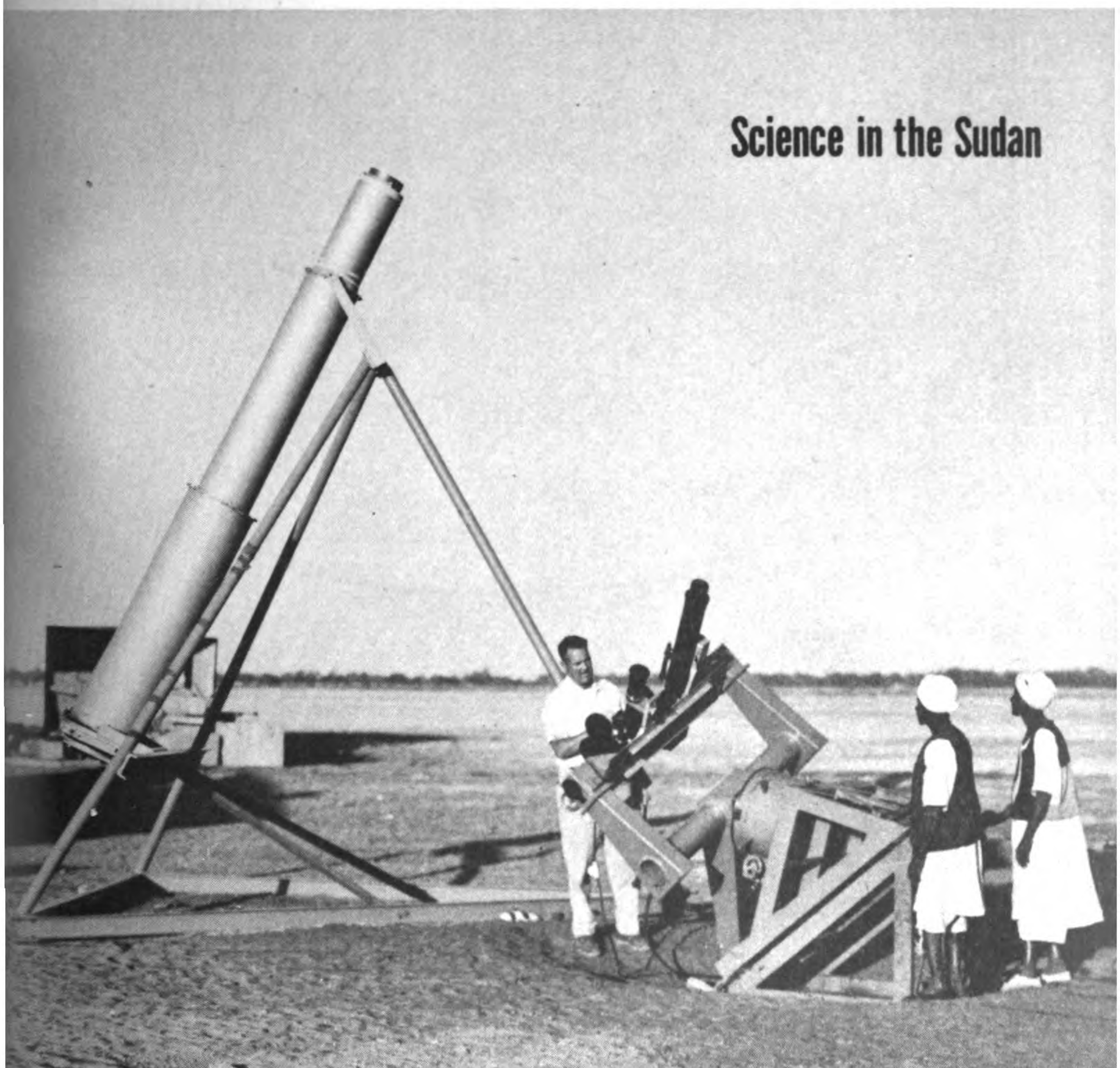
OFFICE OF NAVAL RESEARCH APRIL 1952

RESEARCH REVIEWS



NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: For years travelers in Egypt have been focussing their cameras on everything from the Sphinx to the tombs of the Pharaohs. This one, however—David S. Hawkins of the Naval Research Laboratory (ONR)—is different. He is preparing for the very serious scientific venture of photographing the sun in total eclipse. This blackout, which occurred on February 25, was the lodestone which drew to Khartoum's sultry sands some 140 astronomers from all parts of the world, including an expedition headed by NRL's Director of Research, Dr. E. O. Hulburt and Dr. John P. Hagen, Head of the Radio Frequency Research Branch. More pictures taken on the expedition are shown on p. 26.

Approved by Bureau of the Budget, 14 February 1952.

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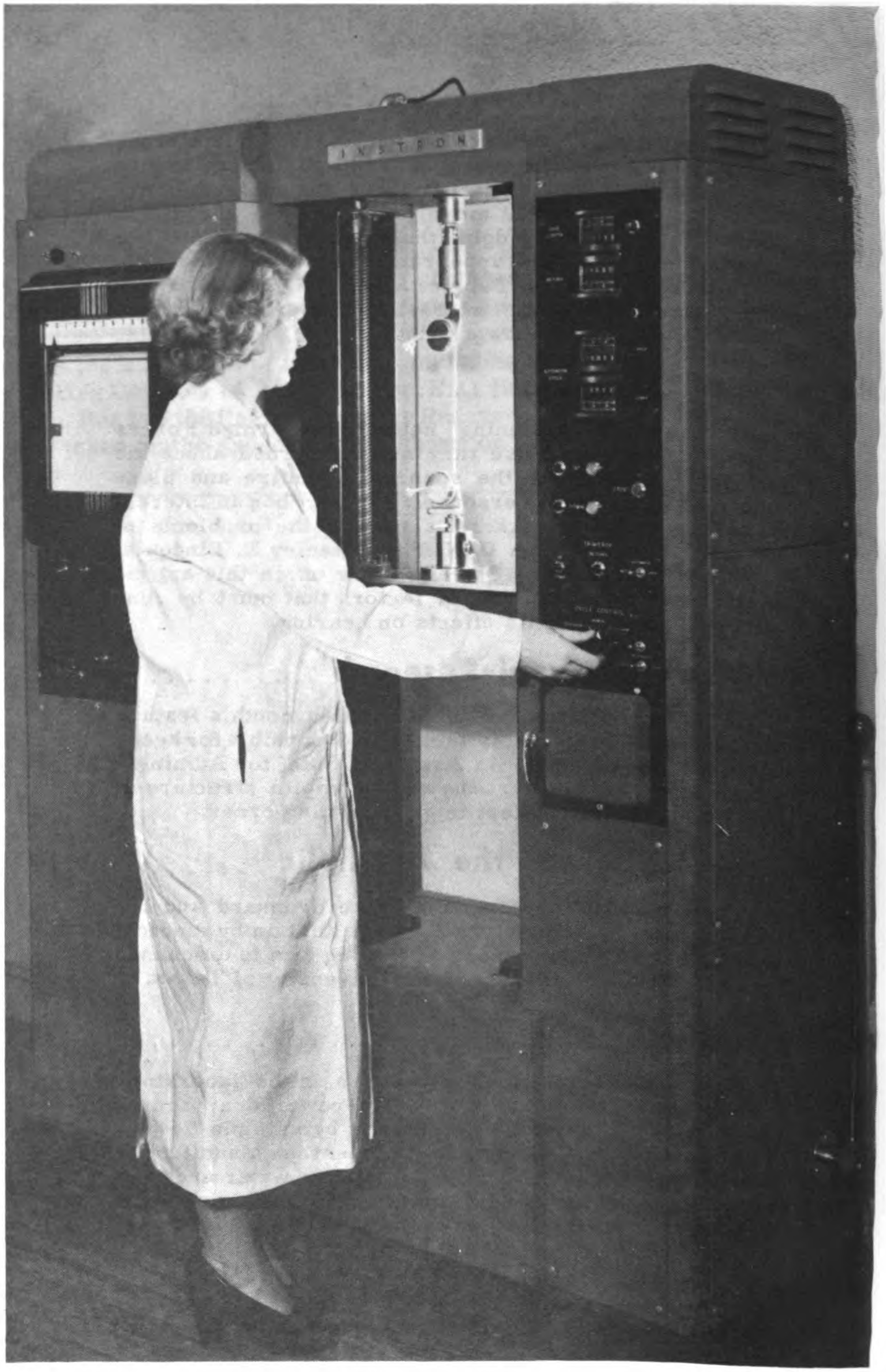

How well will your new suit wear? This machine, being operated by a technician at Fabric Research Laboratories, Inc., may help to answer that question. Called a "constant rate-of-strain" tester, it has helped researchers discover new facts about the resilience of materials. It is one of the devices which have produced profound changes within the textile industry in the last decade.

