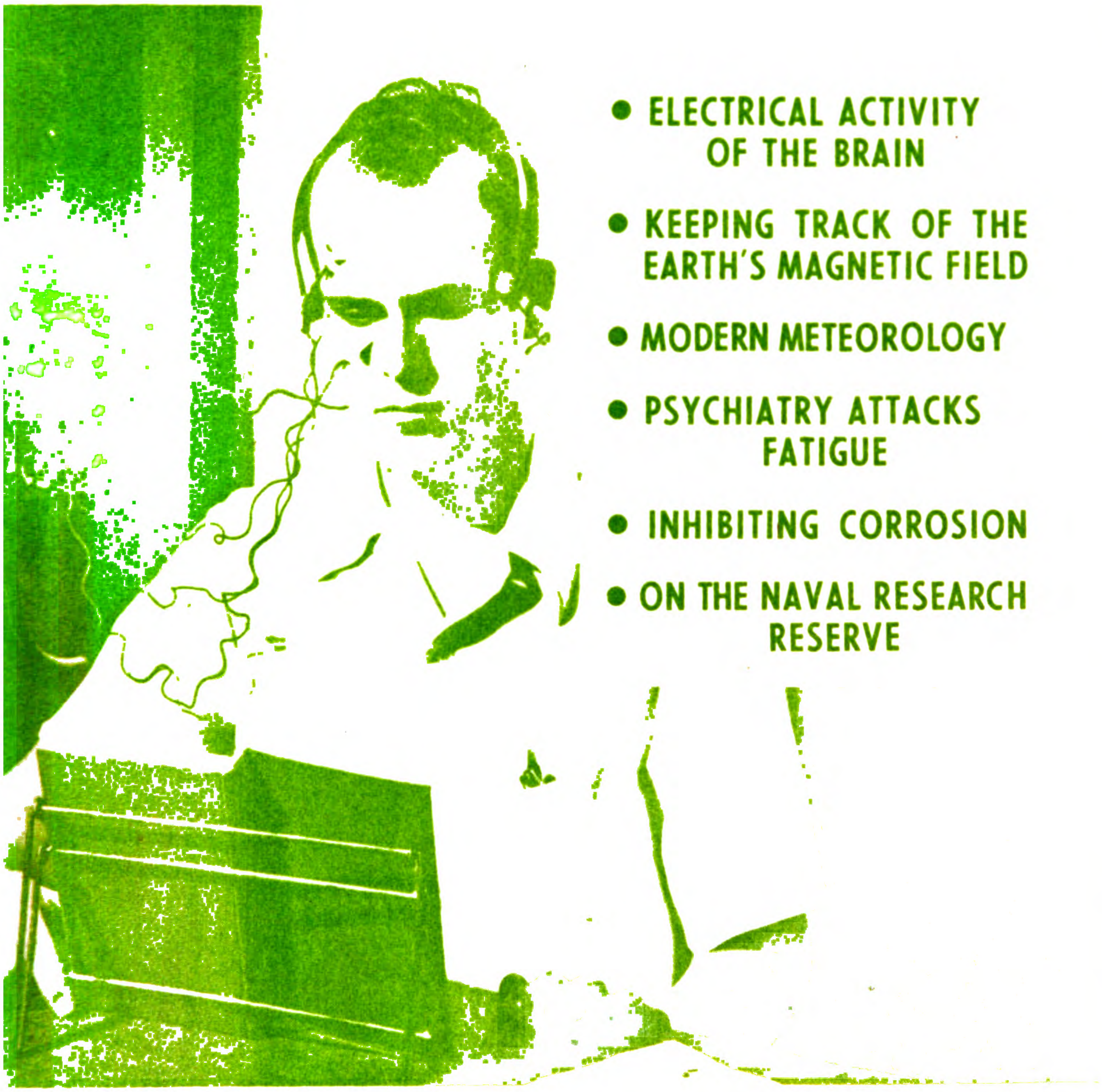
JUNE 1949 FOR OFFICIAL USE ONLY

RESEARCH REVIEWS



- ELECTRICAL ACTIVITY OF THE BRAIN
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- ON THE NAVAL RESEARCH RESERVE

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

NAVEXOS P-510

COVER PHOTO: Subject with electrodes attached. The electrodes lateral to each eye will yield a record similar to that shown in Fig. 1, p. 2. (See the article, "Electrical Activity of the Brain," p. 1.)

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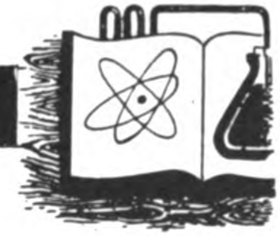
June 1949

Approved by Bureau of the Budget, 13 April 1948.

RESEARCH REVIEWS



● *Informs the Fleet of ONR-sponsored Research*

Editorial Notes

300,000,000-electron volt synchrotron. At the General Electric Research Laboratory, Schenectady, New York, a new kind of atom-smashing synchrotron is being built under a contract with ONR. Of non-ferro-magnetic construction, it is listed as a 300,000,000-electron volt instrument which may ultimately produce one billion electron volts.

X-rays at high altitudes. In collaboration with Army Ordnance at White Sands, N. M., Naval Research Laboratory scientists reported the discovery of x-rays in atmospheres pierced by high-altitude V-2 rockets. These soft x-rays, believed to come from the sun, are actually gentler than those used by a dentist, and are responsible for the ionosphere or electrified air layers in the atmosphere that reflect the radio waves and enable these waves to travel long distances. Theories have hitherto credited the sun with emitting radiations like those now observed to cause the radio-reflecting layers but they have never before been discovered.

Cosmic rays. ONR research on cosmic rays was described on the "Adventures in Science," a radio program sponsored by Science Service. Dr. Urner Liddel, Chief, Physical Sciences Division, ONR, and Dr. H. V. Neher, ONR contractor at the California Institute of Technology participated. Dr. Liddel stated that cosmic rays, which are continually bombarding us without doing any apparent harm, may be a hazard to the operation of electrical equipment on future high flying airplanes. ONR is supporting a dozen teams of researchers on cosmic ray studies.

Solar furnace. Rockhurst College, Kansas City, Missouri, is the home of the only "sun furnace" in the United States. Research there on methods of harnessing the solar rays is under the supervision of Dr. W. M. Conn, ONR contractor. The instrument, which weighs five tons but is so delicately balanced that it can be turned by hand, is capable of focusing solar radiation to obtain temperatures up to 4500°C in small areas. This extraordinary instrument will be used to investigate further the physical chemistry of refractory compounds, and thus provide a basis for future development of heat-resistant materials.

Animal brain kept alive outside body. Two University of Chicago physicians reported to the Federation of American Societies for Experimental Biology that they had succeeded in keeping part of an animal's brain alive outside its body to permit study of the functions of the nervous system. Drs. R. D. Tschirgi and R. W. Gerard reported this achievement, the first of its kind in medical history. The experiment involved removal of the spinal cord of a rat, together with the feeder artery which transports its sustenance. Keeping the cord alive in a carefully regulated atmosphere, the physicians were able, by pumping chemicals into the cord instead of blood, to determine its needs and to enable it to transmit messages over the complex nervous system. The doctors, working under a contract with the Office of Naval Research, are being assisted by Drs. L. L. Boyarsky, J. Z. Hearon, and H. Jenerick, all of the University of Chicago's Department of Physiology.

Letters

Dear Sirs:

We have here four issues of Research Reviews, Office of Naval Research, dated January, February, March and December 1948. They are all marked as restricted. Would you please advise me whether these issues have been declassified.

R. v. Mises
Graduate School of Engineering
Harvard University

On January 6, 1949, all the issues of Research Reviews for the year 1948 and the January 1949 issue were declassified from "Restricted" to "Open." Issues subsequent to January 1949 have also been unclassified.

The Editors

One of our contributors for this issue writes us:

"...We have received the magazine (Research Reviews) now for some time and have found the articles to be extremely interesting and very well written. We have been working on an ONR-sponsored contract in micro-meteorology now for about two years and we believe the article will prove of interest to most of your readers..."

John R. Gerhardt
Assistant Director
Electrical Engineering Research Laboratory
University of Texas
Austin, Texas

The Editors thank Dr. Gerhardt for his remarks and believe his comments should be passed along to the contributors to Research Reviews for they are the ones who make this journal a success.

The Editors

Dear Sir:

"I wish to thank you for adding the name of this office to your distribution list for the publication Research Reviews. I feel that it will be beneficial to this office in planning and coordinating work that is being carried on here."

Frank L. Fuller
Superintendent
University of Minnesota
Rosemount Research Center
Rosemount, Minn.

Dear Sir:

"I thoroughly enjoy Research Reviews because it gives us glimpses into fields we are not ordinarily familiar with. I appreciate your putting my name on the mailing list."

W. A. Weyl, Head
Department of Mineral Technology
Pennsylvania State College
State College, Penna.

The Editors are glad to learn the different ways in which Research Reviews serves its readers.

The Editors

ELECTRICAL ACTIVITY OF THE BRAIN

Leonard C. Mead
Tufts College

Often the scientists' research efforts lead to entirely unpredicted and unanticipated results. This is true notwithstanding the fact that the prediction of events in nature is part of the main business of science. A common fallacy concerning the way that scientists behave is the assumption that they carefully manipulate and control a novel set of objects and events "just to see what will happen." Actually, of course, a research worker performs his experiments in a particular way because he has a pretty good idea that something new will happen or that something old will not happen. In other words he is trying to prove or disprove a theory or hypothesis proposed by himself or by someone else.

This report describes a newly discovered biological phenomenon which may have far-reaching importance. In the present instance, however, the result was neither predicted nor expected and had no relation to the primary object of the original experiments. This is a discovery, therefore, in which the usual sequence of events, i.e., prediction corroborated by experiment, was reversed. Our narrative may be of interest for its own sake; it also raises certain basic questions concerning the direction and control of research. If fundamental scientific information can be obtained by the process of merely making a working environment available to active and inquisitive research personnel, one may well ponder the extent to which research should be "programmed." Obviously, one can find many examples of important discoveries, theoretical and applied, which came about in the course of either "programmed" or "incidental" research. In this day and age of extensive federal support of basic and applied research it is important that both types of investigation be allowed to continue. The writer believes that the various programs which are sponsored by the Office of Naval Research still allow sufficient freedom to the research worker so that he may at least observe and develop the implications of results which were incidental to his main purpose, thereby preserving these novel and unexpected findings for later investigation.

Leonard C. Mead is Coordinator of Research for Tufts College and associate professor of psychology. He is also on the staff of the Tufts College Institute for Applied Experimental Psychology, under which the work of the project described in this article was conducted.

Dr. Mead is a graduate of Dartmouth College, holds M. A. and Ph. D. degrees from the University of Rochester in the field of psychology. He was instructor and later assistant professor of psychology at Tufts College from 1939 to 1946. During World War II, as assistant director of the Laboratory of Sensory Psychology and Physiology, he undertook two wartime projects under the Applied Psychology Panel, National Defense Research Committee, OSRD. He also participated in research and development on training equipment for the Special Devices Division of the Navy. From 1946 to 1948 he was on leave of absence from Tufts College as Head of the Human Engineering Branch of the Special Devices Center, Office of Naval Research.

The studies described herein were conducted in the Institute for Applied Experimental Psychology at Tufts College under contract with the Special Devices Center of the Office of Naval Research.* Originally, the intention was to develop a device which would automatically assess the adequacy of behavior of the eyes during reading. One criterion of reading adequacy is the number of movements which the eyes make while reading a standard passage of print. Eye movements can be recorded in a number of ways; one of the newer techniques is to measure the electrical potential differences (between the front, or cornea, and back, or retina of the eye) which develop in proportion to the frequency and amplitude of eye movements. These corneo-retinal potentials are usually measured by attaching electrodes to the skin near the external corner of each eye; the small potentials are then fed to an amplifier whose output drives the pen of an ink-writing oscillograph. The cover photograph shows a subject with electrodes attached; Fig. 1 demonstrates characteristic reading movements of the eyes.

