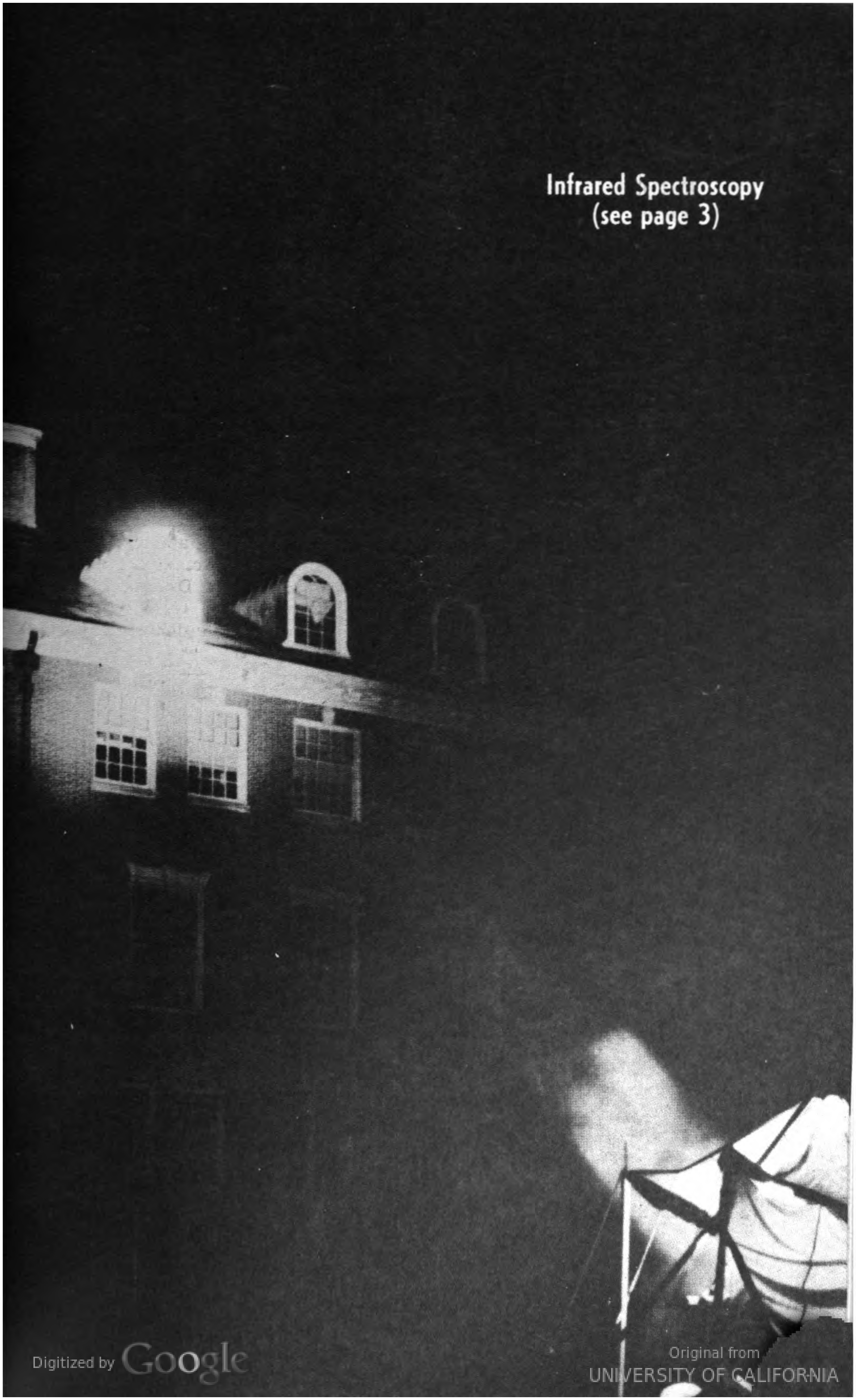
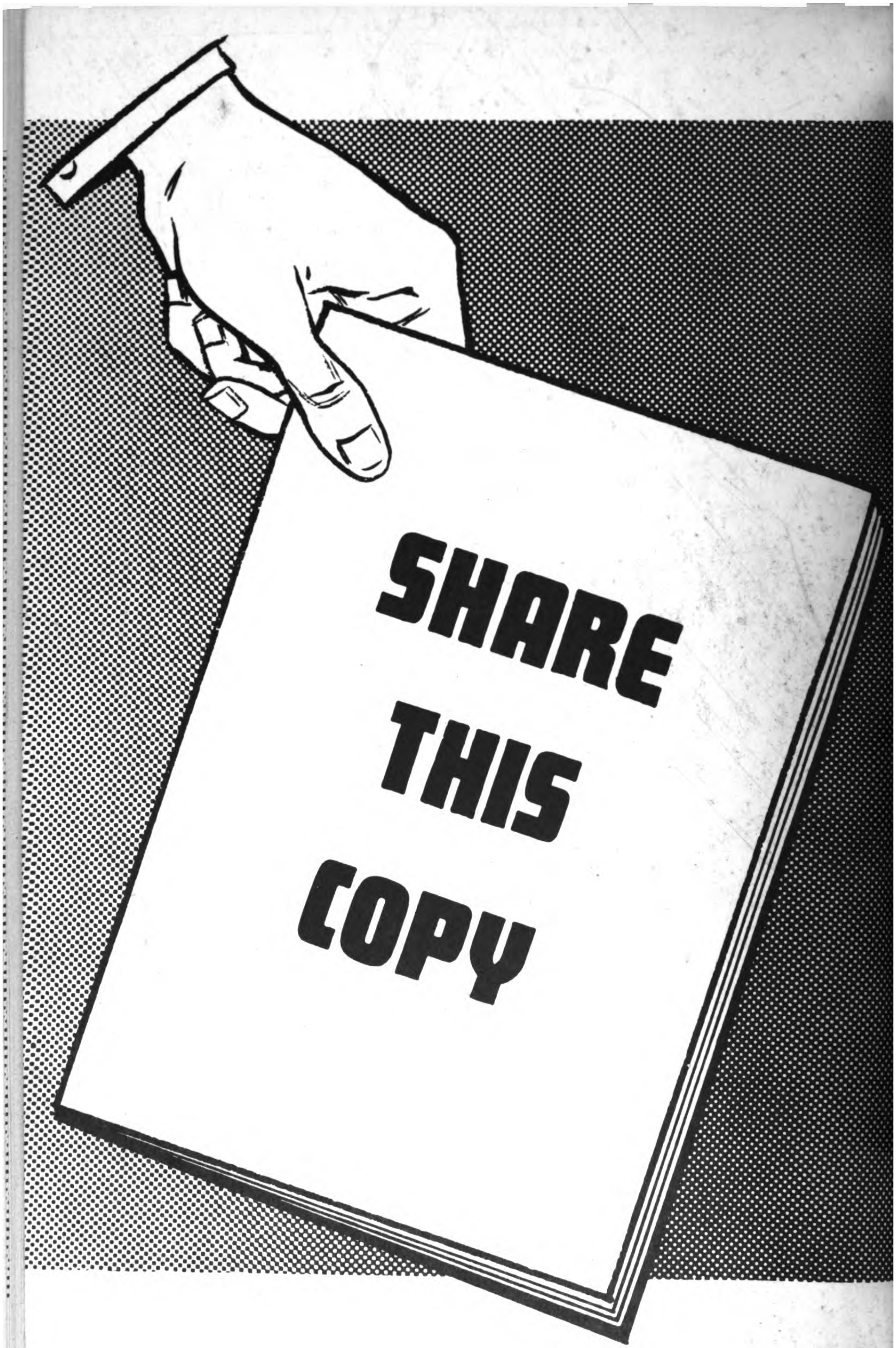

Infrared Spectroscopy
(see page 3)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