Revolution in Textiles

by

Simon Williams
Fabric Research Laboratories, Inc.

The past ten years have seen what practically amounts to a revolution in the textile industry. In the decade since the start of World War II, two vital forces have radically modified thinking in this field: the introduction of man-made fibers and advances in textile physics. Since these two factors have changed the entire industry, their effects require careful consideration by everyone concerned with procuring fabrics, whether for clothing or other uses.

For ten thousand years the changing patterns of textile designers developed largely "by guess and by gosh," and quantitative measurements of the properties of fibers, yarns, and fabrics were unknown. During the period between World War I and II, a fairly widespread use of tensile testing equipment was introduced, adapted from machines used in the testing of rigid structural materials such as steel, wood, and concrete. Tensile strength and elongation-to-rupture became limiting factors governing textile specifications and still persist in many parts of the industry--in spite of increasing evidence that the standards frequently failed to apply. Strong fibers (as indicated by the testing machines) frequently performed less efficiently than weak fibers; increasing the strength of yarns and fabrics, as demanded in civilian or military specifications, rarely solved the problems associated with the weaker material.

Coincident with the appearance in textile marts of many new materials--nylon, glass, vinyon, etc.--the outbreak of World War II and the complex demands on textiles for military use forced the development of more meaningful criteria of physical performance. These may be summarized as follows.

First, it was observed that textile fibers are not perfectly elastic, in that load and elongation are not proportional in those portions of the stress-strain curves representing recoverable deformations. Therefore, it seemed sensible to test fibers in such a way as to sensitively plot the <u>shape</u> of stress-strain curves and an instrument was developed through the joint efforts of the Massachusetts Institute of Technology's Textile Division, and Fabric Research Laboratories, Inc. Using a cantilever beam, on which were mounted a set of strain gages, the take-up or decay of load as the fiber was strained could be readily detected.

Second, when textiles are used, they are rarely subject to loads reaching the breaking strength of the material. Rather, in most uses,

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the textile fibers must resist loads of a low order of magnitude but of very frequent application. In other words, the success or failure of a material depends in large measure on its ability to absorb and return energy under repeated small loadings (and hence small strains). To accurately measure this "energy absorption capacity" of fibers it was necessary to develop an instrument which defined how fibers behaved at low strains. To this end, the Pulse Propagation Meter was developed by Fabric Research Laboratories, Inc. and the Magnetic Amplifier Corporation. The "PPM" measures instantaneous elastic performance, by the rate at which sound is propagated through the material while it is being loaded. By studying the ways in which fibers behave under repeated loadings and unloadings, at both low and high strains, our knowledge of how and why textiles perform as they do has been greatly advanced.

To this point, we have been discussing fibers. Fibers, of course, are only used in complex structures such as yarn and fabric. Thus, as the picture of the physical basis for fiber performance has unfolded and more and more fibers have been studied in this new frame of reference, it has been necessary to build on these data an understanding of the influence of yarn and fabric geometry on the translation of these inherent fiber properties into desirable end-use properties. Therefore, in studying yarn and fabric behavior, the influence of staple length, filament denier, number of filaments, yarn size, yarn twist, and fabric construction, all have had to come under scrutiny for the determination of the same physical properties measured for fibers. For four years, for example, Fabric Research Laboratories,[1] has been investigating first the filament properties, then staple (cut filament) properties from the same material, then yarn properties, then fabric properties, made of <u>one</u> fiber, acetate. Three years have been devoted to a similar study on cordage fibers.[2]

Out of this research have come mathematical expressions which provide techniques, far superior to any previous methods, for predicting the performance of fibers in yarns and fabrics. While still far from a complete scientific story, the Fabric Research Laboratories' theory of yarn performance can be correlated to crease resistance, abrasion resistance, tear resistance, and other functional fabric properties. It has been demonstrated that in identical fabric constructions, superior yarn properties are directly related to superior fabric properties.

It should be emphasized that the variables that must be taken into account in the stress of a textile yarn are numerous and not all readily defined. The mathematical and physical tools used for stress analysis are frequently of a high level of abstraction and not easily visualized or related to actual experience. The field of textile physics is new and the application of the field to practical mill problems is of even more recent origin. Therefore the most artful blending of theory and practice depends upon patient, constant examination and re-examination of the many questions that are raised, until the subtleties which tend to confuse the communication between textile research and practical application are fully explored and rationalized.

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[1] With the support of the Office of the Quartermaster General and the Office of Naval Research.

[2] Under contract to the Office of Naval Research.

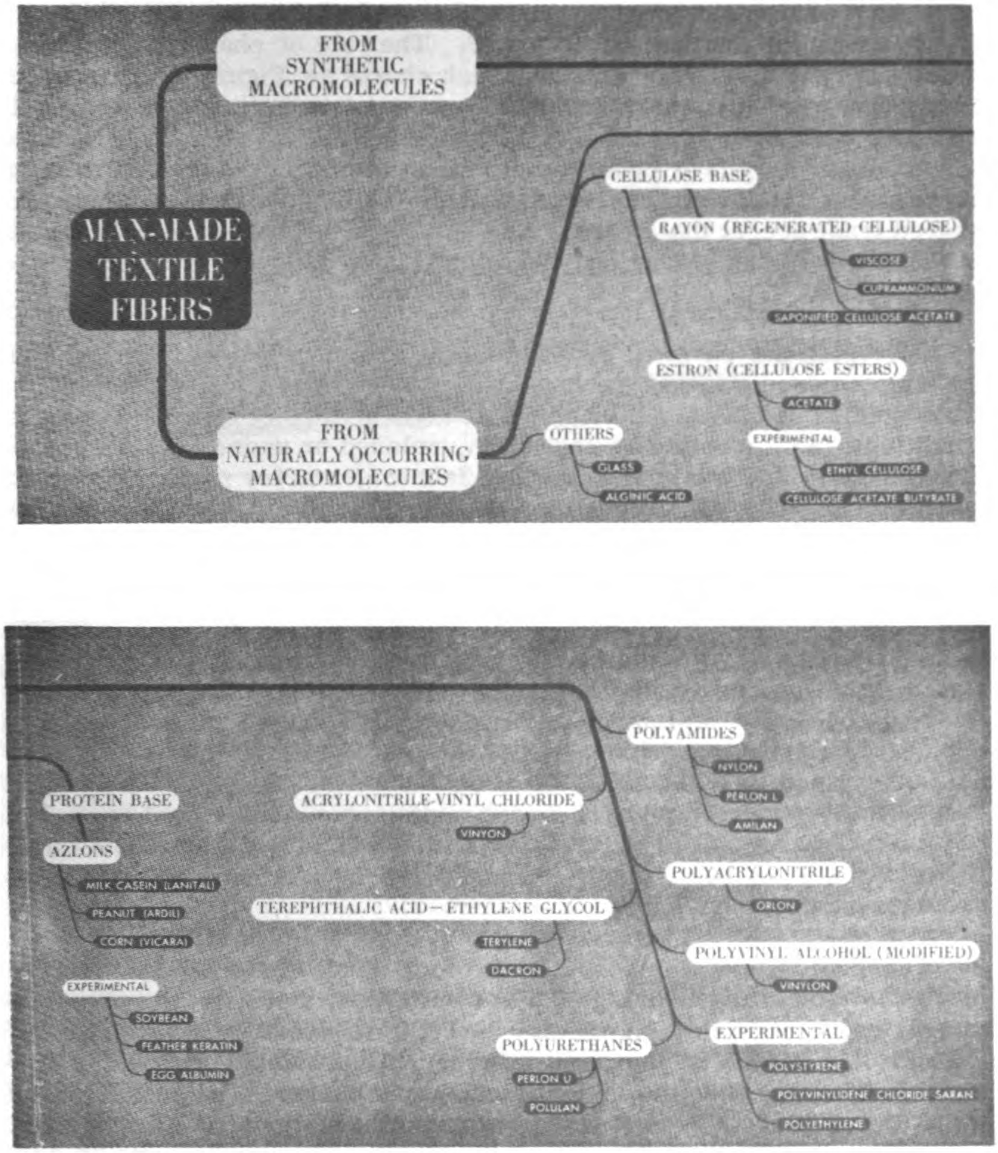

Figure 1. Synthetic fibers. Top and bottom are left and right hand sides, respectively, of single chart.

These, then, are the basic concepts underlying the evaluation of any fiber for textile application. With these ideas as background we can examine synthetic textile fibers commercially available or in an advanced stage of experimentation, and their properties which are significant in the light of practical usefulness.

It is estimated that the world-wide production of man-made fibers now approximates 3-1/2 billion pounds (1-1/3 - 1-1/2 billion pounds in the United States). Viscose rayon and acetate account for over 90 percent of this output. Among the other fibers, nylon and Bemberg rayon provide roughly 6 percent of production; all of the other fibers make up the remainder. The exact proportions of production accounted for by each of these latter fibers cannot be calculated. Reports of foreign production are too few and frequently of dubious accuracy, and changes in production schedules in the United States are very frequent and not regularly reported.