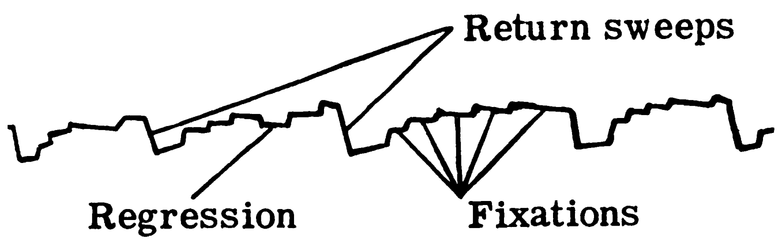


Fig. 1. Typical eye movements while reading four lines of print. The return sweeps are movements from the end of one line to the beginning of the next line. The fixations are the pauses along the line. Note one regression back to an earlier portion of the line.

In the Tufts project it was desired to substitute an automatic counter for the more tedious and non-automatic process of counting the various movements on the paper tape. This automatically determined count was then to be correlated with other criteria of reading efficiency to evaluate its value as an eye movement score. An electronic counter was developed which would be triggered off every time a potential of a predetermined magnitude was reached. Numerous observations were made using both the counter and the paper tape recording. It was found that the counter score was always higher than the one which was obtained by hand counting on the ink records. Many variations of experimental conditions were tried but the electronic device continued always to count "too much." At this point the experimenters were about ready to discard the counter as of no value for this particular purpose.

In attempting to arrange conditions so as to produce a correspondence between the counter and paper records of eye counts, variations

*Kennedy, John L., Gottsdanker, Robert M., Armington, John C., and Gray, Florence E. A new electroencephalogram associated with thinking. Science, November 1948, 108, 527-529.

in the gain of the amplifier were made. Also, in order to be sure that a subject read a known amount of printed material in the various trials, the subject routinely fixated for a short period the first word in each new paragraph. While so fixating the subject would press a finger signal marker which appears on the paper tape of the oscillograph. The experimenters observed, under these conditions of high gain and eye fixation, that there would often appear a series of waves at a frequency of about ten per second. A typical record is shown in Fig. 2. At first these waves were regarded as errors of fixation or as muscle potentials from tissue around the eyes. It seemed very likely that the counter was activated by these waves, as well as by the bio-electric potentials produced during reading, and considerable effort was expended in an attempt to eliminate them. Dr. Kennedy was the first to propose that these waves might be brain potentials similar to those found in the ordinary electroencephalogram (EEG or "brain wave").

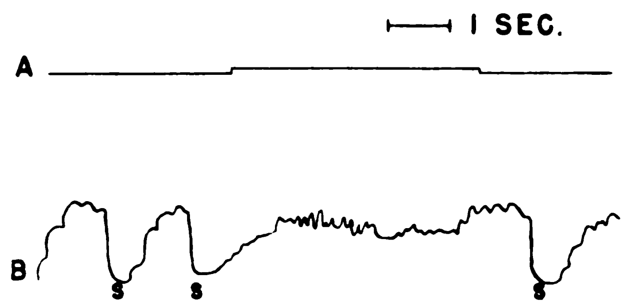


Fig. 2. Kappa bursts during reading. The job in Line A shows when the subject maintained fixation. S is a return sweep.

Thus we come to the first deviation from the planned course of this research project. It became necessary to find out what these "intruding" phenomena were so that they could be eliminated as a source of interference with the original goal. A number of experiments were carried out to ascertain the cause of what the rest of the staff called "Kennedy's waves." With hindsight, it is not now surprising that they turned out to be true brain waves. On the other hand, no electroencephalographer "in his right mind" would ever put his electrodes on this placement near the eyes; blinks and eye movements have long been known to "clutter up" brain waves. Under conditions of eye fixation (to eliminate this cluttering effect) these 10 per second waves were first demonstrated to be of brain origin.

The next question was to determine whether these brain waves were like other brain waves. It has long been reported that brain potentials from the back of the head, when the subject is in the dark or with his eyes closed, will appear at relatively large magnitude and at a frequency of ten per second. These waves, called "alpha" waves, are inhibited by light flashes or mental activity and are augmented when the eyes are closed and the subject is mentally relaxed. On the other hand, the alpha rhythm has been reported to occur much less frequently when the electrodes are placed on the frontal regions of the scalp as in the present case. Some of the conditions which were tested to see whether "kappa" waves (as they were now called by the staff) occurred were the effects of light or darkness, voluntary and involuntary eye movements and blinks, mental arithmetic, problem solving, memory tasks (as in recalling the 48 states), learning tasks (both mental and muscular), keeping the "mind a blank," pulse rate, breathing, talking, and discrimination between the lengths of musical tones. Findings disclosed that all those tasks which involved "thinking" were accompanied in some subjects by these kappa waves; also, the percentage of kappa waves produced was proportional to the difficulty of the thinking task. Thus, counting to oneself by ones produced little or no kappa bursts; saying the alphabet backwards produced many more bursts than saying it forward; memorizing and recalling a long list of nonsense syllables produced a considerable number of bursts. There seemed to be no relation to such physiological changes as breathing cycle, pulse rate, eye movements, talking or performing other habitual tasks. These kappa waves also behaved in a manner opposite to those conditions which produced alpha waves; thus alpha disappears when you open your eyes, but there is no effect on kappa; mental arithmetic causes alpha to disappear, but this is the very condition that produces kappa. In other words, it appears that an entirely new sort of brain wave has been discovered which is associated with thinking. If this is true then this incidental discovery is a significant advance in the field of electroencephalography which has been seeking just such evidence ever since 1929 when it was first reported that brain activity could be recorded from the intact scalp.

What does all this mean? The first reaction of any scientist would be to repeat the experiments so as to check or disprove them. In fact, the original discoverers are busily engaged right now in further tests of substantiation; they recognize that their present hypotheses concerning these kappa waves might be found as far off the beam as their electronic count of eye movements. On the other hand, if it is really true that these waves are a concomitant aspect of thinking behavior, then all biological scientists who are interested in such phenomena will have a fascinating new tool for investigation. These observations should be of particular interest to psychiatrists, neurologists, clinicians, physiologists, and psychologists. Thanks to the broad support and interest of the Office of Naval Research we may have made one more forward step in our understanding of human behavior.

Titanium

Titanium was the subject of an excellent symposium held in Washington last December. Seventeen papers were presented and discussed by men from governmental agencies and laboratories, industry, universities, and other institutions. The Office of Naval Research sponsored this symposium which represents the greatest concentration of information available on the subject. The final report of the symposium is now on sale by the Superintendent of Documents, Government Printing Office, for 65 cents per copy.

KEEPING TRACK OF THE EARTH'S MAGNETIC FIELD

L. R. Alldredge
Naval Ordnance Laboratory

Early History of Knowledge of Earth Magnetism

There is a magnetic field about the Earth. Direct measurements have been made of this field from deep down in mines up to nearly 100 miles above the surface of the earth. The existence of this field of force which is not detectable by our human senses, as is gravity, has been known for many centuries.

The discovery of the magnetic ore magnetite, often called lodestone, paved the way to the development of the magnetic compass, which

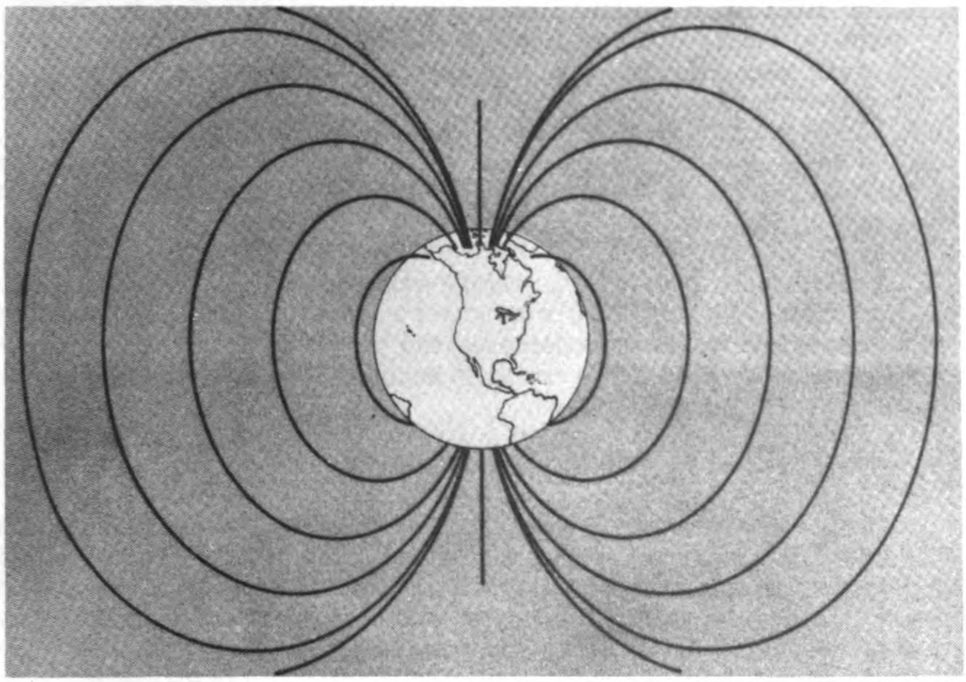


Fig. 3. Magnetic field surrounding Earth.

L. R. Alldredge, Acting Chief of the Electricity and Magnetism Division in the Research Department of the Naval Ordnance Laboratory, is in charge of electricity and magnetism problems pertinent to the Navy ordnance program, including development of airborne magnetometers and interpretation of magnetic survey data. Mr. Alldredge received his B. S. and M. S. degrees in physics from the University of Arizona in 1940. He did additional graduate work at Illinois Institute of Technology and the University of Maryland. In 1940 he was instructor in physics at the University of Arizona. From 1941-43 he was radio engineer with the Federal Communications Commission, and in 1944 he did magnetic work on National defense problems for the Carnegie Institution of Washington. In 1945 he joined the staff of the Naval Ordnance Laboratory.

has been used by navigators since the eleventh century. It was discovered that a piece of lodestone mounted on a block of wood and floated in water always indicated a particular direction. It was later found that such a compass pointed true north only in certain places. At other locations it would point a little to the east or west of true north. This error with respect to true north has become known as the magnetic declination or variation of the compass. It was not discovered until the 16th century that magnetic forces tended to tip a magnetized needle from a horizontal position. The angle between the final position of a magnetized needle free in space and the horizontal plane is called the dip angle or angle of inclination.

The general characteristics of this invisible field of force gradually became known and in the year 1600 William Gilbert published his famous volume pointing out that the Earth itself acts to a certain extent as though it were a great spherical magnet as shown schematically in Fig. 3.

At any point on or near the Earth and at a given instant of time the magnetic field has a definite direction and magnitude. The direction of the field is the direction in which the field would tend to push an isolated north magnetic pole, and the magnitude of the field is measured by the strength of its force on such a pole. At each point, the magnetic field can be completely described by giving the magnitude, declination, and the inclination, or by giving the vertical and horizontal component of the field and the declination, or by giving the vertical, true north, and true east components.

For the past 300 years, geomagneticians have been mapping the characteristics of this field with great success. During this period many investigators have considered the problem of the origin of the earth's magnetic field with very little success. Its origin still remains a well guarded secret of nature.

Characteristics of Earth's Magnetic Field

If the earth's magnetic field could be mapped once and these values would remain unchanged for all future time, the problem would indeed be a rather simple one. A complete detailed declination survey would result in magnetic navigation maps which could be as appropriately used in the year 2000 as today. Unfortunately this is not the case. In some locations quite some distance removed from the magnetic poles the direction in which the compass points changes as much as one quarter of a degree per year. Offhand this may appear to be a rather small rate of change but it requires that surveys be made regularly in order to maintain the required accuracy of the magnetic navigation charts. Near the magnetic poles this rate of change may be much greater. These long-period changes are called secular changes.

In addition to the slow change with time there are much faster changes which add to the difficulty of making a coherent survey. There are more or less regular variations associated with the position of the sun and moon. There are also irregular variations which occur during magnetic storms. Except for very severe storms these short period variations have amplitudes which are too small to disturb a navigator using a magnetic compass but they are large enough to cause difficulty

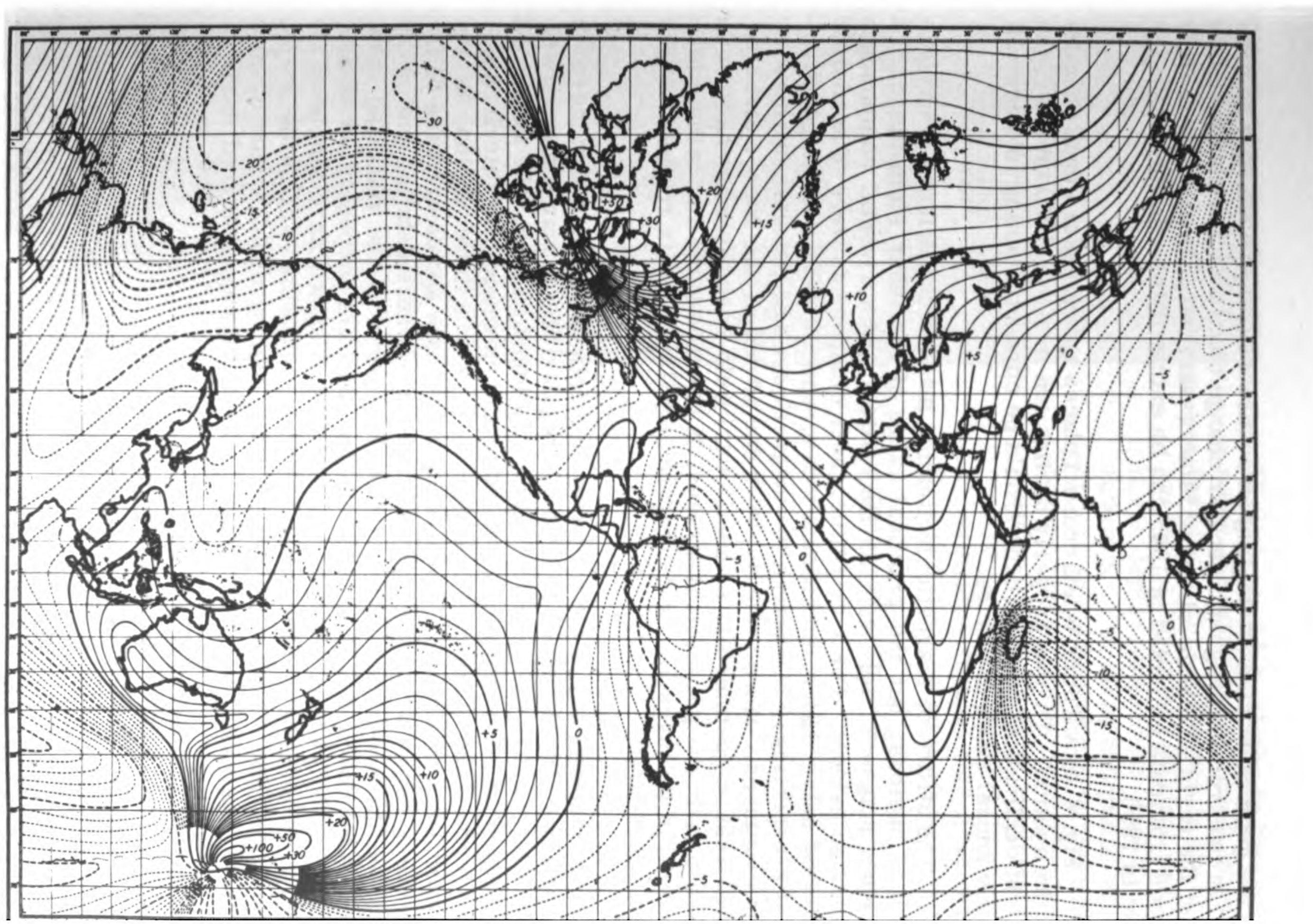


Fig. 4. Geomagnetic secular change in minutes per year, declination, epoch 1942.5.

to the geomagnetician attempting an accurate survey which may be useful in constructing magnetic secular change charts. A knowledge of how fast the earth's field is changing is necessary so that magnetic charts made from data collected in 1945 can be extrapolated into the future for use in 1950.

Fig. 4 shows lines which connect places having equal annual changes in declination. To use properly declination maps in 1950 or later, the latest declination map available should be corrected taking into account these annual rates of change.

The utility of magnetic declination maps in the science of navigation is obvious, but the practical value of the other elements of the earth's magnetic field such as its vertical and horizontal components is not so evident. For a long time, these components were of academic interest only. Later, component measurements were used in geophysical prospecting in the search for magnetic ores or possible oil-bearing substructures. More recently, with the advent of the Navy's airborne total field magnetometer, magnetic total field intensity maps have been used in airborne geophysical surveys. It is conceivable that in the future several of the magnetic field components will be used in routine navigation procedures.

In mapping any of the magnetic elements on the surface of the earth or at a low altitude, many localized irregularities appear which may be much larger than the time variations mentioned earlier. The amplitude and extent of such anomalies depend on the magnetic characteristics of the surrounding geology. The degree to which these anomalies are preserved in map making depends upon the scale and desired use of the resulting map. In most geophysical surveys where detailed geology is desired the anomalies are the important parts of the resulting map. Data taken for a small scale navigation map are purposely smoothed, leaving in only broad regional effects. Fig. 5 shows an example of the degree of smoothing which may occur in compiling worldwide maps. The dotted line was taken from the latest hydrographic magnetic map (1947). The solid line is the actual field which was measured during a

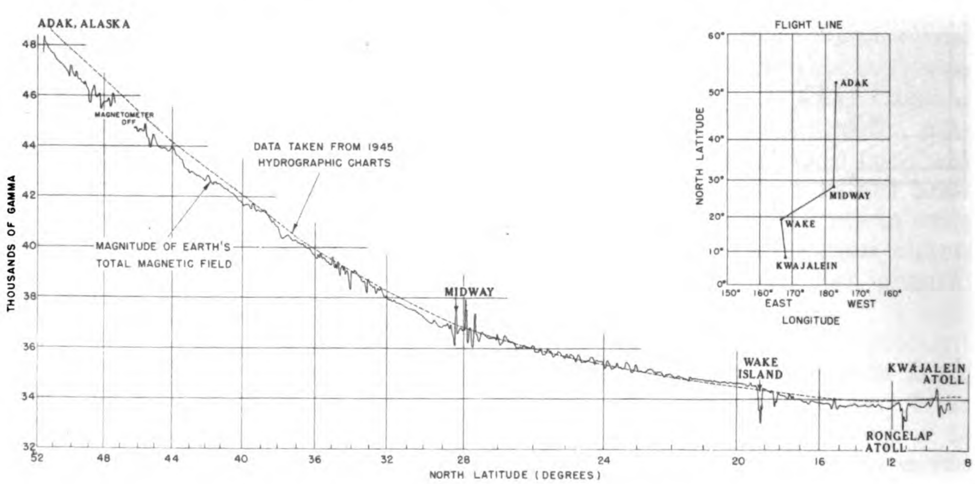


Fig. 5. Magnitude of Earth's total magnetic field, Adak, Alaska to Kwajalein Atoll.

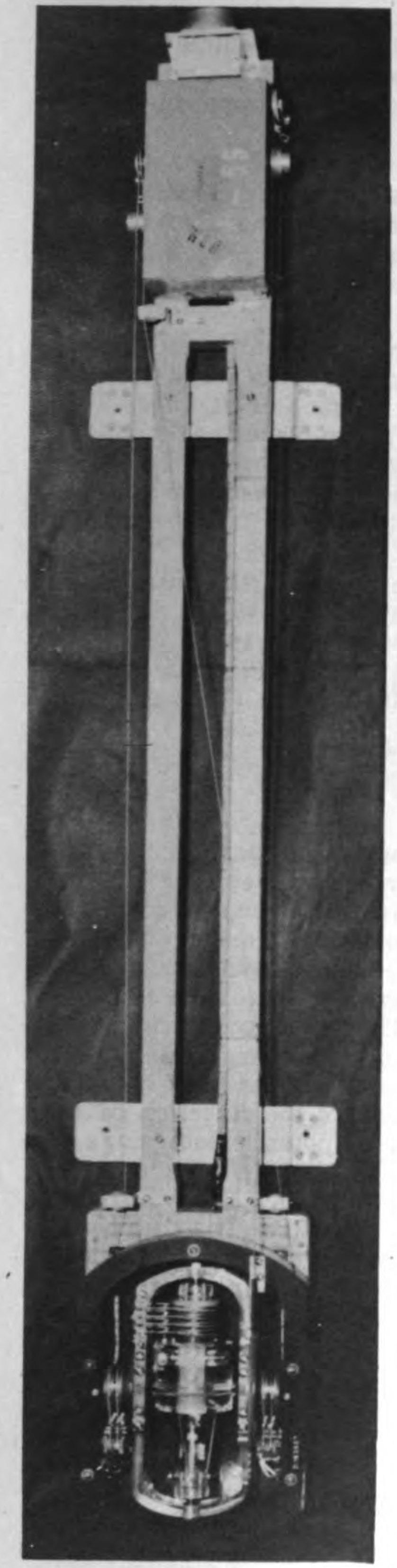


Fig. 6. Airborne magnetic detector head with orienting servo motors.

flight from Adak, Alaska to Kwajalein using the Navy's total field magnetometer. This flight was made at an average altitude of 1000 feet and the ocean depths range from 2000 to 3000 fathoms. The many anomalies which appear would be reduced in amplitude if the flight had been made at a higher altitude. Part of the smoothing indicated in Fig. 5 resulted from lack of sufficient data in this area when the charts were compiled.

Existing Instruments

Nearly all magnetic field measurements before World War II were made using either rotating coils or the deflection and oscillations of small magnets. Many of these instruments are still best for certain types of field measurements.

With these instruments very accurate measurements of all magnetic components can be measured on land and many of them have been adapted for less accurate work at sea in non-magnetic ships. Ordinary floating and gimbaled compass needles are, of course, in this class and are used in aircraft as well as at sea for very rough measurements. Component-measuring instruments of this type have not been adapted successfully for use in aircraft.

During World War II a new type of magnetometer was developed by the Navy. The sensitive mechanism in this magnetometer is a thin permalloy scroll around which a single coil is wound. This coil is driven so as to saturate the magnetic core on each half of a thousand cycles per second oscillation. A 2000 cycle per second voltage proportional to the magnetic field along the core axis is induced in the coil.

Three of these detecting elements are mounted mutually perpendicular. Two of them control servo motors so that the third one is always maintained with its axis parallel to the direction of the Earth's field.

Since this magnetometer is stabilized by the earth's magnetic field itself, it is practically independent of the motion of the vehicle carrying it. This feature makes it readily usable in aircraft. This magnetometer has become known as the magnetic airborne detector and is called the MAD.

During the war the MAD was used to locate submarines by detecting their anomalous fields. Near the close of hostilities the MAD took its place as an important geophysical survey instrument. Fig. 6 shows a MAD detector head with orienting servo motors.

The advent of this successful airborne magnetometer brought clearly into focus the desirability of making worldwide magnetic surveys from the air instead of in slow-moving surface craft. This need was further emphasized by the fact that long range planes could quickly cover large ocean areas which had either never been covered before or at best were surveyed before 1929 when the last non-magnetic ship "Carnegie" was destroyed by explosion in Samoa.

The MAD measures only the magnitude of the earth's total field. This single bit of information about the Earth's field is valuable and has been used extensively for geophysical prospecting. It is not however, adequate for making world magnetic maps. The way in which the data are taken does not permit the calculation of inclination, declination, or any of the component magnetic intensities.

Improved Instruments

The Naval Ordnance Laboratory, working on a project sponsored by the Office of Naval Research, during the past year has been modifying the MAD so that it can collect all of the data required for complete magnetic mapping. As described earlier, the MAD automatically orients itself so that the detector coil always points in the direction of the magnetic field. If this direction can be recorded along with the amplitude then all magnetic components can be calculated. Fig. 7 shows the modification being made to the old wartime MAD to accomplish this. Angle-measuring potentiometers mounted on the two gimbal axes of the MAD detector mechanism permit an electronic measurement of the direction of the field with respect to the aircraft frame. Similar potentiometers are on the vertical gyro axes (shown in upper left of Fig. 7) to indicate the position of the aircraft frame with respect to vertical. A knowledge of these four angles, of the field intensity, and of the aircraft's true heading permit calculation of all magnetic elements. True aircraft heading can be obtained from a directional gyro often reset to true north using an astro compass. A system as just described is now being prepared for a flight test.