As a convenient starting point, Figure 1 illustrates one arbitrary classification of the man-made fibers. The rate of change in the synthetic fiber fields is very high and such charts as Figure 1 are subject to frequent modifications. For example, since late in the spring of 1951, when Figure 1 was prepared, chemical modification of both Orlon and Vinyon (as Dynel) have been rumored; one new fiber derived from an acrylic base has been announced, called Acrilan, and it is a commonly shared trade secret that at least a half-dozen new fibers have been made in the laboratories of various chemical companies and are in process of evaluation.

Keeping the physical concepts in mind and remembering, (a) that the simple descriptions of various man-made fibers to follow are derived from studies of elastic behavior under a great variety of environmental conditions (e.g., swollen or unswollen, relaxed or under strain, wet or dry, cold or hot, etc.), and (b) that fabric geometry can do much to nullify or enhance the properties described, let us look at the specific properties of the new fibers in terms of general performance rather than in terms of tabulations of physical data.

The most versatile modern fiber is, of course, Nylon.

Nylon has a large number of good points: Wet or dry it is extremely tenacious. Combined with its elongation properties, this gives it great wearing power and resistance to abrasion; its light weight enables it to replace silk in such end-uses as parachutes and women's hose; it does not absorb moisture readily, so it is fast-drying and easy to launder; it is also mildew-proof, mothproof, and nonallergic. Nylon will burn, but not with a flame unless it is coated with some inflammable substance. It can be "set" by heat; pleats, for instance, can be ironed in so as to endure repeated washings.

Of course, the same qualities which make nylon so useful also introduce some disadvantages. For instance, because the fiber is impervious to moisture, it is very difficult to dye and the printing of nylon cloth is still an unsolved commercial problem. It is very difficult to bleach. Then too, nylon fabrics may pucker. The puckering or wrinkling may occur during sewing because the material is slippery and difficult to hold in a machine, or it may be caused by exposure to heat that is greater than the "setting" heat, or it may be caused by unequal relaxation of individual yarns.

Nylon, because of its low moisture up-take, builds up a static charge, which may cause garments to cling to each other or to the skin, possibly an annoying nuisance in low-humidity areas. Moreover, the design of nylon garments to be worn in direct contact with the skin is very critical for comfort under conditions of maximum sweating because the fabric does not absorb moisture. A non-absorbent material which constantly contacts wet skin feels uncomfortable and nylon shirts, slips, and other items have been much criticized from this point of view.

Orlon is similar to nylon in most respects. It is not, however, as tenacious or as resistant to abrasion, and it is inflammable. On the positive side, it is more resistant to chemical attack and some claim that Orlon is more resistant to the degrading action of sunlight than any other fiber except glass. Thus it would be useful for such items as

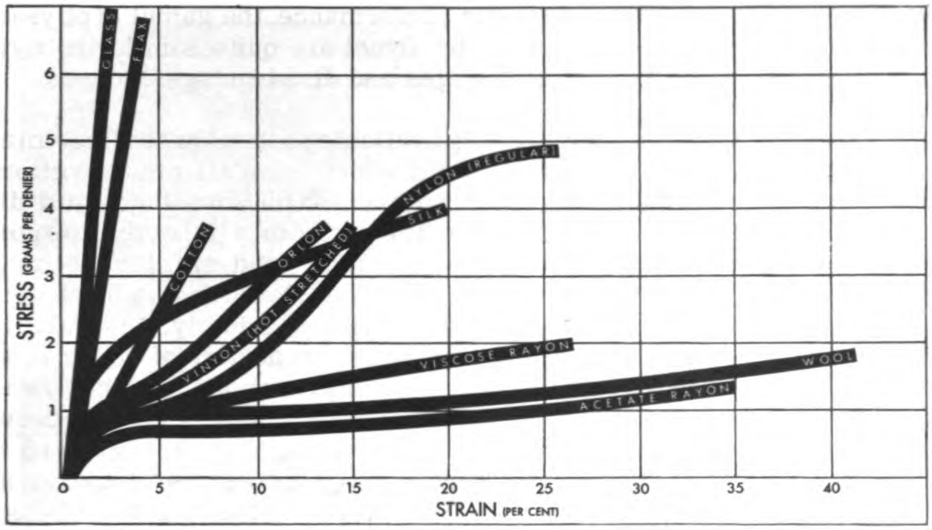

Figure 2. Ten fibers are plotted against stress and strain. Actually the curves change with such factors as moisture content and filament and yarn denier, but the curves are still a fair picture of relative characteristics.

sails, tobacco cloth, et cetera. Staple Orlon does not pill seriously. In addition Orlon has a high bulking and cover capacity and is used in mixture with other fibers like wool to reduce fabric weight in such uses as top-coating.

Dacron appears to be intermediate in all of its properties between Orlon and nylon, with the exception of recovery effects, wet and dry. In this case, Dacron appears to be superior to either Orlon or nylon and in experiments to date, the use of Dacron--by itself or in mixture with other fibers--has made an impressive display in light-weight suiting, demonstrating remarkable crease-resistance under a wide range of moisture conditions.

Glass is absolutely nonabsorbent, it won't burn, it is almost perfectly elastic, and it is the strongest of all textile fibers. On the other hand, it has poor abrasion resistance and when broken can cause severe skin irritation if used in garments. Consequently glass, so far, is not adaptable to wearing apparel. In some textile applications--such as window drapes--it is excellent (it is indifferent to sunlight and holds its shape); used for electrical insulation it is superb. Also, because of its strength and elasticity, it is the preeminent fiber for making plastic-and-fabric laminates.

Dynel is somewhat weaker than nylon, Orlon or Dacron and apparently is not quite as effective in terms of elastic performances (when tested as Vinyon, the continuous filament). However, few data are available concerning Dynel in relation to elastic performance and this report cannot offer too much at this time. Dynel may be heat-shrunk and is actually more sensitive to heat than nylon, shrinking severely above 275° F. It absorbs less moisture than nylon and is equally or somewhat more generally resistant to chemical attack, and has been successfully used in work clothing where chemical hazards are high. On the whole, with the possible exception of elastic performance, the gamut of physical and chemical properties evidenced by Dynel are quite similar to nylon and present the same kind of advantages and disadvantages.

Vicara is the only commercially available protein-based fiber made in the United States. Like rayon, and distinct from all other synthetic fibers, Vicara readily absorbs water, with attendant advantages and disadvantages. It is the weakest of the fibers, with a tenacity approximating one gram per denier dry. Unlike nylon and similar fibers, it loses about half of its strength when wet. Its elongation to rupture is high, both wet and dry, exceeding that of nylon. Actually, few data are available relative to the elastic performance properties of Vicara, and its abrasion resistance, flax life, and similar properties are unknown to this author. Vicara is unique in that it is recommended only in blends with other fibers. Used thus, it imparts a soft, angora-like handle to the fabric and may enhance the water-absorbing properties of nylon and other hydrophobic fibers. It can be dyed with practically every class of dyestuff. In suitings, over-coatings, sweaters, and similar items, Vicara is currently being subjected to a fairly widespread consumer test.

Acetate (no longer to be called "acetate rayon") has excellent bulking and draping qualities and in both staple and filament form has become widely used in apparel. In addition, the dyes which have been developed for acetate do not color rayon or the natural fibers, so that when acetate is blended with these fibers, novel color effects can simply and cheaply be achieved. Acetate absorbs somewhat more moisture than nylon, but swelling shrinkage is low, giving acetate fabrics good dimensional stability under the influence of water. Acetate, however, is a much weaker, less durable fiber than nylon and is very sensitive to temperatures over 200° F. It is also subject to a wide variety of chemical attack. Furthermore, while acetate has good crease-recovery properties at low strains, it is subject to permanent deformations at lower strains than nylon, Orlon, or Dacron, and this has limited the use of acetate in the non-apparel fields.

Rayon is important because it is both available and cheap. It has, in fact, become known as the "work-horse" of the man-made fibers. Actually, in a physical sense, rayon compares unfavorably with the other fibers reviewed, although from an economic and aesthetic viewpoint it is a successful competitor with cotton in the lower priced markets and with silk and wool in the higher priced fields. At a price per unit of service (such units representing any or all of the criteria of performance used by the consumer), rayon has made and is making an important contribution. The low wet strength, poor dimensional stability due to swelling shrinkage, poor crease resistance and crease recovery, and other negative properties of rayon are being partially overcome by finishing treatments such as resin impregnations and coatings, but much remains to be done. Highly stretched rayon, known as "high-tenacity" rayon, has been used with outstanding success in rubber products like tires and transmission belting, where its cost, resistance to heat degradation and flexing, and ease of bonding with rubber, all have worked to its advantage.