At present the main inaccuracies in this system are caused by vertical gyro and true heading errors. As these factors are improved it is quite certain that airborne measurements will attain approximately the same accuracy obtainable in non-magnetic ships.

A combination of dead reckoning, celestial, Loran, Shoran, and Strip camera methods of navigation and recording ground location can be used to obtain ground location.

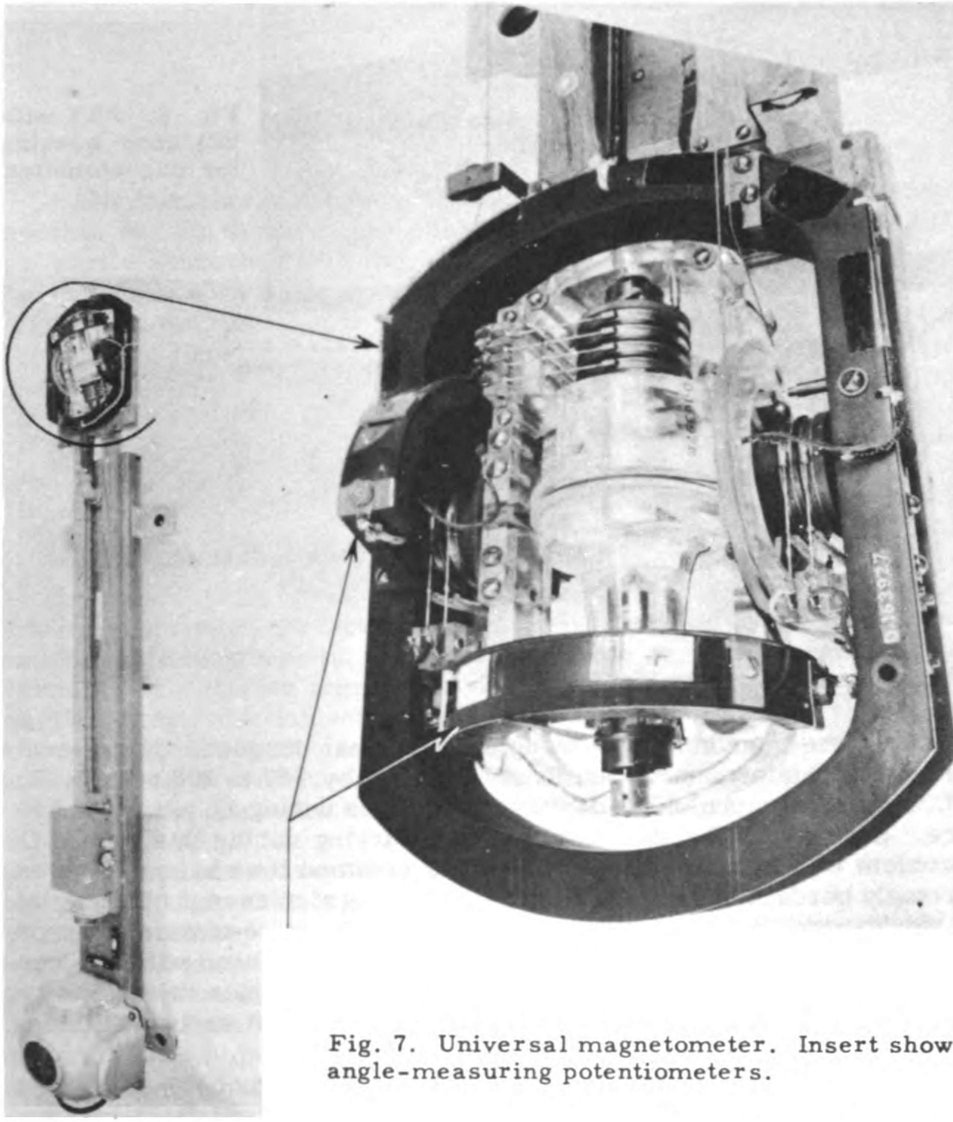


Fig. 7. Universal magnetometer. Insert shows angle-measuring potentiometers.

In making magnetic measurements from ships, elaborate precautions must be taken. Special non-magnetic ships, such as the "Carnegie" which was lost in an explosion at Samoa in 1929 and the "Research" now under construction in England, must be built for such purposes. Fortunately, modern airplanes are built principally of aluminum which is non-magnetic. There are, however, many parts of an airplane such as motors and steel torque tubes which can cause difficulty with magnetic measurements. Many modern military planes with their armor and DC-operated motors with ground return are unfit to carry a sensitive magnetometer. Many aircraft can, however, without great difficulty, be modified into suitable vehicles for magnetic work. In some cases this modification will require the building of a tail cone extension as shown on the PBY in Fig. 8. In other planes such as the DC-4 it may be possible to place the sensitive magnetic element inside the plane. In such cases some form of magnetic compensation will be required.

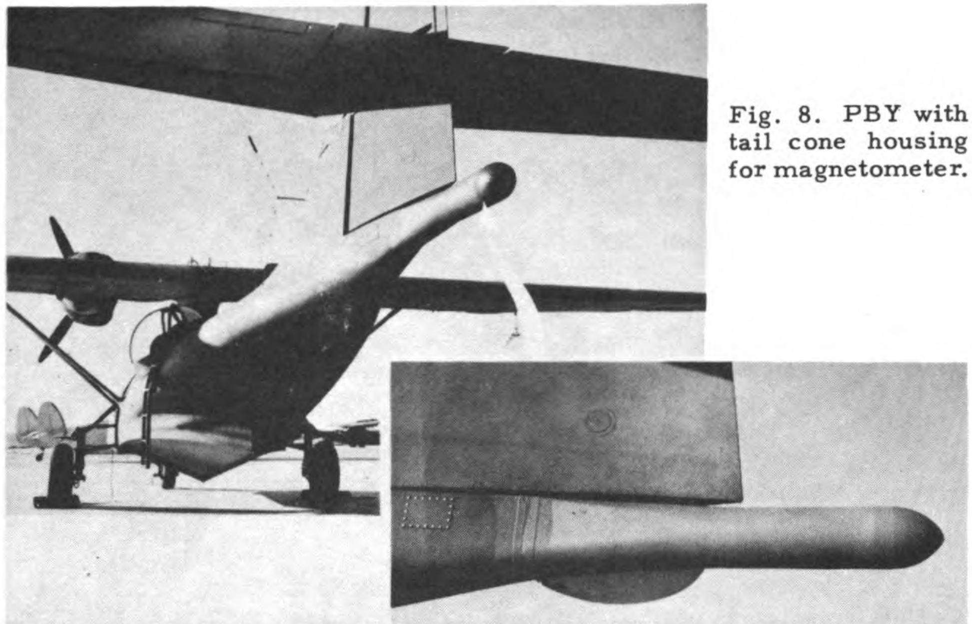


Fig. 8. PBY with tail cone housing for magnetometer.

Comparison of Survey Methods

A non-magnetic ship using conventional magnetic instruments normally obtains data at stations separated by 200 to 300 miles. The "Carnegie" occupied 6000 declination stations during 17 years of service. Because of the secular changes occurring during this period the problem of reducing all of the data to a common time base was an extremely burdensome task. Several cooperating airplanes could complete a world-wide survey rapidly enough to avoid this time-consuming problem. The airborne techniques which are being developed will give continuous data along a flight line. Airborne techniques will be more flexible including operation over land and water and at various altitudes.

Because of the differences in the type of data obtained by non-magnetic ships and by proposed airborne techniques, it is impossible to make an accurate comparison of costs for the two methods.

Taking into account the difference in the speeds of the ship and plane, the time required for maintenance and bad weather delays, assuming that each is equipped with the same instruments, we can estimate that from 10 to 15 ships would be required to obtain as much data as a single plane.

Cost estimates for the two methods would also favor the airborne measurements. In any case, much of the cost of airborne measurements could be absorbed as operational training expense which must continue whether magnetic surveys are made or not.

It should be emphasized that although airborne magnetic survey methods look very favorable, it may be several years before instruments are readily available and have been thoroughly tested in operation. In the interim, it is important that non-magnetic ships such as the British "Research" be put into service.

MODERN METEOROLOGY

John R. Gerhardt
University of Texas

The trend towards ever increasing specialization has finally caught up with our old diehard, the weatherman. True, most of us are still primarily concerned with the weather as it affects us personally, and no matter how esoteric some of the newest research may appear, a significant amount of it is ultimately aimed at improving forecasting techniques. Nevertheless, the atomic age has revolutionized the science of meteorology. The weathermen of the twenties did not have to exert themselves very much to include forecasts for aircraft in their daily prognostications, for the weather patterns at 10,000 feet are not significantly different from those of the surface. The higher speed planes and pressurized cabins of the prewar era, however, brought some of the first new horizons to meteorology, for aircraft at altitudes from 25,000 to 50,000 feet are above most of the normal weather phenomena of the troposphere. Once again, with the very rapid development of jet and rocket propulsion, we have cracked the old ceiling wide open and we now have meteorologists engaged in research on atmospheric characteristics at altitudes from 10 to 200 miles above the surface of the earth. A somewhat fantastic extension of this research is derived from the fact that the earth certainly isn't the only cosmic body with an atmosphere, and preliminary studies are already underway on the meteorology of the sun and some of the planets.

Although there can be no doubt as to the need for and the dramatic aspects of high-altitude meteorology, we must not overlook the very pertinent and very practical problems involving the meteorology of the layers of air immediately adjacent to the surface. This branch of meteorology has been given the rather impressive name of micrometeorology, and it is concerned primarily with the study of the effects of the surface upon the air within the first few hundred feet above the surface. Such well known phenomena as mirages, ground fog, frost, dew, and evaporation are good illustrations of these effects. Micrometeorology is of special interest to all agriculture, for the "weather" at crop level may be strikingly different from that recorded by standard installations. Some indication of this may be found in the fact that on clear calm nights, the temperature at four feet may be as much as 8-10°F greater than the temperature at the surface, while during the day under the same calm, clear conditions, the temperature at four feet may be up to 50°F less than the temperature at the surface. It is often possible to fry eggs on the sidewalk under these conditions.

John R. Gerhardt, assistant director of the Electrical Engineering Research Laboratory, University of Texas, received his B. S. degree from the Illinois Institute of Technology in 1940. He attended a war course for meteorology officers offered at New York University in 1943. During the war years he was engaged in wartime research programs with the Air Forces Board, Signal Corps, and National Defense Research Committee on the meteorological aspects of microwave propagation. He is now working on an ONR contract involving the mechanics of heat and moisture transfer in the lower atmosphere.

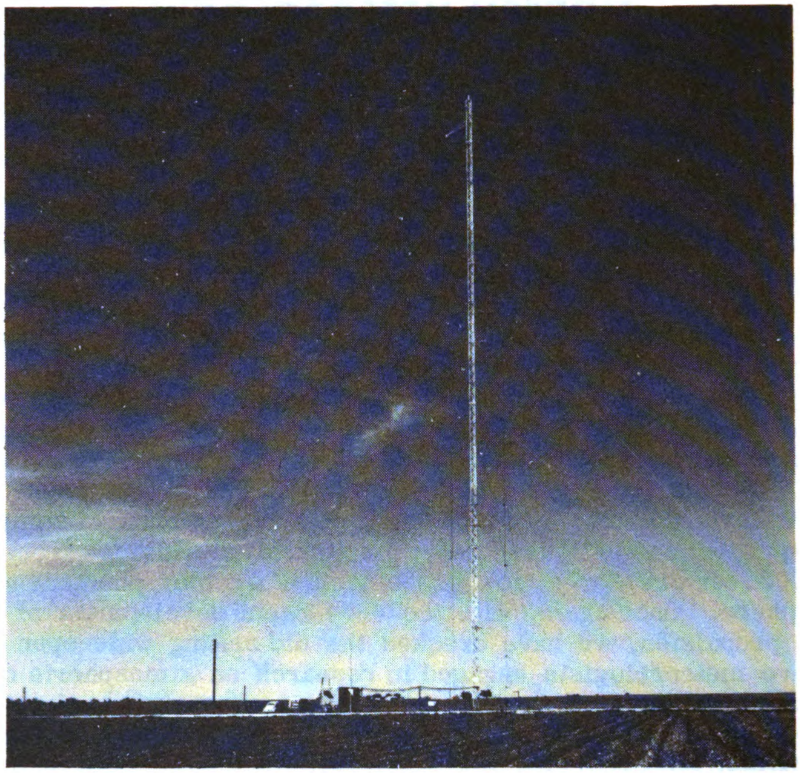


Fig. 9. General view of the 300-ft meteorological tower of the Electrical Engineering Research Laboratory, University of Texas. This tower is located about 15 miles northeast of Austin, Texas, on a gently rolling cotton cultivated terrain. Instruments for measurement of temperature, moisture, and wind gradients are strung from booms at top of tower.

A very up-to-date aspect of micrometeorology comes in the fields of radar, radio relay transmission, and television. These communication devices employ ultra-high frequency and microwave radiation, and it is in the propagation of this short wave length electromagnetic energy through the atmosphere that we encounter strange effects. It seems that the air is able to refract or bend this energy much in the same fashion as light is bent when traveling from one medium to another. Under certain conditions which are functions of air pressure, temperature and moisture, the refraction can become such as to distort completely the normal propagation patterns, and the micrometeorologist is interested in the understanding and prediction of these effects.

Another new field for very low level meteorology has come into existence recently with improved chemical warfare procedures and the development of large scale atomic energy plants. Both of these processes are fundamentally concerned with the mechanism of the diffusion of matter through the lower atmosphere. In the first instance, the micrometeorologist must be able to determine the behavior of a gas or smoke cloud under all types of weather and surface conditions. In the second case, where a radioactive efflux is emitted as a by-product of atomic disintegration, it becomes essential to know just how this very active material will disperse through the atmosphere and under what weather conditions the discharge might become dangerous to nearby personnel. These problems are quite complex but are related primarily to the detailed gradients of temperature and wind speed near the earth's surface.

Fig. 10. A closeup of the University of Texas micrometeorological research site. The van at left houses the amplifying and recording equipment.

The primary interest in micrometeorology is, however, a more theoretical one, and is concerned with the overall heat balance of the atmosphere. It is well known that the sun basically powers the enormous atmospheric engine with its many large and small scale circulation patterns. However, it is the surface of the earth which transmits most of the sun's energy to the atmosphere and it is only in a study of the mechanisms of convection, conduction, and radiation at the surface that we can hope to understand the complex nature of the transfer of this energy to the atmosphere as a whole. More locally, a good portion of the free air turbulence that a pilot encounters in flight and the widespread airmass-type showers and thunderstorms are evolved directly from turbulence initiated at the earth's surface.

The meteorological research being undertaken by the University of Texas for the Office of Naval Research does not thus have as an aim the solution of any particular practical problem, but is concerned primarily with the mechanics of heat, mass, and momentum transfer in the lower atmosphere. We are interested in the development and structure of turbulence, and in the relative contributions of convection, radiation, and conduction in these transfer processes. From a well-equipped 300-foot tower near Austin, Texas, comprehensive records are being made of the detailed gradients of temperature, moisture, wind speed, and direction near the earth's surface. Through analysis of these and other records, it is hoped that we will be able not only to contribute materially to micrometeorological theory, but also to throw light on the practical aspects of the forecasting of phenomena such as fog, frost, microwave propagation, and smoke diffusion.

Scientific Research

"Research is and should be a truly democratic activity. Its planning and support should never become a monopoly; a dictatorship for research is unthinkable. Its strength rests in large measure upon the degree to which scientists and engineers have opportunity to exchange and discuss views, in scientific and engineering publications, in conference and in personal contacts. As in all democratic processes, an element of competition is very desirable, as are teamwork and cooperative enterprise. As long as the professional reputation of a scientist or engineer depends upon the soundness and originality of his work, artificial and forced methods for coordination in true research are unnecessary; it is only essential that research men and women in the same field are aware of each other's work. . . .

"The current emphasis upon research is, of course, due primarily to the realization of its power in technological progress. Now, in the ordinary course of events, technological advances occur by successive stages in the sequence: basic research, with or without background research, applied research, and development. This process is a time-consuming one and generally requires a period from five to ten years under present conditions. One of the technological problems of the future is how best to streamline this evolution. For the present I wish to stress two fundamental aspects of this sequence: (1) that each step in the process is invariably present and in fact indispensable, and (2) that each step in general requires a different kind of talent and hence a different class of experts for successful progress. This latter is one of the cogent reasons for cooperation between academic, industrial and governmental agencies. The steps involved may, as often happened in the past, have taken place over very many years, by different generations and in different countries. In particular the basic research step may come from our library of scientific knowledge, without the need for special investigation. Many indeed are the items of research which remain only in our library of knowledge, and for which no practical use is foreseen--some to await the day when they are brought forth to fill urgent practical needs. But right now accessions to this scientific library are critically needed, in view of the thorough going-over it got during the war and the lack of contributions received during that period. . . ." *Dr. Alan T. Waterman, Deputy and Chief Scientist, ONR.*

PSYCHIATRY ATTACKS FATIGUE

Robert S. Schwab
Massachusetts General Hospital

The term fatigue is used so frequently that its meaning should be clear. This, however, is not the case and all sorts of conditions such as boredom, worry, irritability, distaste, and weakness are called fatigue.

The reader will more easily understand some of the problems connected with fatigue as related to military personnel or industrial workers, if we start at the motor organ or muscle and proceed from there to the brain in considering the characteristics of fatigue.

If a muscle is stimulated by a suitable electric current 4 or 5 times per second, after a time the contractions diminish and finally there is no response at all to the stimulus. A period of time which may be as long as several minutes is necessary for the muscle to recover before it will respond again. From such observations and chemical studies of the muscle tissue, we know that a muscle becomes fatigued for two reasons. The first is an exhaustion of the materials that are used for the production of energy, i.e., the fuel supply, oxygen and glucose. The second is the accumulation of carbon dioxide and lactic acid resulting from oxidation (metabolism) of the fuel supply in the muscle. These waste products produce an acidosis which is most intense in the muscle itself, but is detectable throughout the body as these products are carried in the blood stream. It is the property of both muscle and nerve to require more intense stimulation to achieve a response in an acid medium; conversely, the threshold is lower in an alkaline state. The cells of the conducting nerves between the brain and the muscle and the nerve cells in the brain itself are also fatigued when they are overdriven by too intense or frequent stimulation. This central or brain fatigue is somewhat different from that in muscle. No reduction in fuel supply is evident and there are no data that metabolites have accumulated in excess. The nerve cells that are stimulated too often become refractory so that they do not transmit the next stimulus down their axone to the next neurone. The slight acidity in the blood from metabolites

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Robert S. Schwab, is instructor in neurology at Harvard Medical School and Director of the Brain Wave Laboratory at Massachusetts General Hospital. He received his A.B. degree from Harvard College, 1926, his M. A. degree in physiology from the University of Cambridge in 1929, and his M. D. from Harvard Medical School, 1931. During World War II Dr. Schwab was in the U. S. Navy Medical Corps with the rank of Commander.

Dr. Schwab's interest in fatigue began with a study in 1935 of patients with Myasthenia gravis, which is a disease producing chronic and acute fatigue in the muscles, previously fatal in most cases but since the discovery of the drug, prostigmin, dramatic results have been achieved in checking the disease. Dr. Schwab is principal investigator for an ONR-sponsored project at Harvard University to study the different types of fatigue. His work is coordinated with that of Drs. Stanley Cobb and Jacob Finesinger, also of Harvard, who are studying the effects of anoxia under ONR-sponsorship.

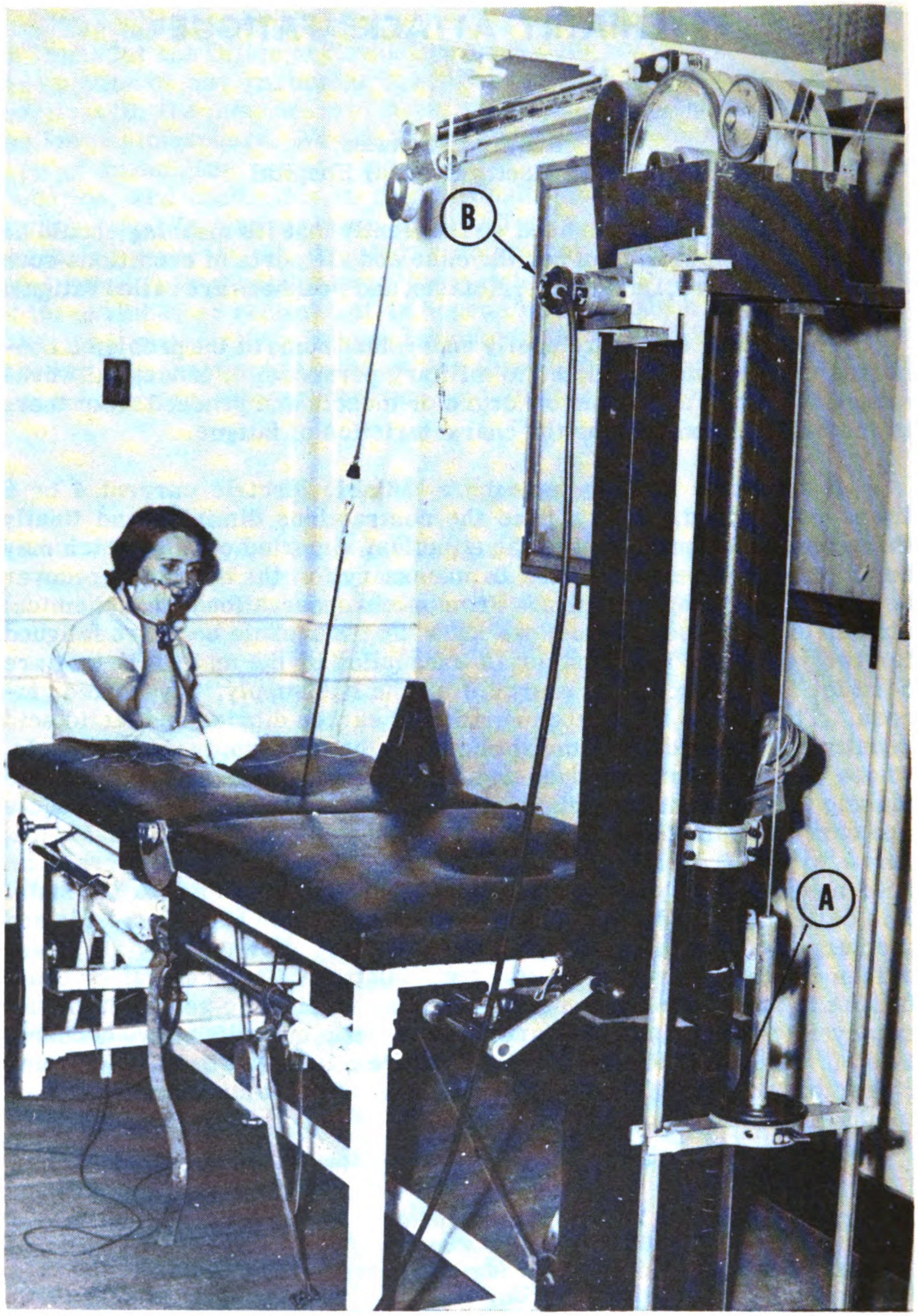

Fig. 11. Type of ergograph used in this study. Subject contracts her biceps muscle which flexes her arm and pulls weight A through a distance of approximately 30 cm. The rope which elevates weight A turns the Selsyn motor B as illustrated in Fig. 12.

resulting from muscular activity facilitates the development of this refractory state. In the sensory cortex of the brain, for example, even a strong stimulus sent in through a sensory nerve produces a refractory state which lasts only 1 to 2 seconds. This much shorter period of

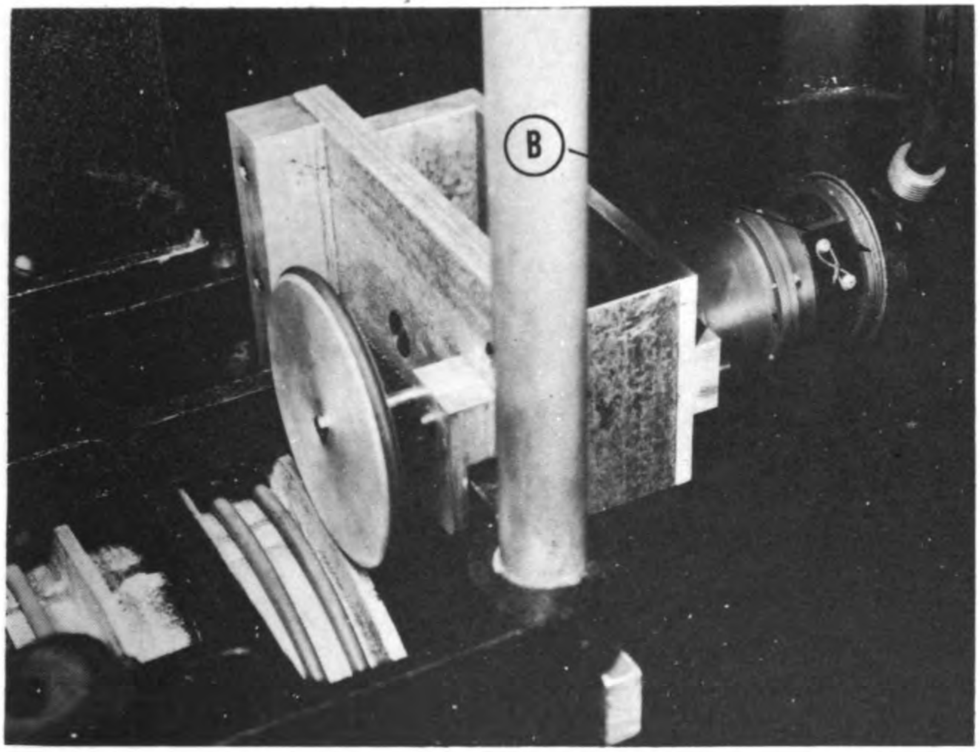

Fig. 12. Selsyn motor.

recovery in fatigue of the brain cell as compared to the muscle cell is another and most vital difference in their properties. This article attempts to elucidate this difference.