It is probably obvious by now that the selection of a textile fiber for a particular use is far from simple, even though generalized physical principles do exist as guides. Many of the new fibers are very similar

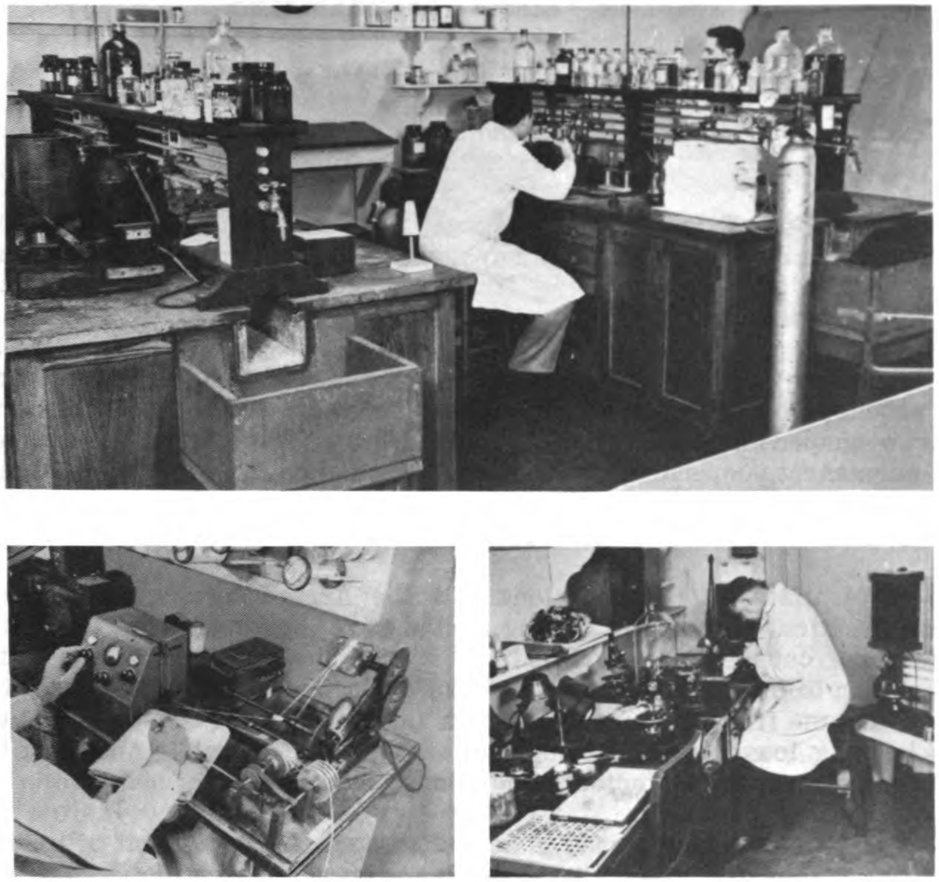

Figure 1. Textile Testing at a Modern Research Laboratory

Improvements in everything from dress material to military equipment may come out of the type of research being carried on by Fabric Research Laboratories, Inc. Above: A development unit where basic studies were made of parachute shroud lines. Lower left: Researchers are seeking a method for "un-dying" discarded wool so that it may be re-used. Lower right: Microscopy laboratory, where yarns and fabrics are studied in great detail to unearth basic facts about textiles.

over a wide range of properties. Frequently, the availability of a fiber in staple or filament form, in crimped or straight form, in one or another denier, at a given price, is more important than the existence of a vital and unique property.

Let me also emphasize again the speed with which the fiber field is changing. Not only are new fibers being announced regularly, but the chemical constitution, the physical properties, the price, the availability of staple versus filament, of different deniers, and of different finishes, changes almost daily. This demands a very vigorous examination of many factors by any engineer contemplating the use of a textile fiber. While it is not meant to imply that the selection of the best fiber for a certain job cannot be made at a given time, the need for caution and careful study is greater now than ever before in the history of the textile industry.

Noise and Deafness

by

William D. Neff and Stanley E. Lindquist
University of Chicago

In this raucous mechanized age, the dangers of deafness from exposure to intense sound are many and varied. Noise produced by gunfire, by airplane engines, and by factory machinery are just a few of the hearing hazards faced by modern man.

Intense sound from such sources wreaks its damage by the effects it produces on the cochlea, the sound-sensitive portion of the corkscrew-shaped inner ear (Figure 1). The injury may be either temporary or permanent, depending on the severity of the cause. In any case, the victim may be handicapped in meeting the demands of his job, particularly if speech communication is essential to successful performance.

Scientists, of course, along with the Armed Forces, have some very practical reasons for asking a number of questions about the damage noise causes to normal hearing. What kinds of sounds are most damaging to the ear? What is the connection between range of hearing loss, and the frequency composition of the sound which caused it? How do hearing losses affect the ability to perceive speech? And finally, how can the ear be protected from damage by noise?

Some of the terms used in acoustics need, perhaps, a bit of explanation. Frequency, often expressed in cycles per second (of acoustical energy), refers to the characteristics of sound popularly known as "pitch". A high-pitched sound has a greater number of cycles per second—i.e. a higher frequency—than a low-pitched sound. What most of us call loudness is referred to by the physicists as "amplitude". One particular sound can be made up of a mixture of frequencies; in fact a "pure" tone is rather rare in everyday noises.

Actually many studies of the effects of exposing the ear to intense sounds have not had, as their primary aim, the solution of an immediate practical problem. The research worker interested in understanding the physiological processes of hearing has found that by exposing an animal's ear to intense sounds he can produce changes within the cochlea without damaging the middle ear or the hard bony case which protects the sound-sensitive receptors in the cochlea.

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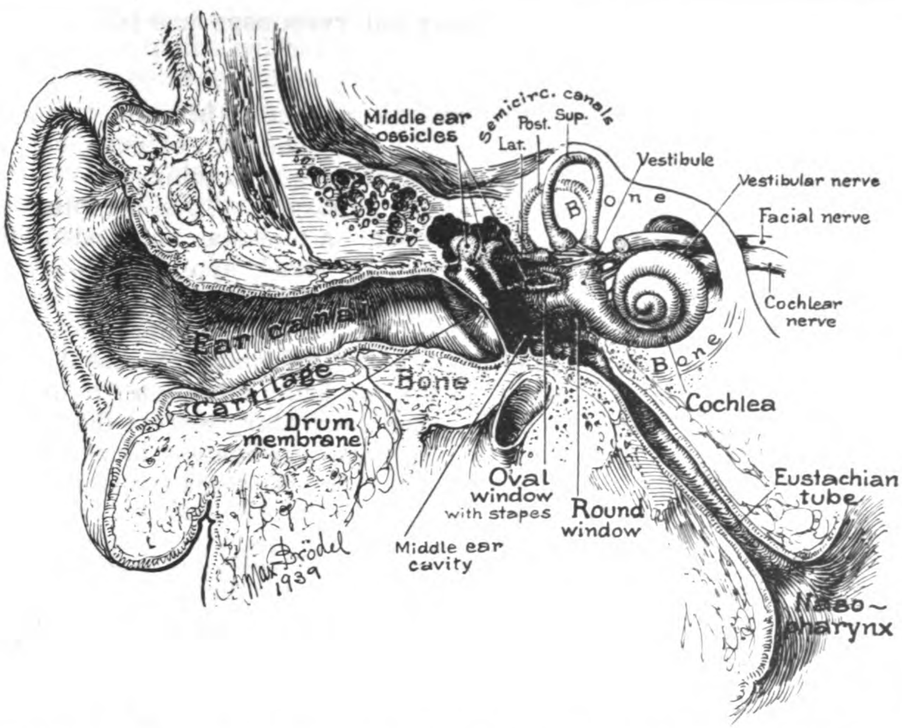

Figure 1. A cross-section of the right human ear as viewed from the front. (From a drawing by Max Brödel. Reproduced by permission of W. B. Saunders Company.)

The animals can be killed after exposure and the cochleas prepared so that the fine structure inside can be examined under the microscope. The type of damage can then be related to the type of sound which caused it. Such evidence bears upon the question of how the cochlea functions in the analysis of sounds.

In addition, certain measurements of physiological change may be made prior to killing experimental animals. Cochlear microphonics, which give information on the mystery of how cochlear cells transmit sound vibrations to the brain, via the auditory nerve, may be recorded. And the action potentials of the auditory nerve will tell us something about the kinds of signals which are being sent into the brain. But neither kind of information answers the question: What does the animal hear—i.e., what kind of auditory discriminations can it make?

In human subjects, on the other hand, we can measure changes in hearing after accidental exposure to sounds which produce permanent damage, or after intentional exposure to sounds which produce reversible damage. We cannot, however, as in the case of experimental animals, examine the structures of the inner ear to see what damage has occurred, nor can we obtain electrical measures of receptor and nervous system function.