In a living organism it is important that there be a number of protective mechanisms to prevent the effector organ with its long recovery time from ever being completely fatigued. These belong to the same group of servo-mechanisms or negative feed back systems which are so well known in engineering and electronics. The centrifugal speed governor on a steam engine is perhaps the best known example of such a mechanism. The reader is referred to the fascinating recent monograph on this subject as applied to the nervous system and behavior in man by Prof. Norbert Wiener called Cybernetics.* In animals and man that part of the brain where volitional action and consciousness exist becomes fatigued before the conducting pathways and effector organs. If this were not so, for example, overdriving of the muscles of respiration would soon render them completely fatigued. They would not respond to further stimuli, respiration would cease, and death of the whole organism would follow. In the human, cardiac arrest from fatigue that lasted more than 10 or 12 seconds might be fatal and would invariably produce unconsciousness. With the utmost determination of will power a track athlete can fatigue his leg muscles so that he is unable to support himself after crossing the finish line -- and falls to the ground -- but he can still move individual muscles voluntarily and all are excitable to electric current or reflex stimulation (the tendon reflex is elicitable in such cases).

*Wiener, Norbert: Cybernetics, or Control and Communication in the Animal and the Machine. 194 pp. John Wiley & Sons, Inc., New York (1948.

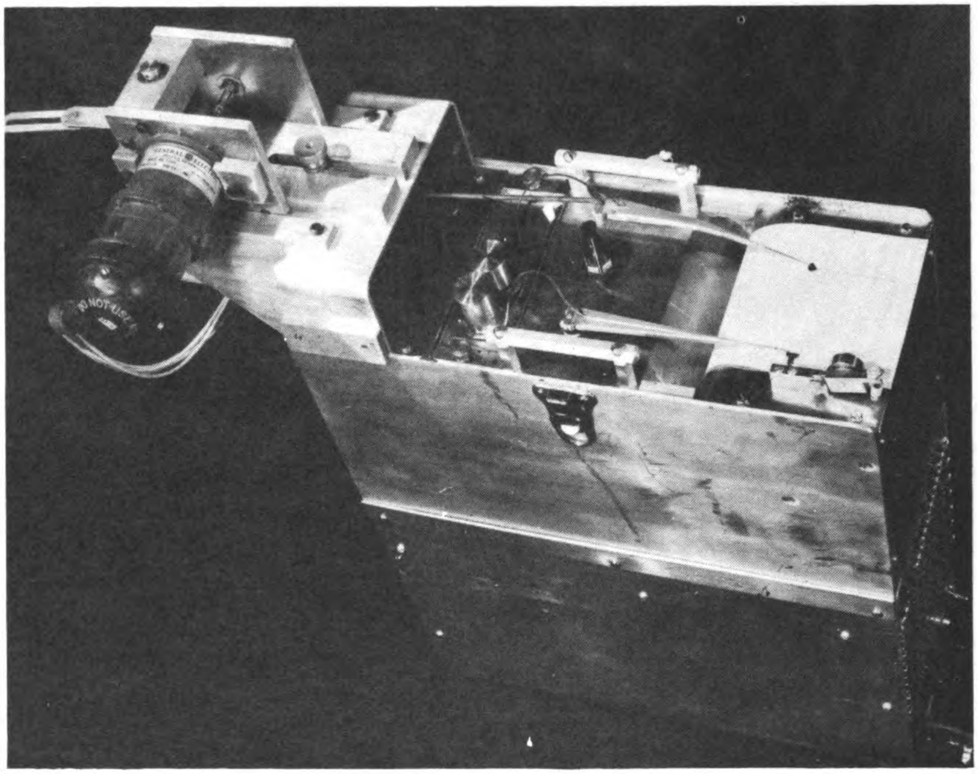

Fig. 13. Recording mechanism. Rotation of Selsyn motor B (see Fig. 12) is communicated to its mate Selsyn Motor C and this moves the write-out pen shown on upper right, which records the movement of the weight so that 30 cm is equal to 3 cm. The electrical activity of the muscle (electromyogram) is amplified electrically in the unit below the pens and actuates the pen on lower right.

There are two sorts of protective mechanisms or negative feed back systems at work in the body to keep the muscle from ever being more than partially fatigued.

The first negative feed back is a chemical one, owing to the production of CO_2 and lactic acid by the contracting muscle fibers. This works in two directions. On one hand these metabolites, by dilating the capillary bed in the muscle 20 to 30 times, tremendously increase the amount of oxygen and glucose available as fuel and a more rapid removal of the waste products themselves. Remote stimulation via the blood stream of the respiratory and cardiac centers by these same metabolites pulls in more oxygen from the atmosphere and drives more blood to the muscles (faster pulse, higher blood pressure, hyperventilation). In this direction, the chemical system is directly improving the operating efficiency of the muscle. On the other hand, the metabolites from resulting acidosis increase the threshold of contraction, so stronger and stronger stimuli are required. In this second direction, the chemical feed back is acting as a brake, making the contraction more difficult to produce.

The second feed back system is the more important and the one that concerns us in understanding some of the problems in military and industrial situations of fatigue. It deals directly with the previously mentioned brain-cell fatigue. In every muscle and tendon there are

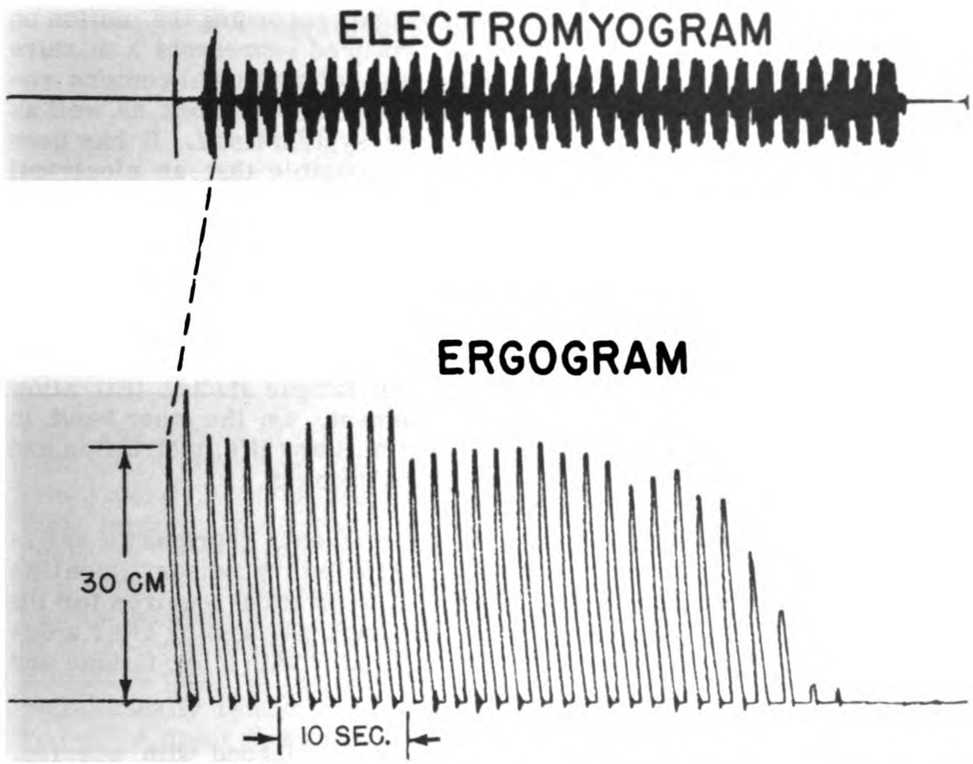

Fig. 14. Electroergogram and electromyogram show fatigue curve in a patient with arthritis who has pain in joint (elbow). Biceps muscle tested. Weight lifted 5 kg. Note: With decrease in power (left) more electrical motor units are firing as shown in increase in electromyogram.

numerous pain and sensory nerve endings which are vigorously stimulated by the muscle movements as well as by the increasing metabolites. These proprioceptive and pain stimuli begin to stream along the sensory nerves to the brain early in muscular exercise. They are greatly increased in number and intensity as fatigue in the muscle begins to set in. They are augmented by the arrival in the sensory cortex of the brain of stimuli from sensory endings in the organs of breathing and circulation. In addition, stimuli of a more complicated type, dealing with memory of previous fatigue and discomforts of exhaustion, pour in from neighboring association areas of the brain. In the tremendously complicated nets of millions of interlocking nerve cells that make up the cerebral cortex, the increasing arrival of sensory stimuli produce an ever-increasing spread of refractory cells (inhibitory state) which interferes more and more with the transmission of impulses from the voluntary centers to the nerve cells in the motor area until voluntary motion ceases. The incremental spread of refractory cells in most situations is partially balanced, for a time at least, by increase in the messages from association areas of higher centers dealing with patterns of pride -- determination -- or even fear which augment the impulses from the voluntary centers to the motor cortex.

There is thus a differential mechanism which allows the controlling and motivating areas to become fatigued first, leaving the motor apparatus in a position to function and maintain its activity indefinitely. This is vital to the continuation of breathing and circulation and essential to the muscles of locomotion, chewing, and swallowing. We, therefore, do not see in the living creature during ordinary existence the type of fatigue curves that we can obtain by electrical stimulation of the muscle-nerve preparation. When a voluntary contraction of such a muscle as the biceps is made against a weight, recording the motion on a kymograph, the fatigue curve that is produced represents a mixture of partial muscle fatigue and the exhaustion of volitional centers resulting from the unpleasant stimuli from the muscle at work, as well as the presence of metabolites in the nervous system itself. It has been shown after voluntary effort is no longer possible that an electrical current applied directly to the muscle will drive it further until actual and complete fatigue takes place.

Therefore, when we study the voluntary fatigue curves of human muscles, we must keep in mind that we are measuring a system that is far more complicated than that of the effector organ itself. In fact, a good deal of criticism has been directed at fatigue studies that allow voluntary control over the muscular movement. On the other hand, in dealing with the problem in industrial and military life, motivation and voluntary control is an essential part of the problem.

Thus in ordinary life most muscle movements represent a satisfactory balance or equilibrium between the inhibitory sensory impulses from the earliest fatigue and the degree of motivation required for the act to be completed. In unusual situations such as dashing after a departing train, the balance is achieved much later with more fatigue and often failure to achieve the goal.