Published reports of investigations of stimulation deafness give measures of the electrical activity of the cochlea and auditory nervous system in animals for which inner-ear damage has been determined post-mortem, and we have measures of auditory discrimination for human subjects. Our purpose was to test auditory discrimination in animals for which measures of electrical responses and post-mortem histology could be obtained.

Cats were used as the experimental subjects. In order to confine hearing tests and exposure to a single ear, one ear of each cat was destroyed surgically. Next came the problem of finding out what the animals heard, both before and after the exposure. To accomplish this the following training procedure was used: A tone was sounded for four seconds and was immediately followed by shock applied through the cross-bars of the cat's rotating cage. The cat soon learned to run forward in response to the tone; when he did so he avoided the shock. This habit, once learned, was retained for a long time; only occasional "reinforcing" shocks were necessary. Thus, we had a situation for the animal similar to that used in the clinic or laboratory to test the hearing of a human subject. The latter indicates when he hears a tone by pressing a button or raising his hand; the cat indicates when it hears by taking a few steps forward in a rotating cage.

In each situation we wanted to find out how faint a sound the animal could hear at a particular pitch—i.e., his intensity threshold, for a particular frequency. To accomplish this, the intensity of the tone was reduced at octave steps throughout the frequency range (usually 62.5, 125, 250--16,000 cps) until the animal no longer made a response. A curve was plotted showing the threshold or limit for each frequency; such a threshold curve is called an audiogram.

When a stable audiogram had been established for the experimental animals, each one was exposed either to the blast from a .32-calibre starting pistol or to "white noise"[1] at high intensity. Audiograms were

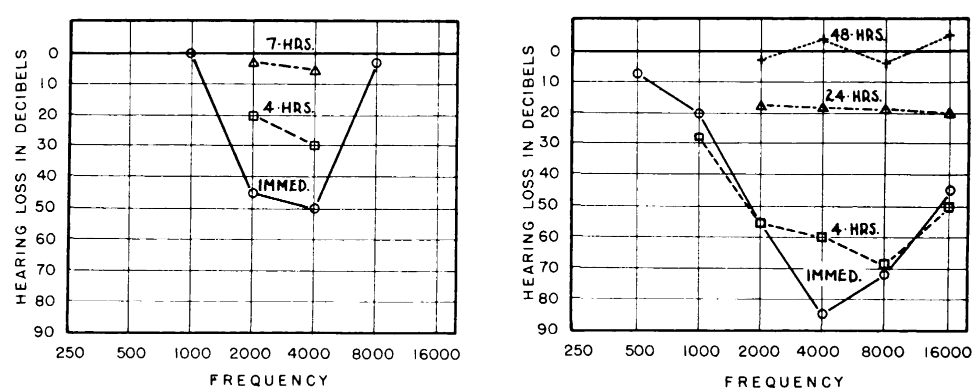

Figure 2a(left): Audiograms of cat 3 taken at different times after 15-minute exposure to intense noise. Pre-exposure hearing level is represented by 0-line; hearing losses produced by exposure by deviations below the 0-line. Tests were made at octave steps throughout the frequency range from 62.5 to 10,000 cps. In Figures 3-6, however, points are not included for frequencies at which post-exposure tests were normal. Figure 2b(right): Audiograms of cat 1 taken at different intervals after exposure to intense noise for 60 minutes.

[1] White noise is sound whose spectrum is continuous and uniform. The spectrum of noise in this experiment was continuous but not uniform; the major portion of its energy was concentrated in the range from 70 to 8000 cps.

taken at intervals, after exposure, until the animal's hearing had returned to normal, or until hearing loss had remained at the same level over a period of weeks thus indicating permanent damage.

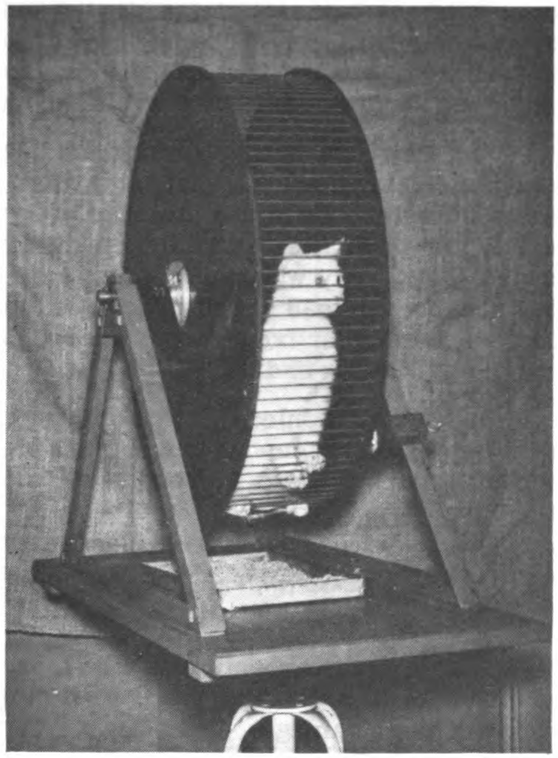

Figure 3. Rotating cage used in training cats for hearing tests.

In some animals which had suffered permanent hearing loss, electrical tests of the cochlea and nerve activity were made. All animals with permanent loss were sacrificed, the cochleas decalcified and serially sectioned, and plots made of the intra-cochlear damage as determined from microscopic examination of the stained sections.

In many instances, after exposure either to blast or to white noise, a loss of hearing occurred, but there was gradual recovery so that within a few hours or days, the audiogram was the same as before exposure. Data from two experiments are shown in Figures 3 and 4. The cat whose audiograms are shown in Figure 3 was exposed to white noise at an over-all intensity level of 107 db (re 10^{-16} watts/cm^2) for 15 minutes. Hearing tests made immediately after exposure indicated that the thresholds for frequencies of 2000 and 4000 cps (normal speech would lie within this range) were raised by 45 and 50 db respectively—i.e., at these frequencies sounds had to be increased in loudness before the animal would respond to them. At other frequencies the hearing was the same as before exposure. Four hours later, partial recovery had taken place; and, after seven hours, hearing was back to normal at all frequencies. A more severe loss which followed a 60-minute exposure to the same noise is shown in Figure 4. In this case, full recovery did not occur for 48 hours.

It might be inferred from Figures 3 and 4 that amount of hearing loss and length of recovery time are directly related to length of exposure. This was not true, however, in many cases. Some animals showed as great or greater impairment of hearing after a 15-minute exposure to the intense noise as they did after 60 minutes.

Permanent hearing changes which followed exposure to blast stimuli are shown in Figures 5 and 6. The animal whose audiograms are shown in Figure 5 was exposed to nine blasts from the .32-calibre starting pistol. The cartridge chamber of the pistol was held six inches from a speculum inserted into the ear of the anesthetized cat. As the threshold curves indicate, there was a loss of hearing for the frequencies 2000, 4000, and 8000 cps when the animal was first tested two days after exposure. After 20 days, there was a partial recovery at 2000 and 8000 cps. After 41 days, hearing appeared to have reached a stable level; the animal was then sacrificed and the cochlea prepared for detailed examination. This examination failed, however, to reveal any damage in the inner ear or in the middle ear which would account for the hearing loss.

In Figure 6 are shown the audiograms of a cat which suffered much more severe loss of hearing after exposure to gun blasts. Again, nine shots were fired at a distance of approximately six inches from the ear. Two days after exposure, the animal made responses to all frequencies, but only when their intensities were very high. During the next two months, instead of improving, hearing grew a little worse, particularly at the higher frequencies; no responses at all could be obtained to tones of 2000 cps and above.

When the cochlea of this cat was examined (post-mortem) severe damage to the receptor and neural elements within the cochlea was found. Figure 7 shows a cross-section of the organ of Corti taken from the upper basal turn of the cochlea, and a similar cross-section from a normal cochlea. As may be readily noted, the receptor cells are almost completely obliterated, and there is severe degeneration of neural elements.

From many experiments like these, we know more about the effect of loud sounds on hearing and the relation between such hearing loss and intracochlear damage.

Exposure to intense noise or blast often produces only a temporary loss of hearing. This loss is usually greatest for frequencies in the range from 2000 to 8000 cps. Although the total hearing range is not alike for cat and man[2], the region for which the greatest temporary loss occurs is approximately the same.

The extent of such impairment depends somewhat on the loudness of the noise and on the length of exposure time, but individual differences in sensitivity to temporary damage (and perhaps differences in sensitivity from time to time in the same individual) are great.

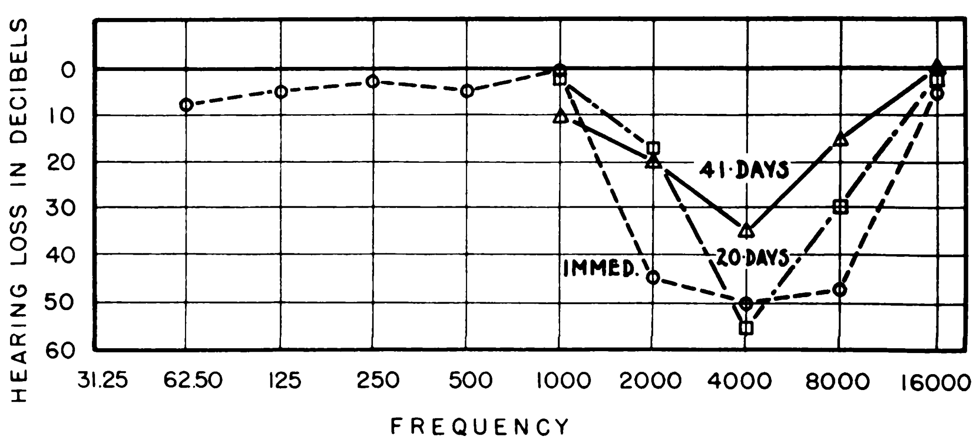

Figure 4. Permanent hearing loss produced on cat 9 by exposure to gun-shot.

[2]In man the range is approximately 1 to 20,000 cps; in the cat 1 to 40,000 cps. The upper limit in the cat has not been determined accurately.

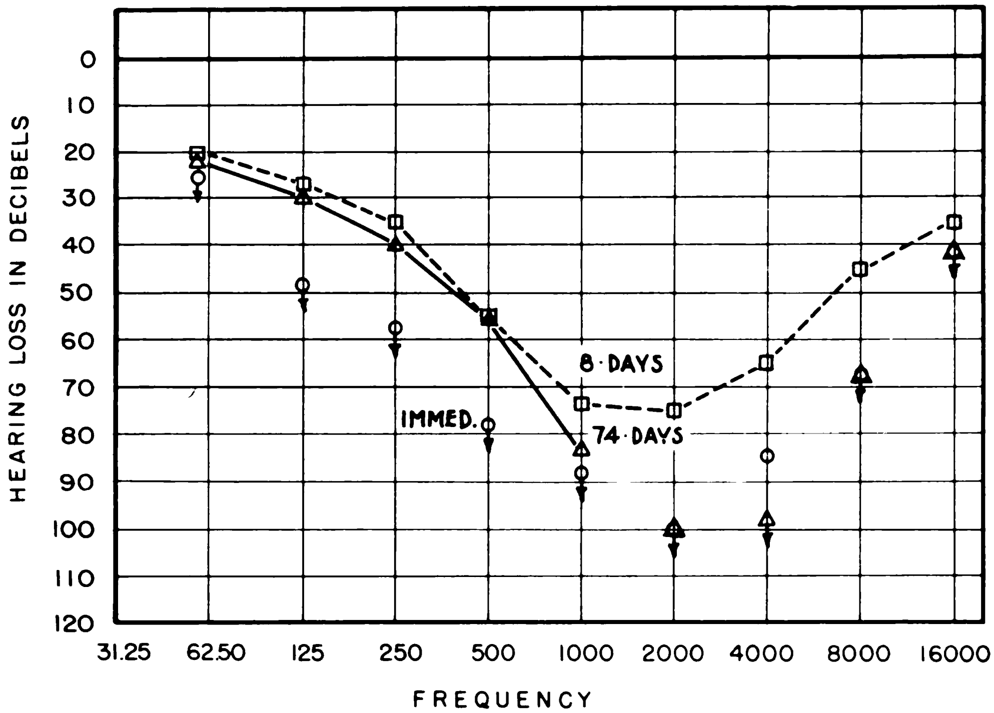

Figure 5. Severe hearing loss resulting from exposure of cat 3 to gun-shots.

Permanent hearing losses produced by gunshots are also maximal in the range 2000 to 8000 cps. When the loss is great, severe damage to the receptor cells and nerve cells in the upper basal coil of the cochlea can be found. In some cases with less marked hearing loss, the receptor and nerve cells appear normal. At least, our present histological techniques fail to show any change.

It is interesting to note that the kinds of hearing loss and cochlear damage produced in cats by exposure to noise and gun blasts are very similar to those which occur after a blow to the skull.[3]

There are many problems which remain to be studied. We still do not know why hearing for frequencies in the range centered around 4000 cps is the first to be affected by many kinds of noise and blast stimulation. It has been suggested that the part of the cochlea which responds first to sounds in this frequency range is structurally weak and thus is easily destroyed by overstimulation. However, adequate anatomical evidence for this view is lacking. In most studies made in the field and in many made in the laboratory, we have not had sufficient information about the frequency spectra of sounds which produced the 4000 dip type of hearing loss. It may be that in many cases, the region of hearing loss can partly be accounted for in terms of the frequency characteristics of the stimulus.

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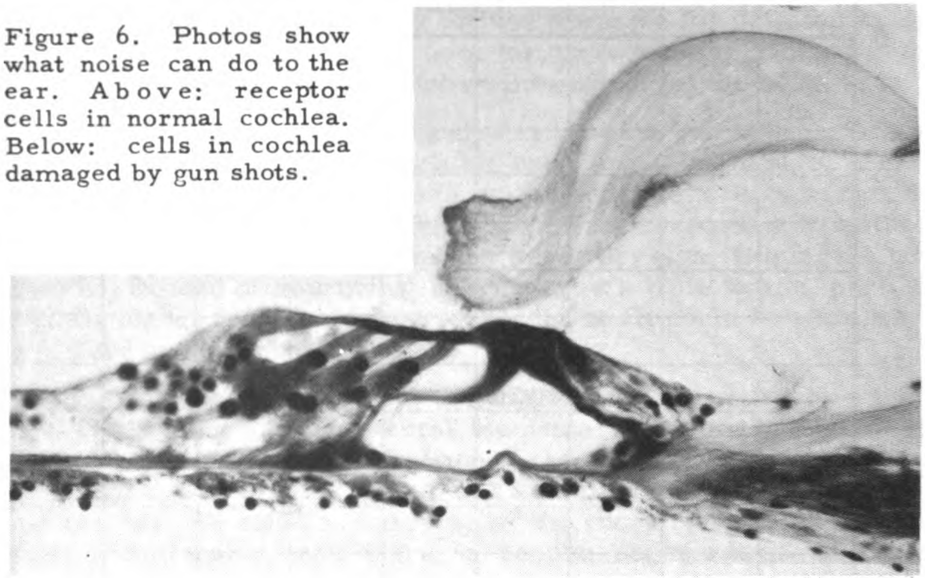
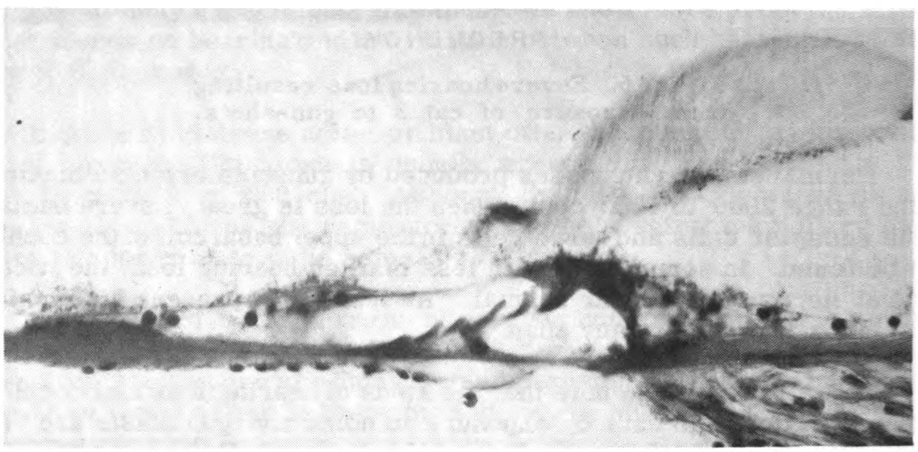
[3]Schuknecht, H. F., Neff, W. D., Perlman, H. B. An experimental study of auditory damage following blows to the head. Annals Otol., Rhinol., & Laryngol., 1951, 60, 273-290.

Figure 6. Photos show what noise can do to the ear. Above: receptor cells in normal cochlea. Below: cells in cochlea damaged by gun shots.





We still need evidence on the relation between hearing loss produced by pure tones at high intensities and area of damage in the cochlea. We know that high tones will produce maximal damage in the basal part of the cochlea and lower tones in the more apical parts. Experiments are now underway to correlate such damage with hearing losses as measured by behavioral tests.

From a practical standpoint, a most important problem is to determine the effects of repeated exposures to sounds which do not produce damage at a single exposure. At first glance, the evidence from many investigations suggests that repeated exposure to gun-fire or to noise in a factory or plane results in a gradually increasing loss of hearing. But we do not know whether the increasing loss is due to the constant exposure or to occasional peaks of sound that are above the ordinary level, and capable of producing damage at a single occurrence. Nor do we know how important is the factor of recovery between repeated exposures. Studies to solve these problems can only be done in the Laboratory, where the stimulating conditions can be exactly controlled at all times.