If the various parts of the brain are heavily loaded with worries, anxiety, and tension, as those seen in disturbed people such as severe neurotics, these thoughts, fears, and ideas occupy numerous circulating paths of nerve cells. In such cases the arrival of the sensory stimuli from the muscles produces the inhibition of the central cerebral voluntary centers earlier. This inhibition may be caused by failure of the normal rise in motivation, owing to the fact that so many pathways are already in use. Furthermore, in subjects under tension there are many muscles in partial contraction which are not related to useful activity, and hence an earlier increase in the acidosis from the lactic acid may follow. Also some neurotics tend to be less efficient by using muscles remote from the exercise group such as those in the face, back, and legs. All of these factors make fatigue of the cerebral type more of a problem in neurotics than in normals.

Since there appears to be evidence that the fatigue and poor muscular performance in neurotics, disturbed, and worried people are primarily caused by cerebral fatigue, it follows that rest and disuse of the muscles will not solve the problem.

Experiences in World Wars I and II and, indeed, in industrial fatigue problems have shown that rest <u>alone</u> often will do nothing for the patients. A change in work, new incentives, changed motivation, or understanding of the disturbing emotional problems may produce improvement.

The problem is very complicated and no simple solutions or explanations are at hand. It is hoped that this communication will serve to focus more attention on the psychiatric aspect of the problem of fatigue, since most of our evidence shows that the muscles in such patients are able to do the work normally if the brain fatigability can be taken care of.

INHIBITING CORROSION

Robert D. Misch and Hugh J. McDonald
Illinois Institute of Technology

More than three-fourths of all known elements are metals and most of them are indispensable to modern technology. Since these metals and alloys are used under all kinds of conditions, many varieties of corrosion problems have been encountered. A few have received particular attention in this laboratory. One of these will be discussed here.

The variety of corrosion problems is evidenced by the consideration which corrosion demands in the fabrication and use of steel and other metals. The susceptibility of metals to corrosion lies chiefly in their tendency to react with water or oxygen and in their electrical conductivity. The latter factor permits current to flow from one portion of a surface to another when various conditions, for example, varying oxygen concentration, cause certain areas to acquire electrical charges of different magnitude or sign. As a result a different chemical reaction takes place at oppositely charged areas. At the anodic areas the metal usually reacts to form a salt or oxide, that is, it becomes corroded. A great many reactions are possible at positively or negatively charged surfaces and results of the study of these form a large part of the field of electrochemistry.

Probably the most important reaction which takes place on a negatively charged surface is the reduction of hydrogen ions to hydrogen

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Robert D. Misch received his B. S. degree in chemistry in 1945 and M. S. degree in 1947 from the Illinois Institute of Technology. In 1947 he was awarded the Weston Fellowship of the Electrochemical Society. He has worked on methods of preventing stress corrosion cracking, corrosion, and the mechanism of electrode processes. Mr. Misch has completed the experimental work for the Ph. D. degree, his thesis being on the general subject of the relationship of molecular structure to adsorbability at electrode interfaces.

Hugh J. McDonald, professor of physical chemistry and chairman of the Department of Chemistry, Stritch School of Medicine, Loyola University, Chicago, received his B. Sc. degree in chemistry from the McGill University in 1935. He received the M. S. degree from Carnegie Institute of Technology in 1936 and the D. Sc. degree in 1939. His major field of study was physical chemistry.

In 1939 he joined the faculty of the Illinois Institute of Technology, leaving there in 1948 as professor of chemistry to accept his present position at Loyola University. This article was prepared while he was still with the Illinois Institute of Technology.

The Corrosion Research Laboratory of the Illinois Institute of Technology was organized under his direction in 1944. He has served as a member of the Board of Directors of the National Association of Corrosion Engineers, as chairman of the Corrosion Division of the Electrochemical Society, and as Secretary-Treasurer of the American Coordinating Committee on Corrosion.

gas atoms and molecules. This reaction is one of the key electrode processes when considered from a theoretical and practical standpoint. In almost all cases of corrosion in aqueous solutions the reaction on the cathodic areas of the surface is the formation of hydrogen gas. Inhibition of this reaction will stifle the entire corrosion process, and it is believed that most organic inhibitors function in this way.

The employment of inhibitors is one of the four important methods of combating corrosion in aqueous media. These four methods are the use of a less corrodible metal or alloy, the application of protective coatings, cathodic protection, and by the use of inhibitors reducing the corrosiveness of the environment. In various cases where the use of more expensive alloys, such as stainless steels, would be prohibitive, it is possible to employ inhibitors instead. Such materials are used in cleaning solutions, cooling brines, pipe line products, packaging atmospheres and other applications. Most of these materials were discovered by practical experimentation, and their specific effects have yet to be determined.

THREE INHIBITOR TYPES

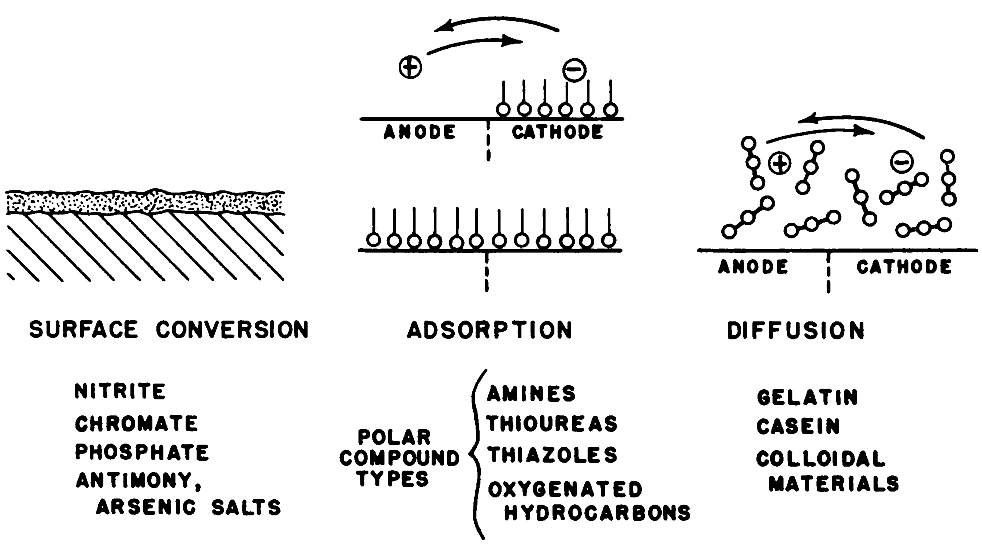

Fig. 15. Three classes of inhibitors.

Inhibitors may be placed in one of three classes: (1) surface conversion inhibitors; (2) adsorption inhibitors; and (3) diffusion inhibitors (see Fig. 15). The first class includes those materials which can react chemically with the metal and their reaction product is relatively impermeable to the corrosion medium. Heavy metal salts such as those of antimony and arsenic are included since they also change the nature of the metal surface by chemical reaction. Other examples are nitrites, chromates, and phosphates. The protection afforded by surface conversion agents will increase with time as the protective layer is built up. It is likely that adsorption is the first step in protection with sodium chromate. The protection does not stop here, however, as in the case of the next class but continues with the formation of a protective layer by chemical reaction. This fact serves to distinguish this class of inhibitor from the remaining two.

The second class, the adsorption inhibitors, includes all the important polar compound types of organic materials, such as amines and thiourea. These substances do not react chemically with the metal surface but form an adsorbed layer which prevents or interferes with electrochemical action. The adsorption may be specific, beginning initially at the anodic or cathodic areas. The end result, however, will probably be complete surface coverage. (See Fig. 16.)

Ionic conductance of itself is not affected by adsorption inhibitors but is affected by the materials of class (3), which may be called diffusion inhibitors. These materials, such as gelatin, casein, and colloidal substances, are not distinguished for their adsorption but serve to increase the viscosity of the medium and lower the ionic conductance. In this way the internal resistance of a galvanic cell is increased and corrosion is reduced. In general, this class is less effective and less important than classes (1) and (2).

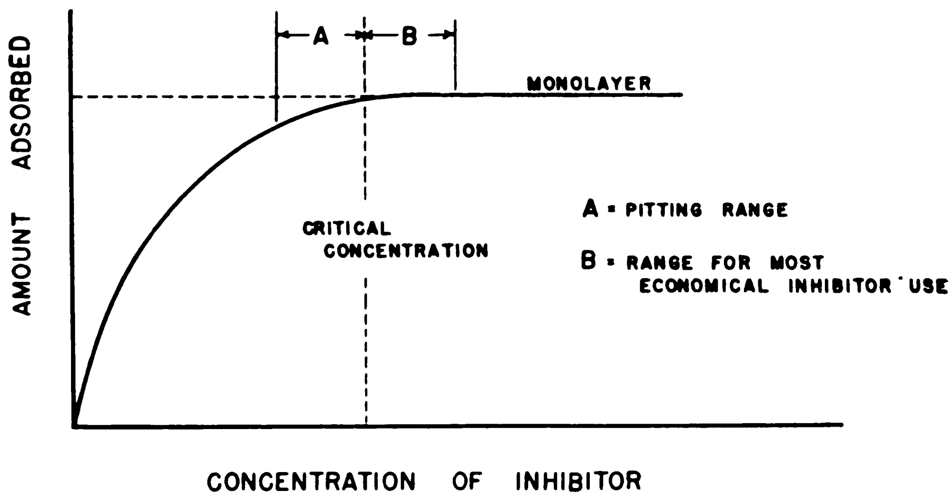

Fig. 16. Typical adsorption curve for a corrosion inhibitor. Amount of inhibitor adsorbed (grams per cm^2) is plotted vs. concentration of inhibitor in solution. At low inhibitor concentrations the degree of adsorption goes up linearly with concentration. At higher concentrations a constant amount (enough for a monolayer) is adsorbed. A certain concentration, which will just maintain a monolayer, is denoted by the dotted line and called the "critical" concentration. Just below this value a complete surface layer will not be maintained and corrosion attack will center on the unprotected areas, resulting in pitting. At lower concentrations most of the surface is unprotected and general attack takes place.

Inhibitors often influence the cathodic reaction since the surface is changed by the presence of adsorbed organic molecules. One aspect of the problem which the authors studied was the effect of films upon the diffusion of hydrogen into palladium. Palladium, iron, and other transition metals can absorb hydrogen, and in this condition, the properties of the metal are changed, viz., tensile strength and conductivity.

The hydrogen dissolves in the atomic state and can penetrate the metal until discontinuities are encountered. When this happens the atoms can associate to H_2, that is, molecular hydrogen, and very high pressures may develop as a consequence. The result is an embrittling of the metal, an effect which sometimes occurs with acid cleaning or "pickling" baths, commonly used in industry to remove scale from sheet steel and other ferrous materials. Dissolved hydrogen can cause difficulty by emerging from the steel and forcing off coatings of porcelain, galvanizing, or electroplated metals. In one instance, for example, the hydrogen produced blistering of the cadmium plating on bolts which had previously been pickled. This is explained by the fact that hydrogen is soluble in cadmium to a negligible extent; the atomic hydrogen on diffusing out of the steel apparently became associated to the molecular form at the steel-cadmium interface and broke the plating away from the surface. It is found in this instance that the blistering can be reduced substantially by increasing the amount of inhibitor, such as an alkyl amine, in the pickling bath.

Other instances are known, however, where hydrogen embrittlement is increased by certain inhibitors and a study of this phenomenon was therefore undertaken. A palladium cathode was used since this metal can dissolve a large quantity of hydrogen. The results of the study have established that certain strongly adsorbed compounds, such as thiourea, can increase the diffusion of cathodic hydrogen while others, such as dibenzylsulfide, di-isopropyl thiourea, and butyl iodide, were found to produce an initial increase in transmission at concentrations below 0.00001 molar and a subsequent decrease at higher concentrations. The type and concentration of inhibitor are the two chief factors which determine whether an increase or decrease results.

By applying this information, the effectiveness of inhibitors can be increased by the use of materials which do not produce hydrogen embrittlement. The elimination or reduction of this effect is often of more importance than saving metal or acid since it can be harmful to subsequent processing which involves the application of impervious adherent enamel or metallic coatings. In addition to these practical considerations, specific information may be obtained on the mechanism of hydrogen discharge and the adsorptive character of different compounds. In this direction, a number of contributions to the study of corrosion and fundamental corrosion processes can be made.