Who's Who in Naval Research

CAPT Rigler

Captain Frank Vernon Rigler, ONR's efficient Assistant Chief for Administration, is a retired naval officer who just can't seem to stay retired. Twice—shortly before, and then shortly after World War II—the Navy let him go, only to call him back to utilize his services and experience. Since last October he has been holding down the desk at which he says, "anything can happen, and often does." Specifically he is responsible for the administrative matters of ONR—a category which includes the myriad details connected with personnel, communications, public information, security, and the various facilities and services that keep the complex organization of ONR running smoothly.

His 15 years of regular naval service were rather typical of a line career. He graduated from Annapolis in 1923 (he was a track man and a member of the Varsity gymnastic team) and went immediately to sea as an ensign aboard the ARIZONA. He stayed on sea-duty assignments for the next five years, serving successively in the destroyer CHASE, in the venerable SEATTLE and finally in the TEXAS on the staff of the Commander in Chief, U. S. Fleet.

Then, like many of the other key naval officers now at work in Building T-3, he specialized in communications early in his career. Between 1928 and 1930 he completed the Radio Engineering PG Course at Annapolis and obtained an MS from Harvard. This was followed by over three years of sea duty, first in communications with the Submarine Force, Asiatic Fleet, and then aboard the USS Houston. After that, he managed to get ashore for two years as District Communications Officer in Boston. From that duty he went to the cruiser LOUISVILLE as communication officer and then to the USS Antures—his last sea duty prior to physically retiring in 1938.

In 1939 when the emergency was declared the then Lieutenant Rigler volunteered to return to duty and was assigned as an instructor in Ordnance and Gunnery at Annapolis. He stayed there until 1943, rising to the rank of Commander. Assigned once more to sea duty, he joined the staff of Commander, Naval Forces, Northwest Africa. He took a prominent part in planning communications for the Allied task-force that landed the invasion forces in Southern France and was aboard the command ship CATOCTIN during the invasion. For his contributions to the success of the expedition he was awarded the Bronze Star Medal, with Combat "V." He later served as communications officer COMNAVNAW.

Right after V-J Day Captain (then Commander) Rigler returned to the 'States and became Executive Officer of the Naval Ordnance Laboratory in Washington. Not quite a year later he retired to inactive status. This time he spent two years as a civilian, one year as Assistant Professor of Mathematics at Washington and Lee University, and the next in a similar capacity at Lynchburg College in Virginia. He was called once more to active duty—reporting to the Naval Academy for another instruction tour in the Department of Ordnance and Gunnery. During this period he was advanced to the rank of Captain. Three years later he was ordered to relieve Captain Coulter at ONR.

At odd times in his busy career Captain Rigler has found time to do some writing. In his first tour at Annapolis he was joint-author of "Naval Weapons and Their Uses," a textbook widely used by NROTC units during World War II. Later, at the Naval Academy he contributed extensively to the preparation of "Naval Ordnance and Gunnery," a textbook that is standard for both USNA and NROTC. He has also had articles in the NAVAL INSTITUTE PROCEEDINGS.

Captain Rigler is married and has one son, Douglas. The latter is a Freshman at Johns Hopkins and plans to enter the Naval Academy this year.

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Antabuse: Hope for the Alcoholic

by

Wiktor W. Nowinski
University of Texas

The other day I met an old friend of mine, who looked terribly depressed. In the course of conversation he told me that he had lost his job as a result of drinking. This meant that his wife and children were without means of support. This is one of the typical cases in which a brilliant man, with an excellent character and record, becomes a burden to his family and associates. If such individuals could be cured of alcoholism, a good many valuable people would be brought back to their families and to society with their usefulness restored. Since the problem of the treatment of alcoholism is so vital, every attempt to solve it should be welcomed.

In an attempt to relieve those unfortunates who are unable to limit their drinking to reasonable amounts, studies have been conducted on a drug called Antabuse. Recently these treatments have aroused widespread interest. One thing should be emphasized at the outset: Antabuse does not affect the psychological factors which many researchers feel are responsible for alcoholism. It does, however, produce physical effects which offer the patient hope of breaking his drinking habit, even though the maladjustments which may be responsible for it are not totally eliminated.

The biological activity of Antabuse was discovered accidentally in a pharmaceutical laboratory in Denmark. The most characteristic change which it produces in the body is an increase in the acetaldehyde level in the blood after consumption of even the smallest amount of beverage (ethyl) alcohol. Traces of acetaldehyde usually can be found in the blood at any time, but an increased amount produces very disagreeable symptoms, including nausea, vomiting, and redness of the face and upper part of the body.

Although the way in which the body breaks down alcohol is not yet completely understood, we know that it is changed to acetaldehyde which, in turn, is broken down into acetic acid. The latter is much less poisonous to the body than either of the other two. With the addition of Antabuse, we assume that the enzymes which ordinarily decompose acetaldehyde are inhibited; consequently an accumulation of the substance takes place.

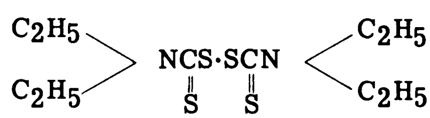
In the clinic, treatment consists of oral administration of progressively diminishing doses of Antabuse (2 grams the first day; 1.5 g second day; 1 g third day; and on the fourth to the eighth days 0.5 g).

Wiktor W. Nowinski is Associate Professor of Biochemistry and Neurochemistry, Director of the Tissue Metabolism Research Laboratory, and Research Associate in the Tissue Culture Laboratory at the University of Texas Medical Branch. He received his Ph.D. in Natural Sciences at the University of Berne, Switzerland, and his Ph.D. in Biochemistry at the University of Cambridge, England. (Since 1946, he has been associated with Dr. Charles M. Pomerat, Director of the Tissue Culture Laboratory.)

On the fourth day the patient undergoes a test. He is given a small amount of alcohol, usually 30 ml (less than a jigger) of whisky or 15 ml of 95 percent ethyl alcohol. Under ordinary circumstances such amounts do not produce ill effects, even in people unaccustomed to drinking. A patient on Antabuse, however, generally develops a series of violent reactions within 30 minutes after the ingestion of the alcohol. These manifest themselves by the symptoms which have already been described and, in addition, by falling blood pressure, increased pulse rate and a feeling of motor restlessness and weakness. The symptoms steadily decrease in intensity and within two hours, in the majority of cases, they completely disappear. Two days later a similar test is repeated and after the symptoms subside the patient is sent home, where he continues to take Antabuse as long as he wishes.

It is easy to guess that the aim of Antabuse therapy is to provoke in the patient a kind of disgust for alcohol by a subconscious association of drinking with unpleasant symptoms--a mechanism which psychologists call a conditioned reflex. Doctors, of course, are principally interested in the end effects which can be produced by this means; researchers, on the other hand, would like to know how they are produced. In other words, what happens to Antabuse in the body and how does it work?

From the chemical point of view Antabuse is only a new name for a substance known for some 70 years by the jaw-breaking name, "tetraethylthiuram disulphide." It was synthesized for the first time by Grodzki in 1881 and is often used in the rubber industry as a sulphur source for vulcanization. In pharmacology, it is recommended as a remedy for intestinal worms. Although the chemical name sounds a bit complicated it is represented rather simply by the formula:



One of the interesting things about this formula is the fact that it contains carbon linked to nitrogen to form cyanide (CN) which, in certain combinations with other elements, is one of the deadliest substances known. (Only recently the newspapers reported the instantaneous death of a young woman who accidentally swallowed a minute amount of potassium cyanide.) In the case of Antabuse, however, the carbon part of the cyanide is attached to two atoms of sulphur—a linkage which substantially reduced the toxicity of the cyanide. Scientists, however, suspected that in the body Antabuse might undergo changes which would release cyanide in a more poisonous form. These suspicions were strengthened when it was found that the use of Antabuse hampered the breathing of body cells—a well-known effect of cyanide poisoning.

Another possibility existed, however, for explaining the symptoms which Antabuse produced in the body. The drug, as we have mentioned, contains sulphur, which has a tendency to combine with hydrogen, an element essential for cell respiration. If Antabuse, on entering the body, underwent chemical changes which used up most of the available hydrogen, then the cells would have a hard time "breathing." This, and not the presence of a poisonous form of cyanide, might be the explanation of the drug's effect on body respiration.

How could researchers find out which explanation was correct? It seemed likely that if Antabuse caused its effects by using up hydrogen, then these effects could be counteracted by adding substances which contributed hydrogen. Ascorbic acid--commonly known as Vitamin C--is one of these substances, and is found in many fruit juices. Preliminary experiments with it showed that body respiration was improved when it was taken along with the Antabuse.