Ultraviolet Microscope

A color translating ultraviolet microscope is an instrument being used on an ONR project at the Research Laboratory, Polaroid Corporation, Cambridge, Mass. Kohlet and von Rohr created the design objectives and the Zeiss Company has produced it commercially. The design objectives used in conjunction with photographic film mark an important step forward in man's ability to see very small structures in spectral regions where his eyes are not sensitive. Many investigators have used this ultraviolet microscope in the examination of plant and animal tissue.

ON THE NAVAL RESEARCH RESERVE

Reserve Program Officers' Conference

From Monday, 18 April through Friday, 22 April, the Reserve Program Officers of the Branch Offices of ONR attended a conference conducted by Commander R. S. Woodbury, USNR, Director of Research Reserve, and his staff. In attendance at this conference were:

Cdr. Joseph H. Graham, USNR, New York
Cdr. Albert B. Cook, USNR, Los Angeles
Cdr. John Lissol, USNR, San Francisco
Cdr. Ray W. Mayhew, USNR, Chicago
LCdr. H. Wray Rohrman, USNR, Boston
LCdr. Walter P. Warren, USNR, Southeastern Area, Washington

The principal theme for this conference was the establishment of training program policies and procedures. At the time of the Program Officers Conference there were 45 activated Research Reserve Units. It was

Meeting of Reserve Program Officers in Washington, D. C., week of April 18. Top row, left to right: Cdr. R. W. Mayhew, USNR, Chicago; LCdr. H. W. Rohrman, USNR, Boston; Cdr. John Lissol, USNR, San Francisco; LCdr. W. P. Warren, USNR, Southeastern Area; Cdr. J. H. Graham, USNR, New York. Bottom row, left to right: Cdr. R. S. Woodbury, USNR, Director, Naval Research Reserve; Capt. C. M. Bolster, USN, Deputy and Assistant Chief of the Office of Naval Research; Cdr. A. B. Cook, USNR, Los Angeles.

decided that the major emphasis should now shift from locating scientific Reservists and organizing them to a training program centering around Research Reserve Projects in the evaluation and application of ONR-sponsored research by the Research Reserve Units.

The conference opened with a program conducted by Capt. J. H. Shultz, USN, Asst. Chief of Naval Reserve, Bureau of Naval Personnel. Other features were conferences with Capt. W. H. Leahy, USN, Asst. Chief for Research, ONR, and with the heads of his divisions. At these conferences the subject discussed was that of making the results of ONR research projects available to volunteer units for review and evaluation. To this end the Quarterly Project Summary of ONR will be furnished on a basis of tear sheets to the Program Planning Officer so that they in turn can furnish information to the units under their technical cognizance. It is planned to divide units which desire to participate in Research Reserve Projects into panels on the basis of types of personnel represented and to assign evaluation projects to these panels. The research divisions of ONR are preparing preliminary statements of some of the outstanding problems for distribution to the units for consideration, requests for available literature, and formulation of research proposals. Units which undertake such projects may request that one or two leaders of the project group be ordered for 14 days training duty in ONR, Washington, in order to get full details of their project before their panel goes ahead with it.

Cdr. F. L. Edmondson, USNR, Training Officer of Research Reserve, held a conference with the group on procedures for assisting units in developing programs. Attention was given to pointing the program for the Annual Scientific Seminar for the Office of Naval Research toward training of Volunteer Units. Lt. Cdr. Mabel H. Doyle, (W) USNR, Administrative Officer, Research Reserve, also held a conference on organization and administration of units.

The Director of Research Reserve conducted a number of informal discussion periods on personnel mobilization and training and on the specific problems raised by the Program Officers based on their experience in their billets.

This conference and the Annual Seminar will give considerable impetus to the training program for the Research Reserve Units established.

WHAT'S NEW ON CREDIT POINTS FOR RETIREMENT?

The Bureau of Naval Personnel has issued the following on retirement: "The crediting of retirement points is confined to items listed in paragraph 2 of Enclosure (B) to NRMAL 54-48 and must be for duty or training sponsored by and under the supervision of the Navy, or for duty or training in an approved joint service program. No credit may be given for any activity sponsored by or under the control of civilian activities or organizations."

NEWS NOTES

Congratulations to the Chicago Branch Office, Cdr. R. W. Mayhew, USNR, Research Reserve Program Officer, for his "Research Reserve Information Bulletin No. 1," and to the Research Reserve Unit 3-1, New York, Cdr. James D. Hardy, USNR, Commanding Officer, for the comprehensive bulletin issued by his office entitled "Naval Research Reservist." The Washington office finds them interesting and informative.

Volunteer Research Reserve Unit 13-1, Seattle, Washington, Commanding Officer, Cdr. H. S. Bennett, USNR, reports news of two interesting meetings. Dr. Joseph E. Henderson, professor of physics and Director of the Applied Physics Laboratory at the University of Washington, addressed the unit on the subject of cyclotron research at the University of Washington. Under ONR sponsorship Dr. Henderson is directing one phase of this research. He outlined the general scope of cyclotron research, discussed the cyclotron now being constructed under his direction, and conducted the group on a trip to see the partially finished cyclotron. Another interesting meeting was held, Dr. George H. Cady, professor of chemistry, University of Washington, being the main speaker. He is conducting an ONR-sponsored project on the compounds of fluorine. Dr. Cady discussed the general nature of fluorocarbons and their properties in comparison with corresponding hydrocarbons. He pointed out that the difficulties in handling strongly reactive fluorine compounds in the laboratory have retarded research in this class of chemicals, but that the compounds of fluorine have many unusual and interesting properties, the importance of which is certain to increase as more is learned about them.

Volunteer Research Reserve Unit 1-1, Boston, Massachusetts, Commanding Officer, Capt. J. W. Hammond, USNR, heard Dr. Leonard Carmichael President of Tufts College, at a recent meeting. Dr. Carmichael is a member of the Naval Research Advisory Committee, which is a body of distinguished civilians who assist the Office of Naval Research in the planning of its programs.

Volunteer Research Reserve Unit 6-1, Atlanta, Georgia, Commanding Officer, Cdr. J. E. Boyd, USNR, has sent in their 1949 program of meetings for the first half of the year. The list is impressive and the group appears to be active and enterprising. The subjects of their discussions range from study of the explosives and submarines, to chemistry of the rare earths, low-temperature research, and nuclear radiations. The unit has submitted a list of projects of interest to their members as a part of the reserve training program.

Volunteer Research Reserve Unit 6-2, Auburn, Alabama, Commanding Officer, Lt. (jg) J. E. Land, USNR, has held a series of interesting spring meetings, discussing such subjects as "Fact and fancy in interpretation of atomic energy research," "Research on a computer for X-ray crystallographic studies," and "Malaria control in war areas."

TRAINING DUTY FOR RESERVE OFFICERS

Naval Research Laboratory. The Director, Naval Research Laboratory, will formalize and enlarge the present program of Naval Reserve training, to provide orientation in the mission of the Naval Research Laboratory and afford specific indoctrination in an individual's specialty, to a greater number of reserve officers. Modifications in the present practice will be made as follows: A quota of not more than six reserve officers (three in the field of electronics, and three in the non-electronics field) is established for each training period. These training periods commence on the first and third Mondays of each month, beginning May 1949.

To assist in indoctrination, a training pamphlet is being prepared. All requests should be channeled through the Office of Naval Research.

Naval Medical Research Institute. The Naval Medical Research Institute will offer to officers requesting training duty specific short-term problems or officers may spend their time in the laboratories becoming familiar with research projects in progress.

PROMOTION OF NAVAL RESERVE OFFICERS

The Bureau of Naval Personnel has issued Naval Reserve Multiple Address Letter No. 15-49 on the promotion of Naval Reserve officers. Selection Boards to consider officers in the promotion zones will be convened as follows: LCDR - line - 1 June 1949; LT. - line - 20 June 1949; LTJG - line - 5 Sept. 1949 (approximate); LCDR & LT. - staff corps - 1 June 1949; LTJG - staff corps - 5 Sept. 1949 (approximate). Further information and copies of this letter may be obtained from the Commanding officer of your Research Reserve unit or from the nearest available Naval activity, or by writing to the Chief of Naval Research.

CHANGE IN PROCUREMENT

The Bureau of Naval Personnel has modified Procurement Bulletin No. 15-48 to the extent that candidates for Naval Reserve Commissions, who were enlisted men of any classification in the Naval Reserve on 24 June 1948, and have continued in that status until the date of application, may be processed for such commission, irrespective of their draft status or classification, provided that no candidate who has actually received orders to report for induction may be placed in process, and any candidate who is actually inducted shall have his processing discontinued therewith.

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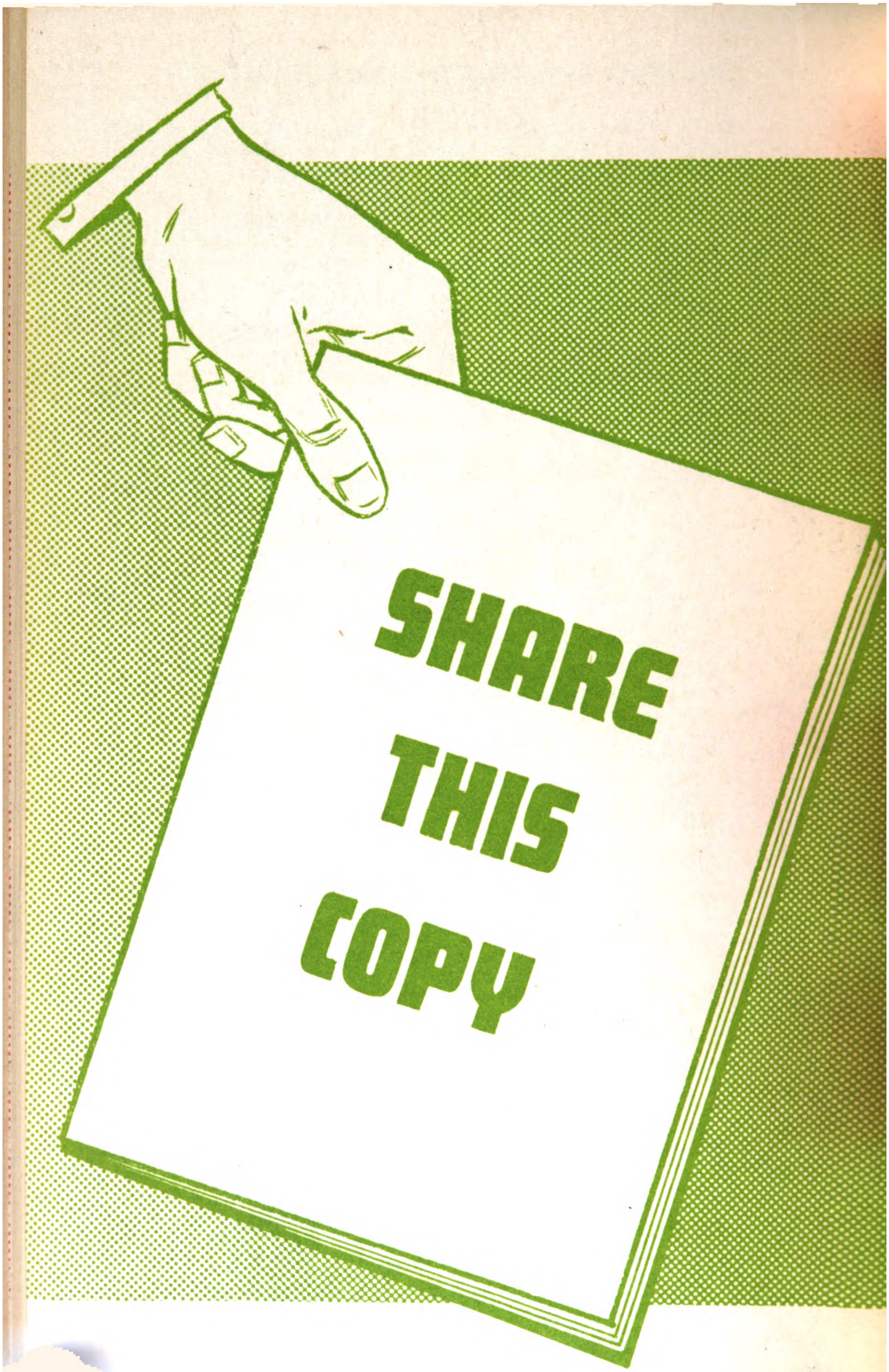
LIST OF FIGURES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