Yet scientists were still not certain that this was a complete explanation of the effects of Antabuse. One reason for their puzzlement was that further investigation, involving exhaustive experiments, confirmed the earlier belief that Antabuse definitely did hamper the body's assimilation of acetaldehyde. The researchers wanted to know specifically what caused each of the various symptoms resulting from taking the drug: the presence of too much acetaldehyde or the diversion of hydrogen from its normal uses in the body.

It was assumed that there were really two groups of symptoms, corresponding to the two types of inhibition of biochemical processes in the patient treated with Antabuse. To verify this assumption we decided to investigate the behavior of the patient during tests carried out with and without intravenous application of ascorbic acid. By comparing the results, the existence of two groups of reactions could be demonstrated. When Vitamin C was used, we could, in fact, observe that such symptoms as headache, palpitation, motor restlessness, weakness and apprehension were either partly or completely suppressed. Estimation of the acetaldehyde level in the blood during these tests showed that ascorbic acid does not decrease it. Moreover, we could sometimes observe that patients developed these symptoms either before or several hours after the test. Analyses of the acetaldehyde content of blood at this moment showed normal figures. The findings confirmed once more the supposition that these symptoms must have been due to the Antabuse breakdown in the body and consequent depletion of hydrogen, rather than to acetaldehyde accumulation.

As a confirming incident, it is interesting to recall that one of the patients being treated with Antabuse confided to his physician, on leaving our hospital, that no ill effects developed when he drank whisky mixed with fruit juices! Obviously the high Vitamin C content of the fruit juices counteracted the corresponding group of symptoms. Thus, in the form of ascorbic acid, the physician has a possible way to control at least some of the symptoms before they become too severe.

In spite of very extensive clinical work, it is still difficult to reach final conclusions as to the effectiveness of Antabuse treatment. Generally it is considered, on the basis of present experience, that 50-60 percent of alcoholic patients are cured completely. According to the prevalent opinion of psychiatrists, however, psychotherapy should go hand-in-hand with Antabuse treatment. There is no doubt that the Antabuse provokes a kind of subconscious association between drinking and the unpleasant symptoms occurring in the test, but this cannot cure the underlying causes of alcoholism. Psychiatrists see, at the bottom of every such case, an internal maladjustment of the patient to certain adversary outside conditions. On the other hand, the distinguished biochemist, Roger J. Williams, has good reason to claim that alcoholism is a metabolic disease that can be remedied either by the reestablishment of normal metabolism or by supplying certain substances in which the body is deficient.

It is difficult for us, and it is not the aim of the present short review, to draw any conclusions about the cause of alcoholism and its relation to Antabuse. But the release of the drug by the U. S. Food and Drug Administration will enable physicians to check its efficacy on a larger scale and to decide how valuable a tool it is for the treatment and rehabilitation of the alcoholic.

NRL Develops Insulator Which Excels Asbestos

As the result of work at the Naval Research Laboratory of ONR, the United States will no longer be dependent on imported fibers for making vital electrical insulating materials. Chemists have succeeded in making a quartz paper which is superior to asbestos for this use and can be made easily and cheaply from plentiful domestic sources.

The paper is made from fibers which are produced in the laboratory but which are chemically identical with the quartz found in nature. Two types have been made into paper: hydrous, which contains water; and anhydrous, which does not. Manufacture of the paper closely resembles ordinary paper making. Individual fibers are about 1/100 the size of a human hair. The quartz pulp is added to water in a paper beater, the stock is circulated for a short time and then dumped into a chest from which it can be pumped into a conventional Fourdrinier paper-making machine. In a recent test run at the National Bureau of Standards the machine was able to run at a speed of 40 feet per minute to produce a paper five thousandths of an inch thick.

Paper made from the anhydrous fiber is expected to have widespread use as an electrical insulating material where resistance to high temperatures and low electrical losses at high frequencies are required. The asbestos commonly used for this purpose (made from fiber imported from other continents) withstands temperatures only up to about 1000°F while the new paper withstands temperatures up to 3000°F.

The quartz paper, in contrast to other synthetic materials available for electrical insulation, is boron-free--a characteristic which makes it very valuable in this atomic age. Unlike boron-containing substances, it does not become radioactive when exposed to atomic radiation. For this reason it will probably be suitable for electrically insulating cables and other components which might be subjected to such radiation. Navy scientists see the new material as potentially useful in nuclear energy power plants, including atom-powered naval vessels.

There are other valuable potential military uses for the paper. Because of its inherent porosity it may find applications in gas masks and other types of filters. And since paper made from the hydrous fibers has a low dielectric constant, it appears to be an excellent material for use in radomes or radar antenna housings.

The new paper was developed at NRL under the same research program which has also recently produced glass fiber paper, mica paper, and a purified Canadian asbestos. All were developed under the direction of Thomas D. Callinan of NRL's Chemistry Division.

Photosynthesis

by
R. H. Burris
University of Wisconsin

Man's existence on this planet is directly dependent upon photosynthesis, for in its absence he would be virtually without food, fuel or fiber. For each person on the earth, approximately 1000 pounds of organic matter are destroyed by oxidation daily; the daily photosynthetic formation of about 1000 pounds of organic matter per person maintains the carbon cycle of nature in balance. The green plant holds the secret of using the energy of sunlight to split water and using the hydrogen produced and radiant energy captured to reduce carbon dioxide from the air. The plant can then transform the primary products of photosynthesis into a tremendous variety of compounds. As a by-product of photosynthesis the plant releases oxygen, which the animal uses in its oxidation of the food which the plant so generously provides.

To determine the sequence of chemical reactions and the compounds they form remains one of the most fascinating among the many problems of photosynthesis. Extensive early work on this problem yielded disappointingly little conclusive information. The discovery of artificially induced radioactivity and the subsequent production of radiocarbon furnished a new and potent tool for tracing the sequence of events in photosynthesis.

Pioneering work before the war with the short-lived radioisotope C^{11} forced the discard of many old suggestions on the nature of photosynthetic intermediates. In 1946 the Atomic Energy Commission offered the long-lived radioisotope C^{14} for research use, and subsequent application of this isotope as a tracer has yielded an abundance of new data. Systematic assimilation of these new results has been difficult, and rapid shifts in interpretation and strong differences in opinion among investigators have developed. Now a general scheme for production of the early carbon compounds in photosynthesis is commonly accepted, but much detail remains to be filled in. During the past five years, Calvin and his co-workers at the University of California have done particularly notable work on the path of carbon in photosynthesis. They combined the use of C^{14}, paper chromatography and radioautography, and the combination proved extremely useful in resolving the complexities of the early photosynthetic reactions. The most significant single revelation was that phosphoglyceric acid occupies the position of the first demonstrable organic product of photosynthesis. Subsequent work centers around this basic fact.

Robert H. Burris (B. S., South Dakota State College, M. S. and Ph.D., University of Wisconsin) has done research on biological nitrogen fixation since 1936 and first applied the stable isotope of nitrogen, N^{15}, to problems in this field. In 1944 he joined the staff of the Department of Biochemistry at the University of Wisconsin. His research in Plant Biochemistry has been concerned with photosynthesis, respiration, metabolism of organic acids, and the mode of action of herbicides. He is the co-author of a book on Manometric Techniques.

If a culture of algae (one-cell plants) or the leaf of a higher plant is furnished C^{14}-labeled carbon dioxide in the light for about 10 seconds, it fixes the carbon dioxide photosynthetically and converts it in this short time into a large number of compounds. These compounds are most readily identified by extracting the treated algae or leaves, concentrating the extract, and fractionating a small portion of the extract by a process called paper chromatography.

For chromatographic separation of compounds a small drop of extract, placed near the corner of a large filter paper, is dried; the paper then is hung in a closed chamber with one edge immersed in a trough of solvent (phenol-formic acid-water), and as this solvent passes through the length of the paper it moves different compounds from the extract different distances. When the solvent approaches the lower edge of the paper, the paper is removed from the chamber and dried. The paper then is rotated 90 degrees and another solvent is allowed to move at right angles to the first solvent employed.[1] When the second solvent approaches the edge of the paper, the paper is removed and dried. The compounds in the extract now have been separated by moving them different distances in two directions with two different solvent systems.

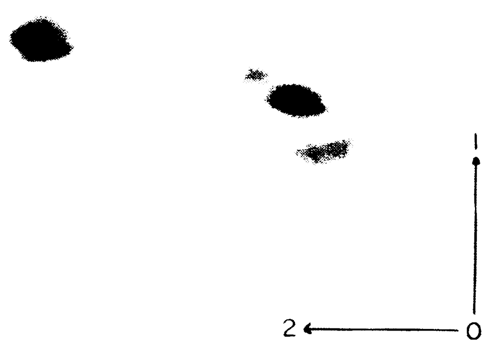
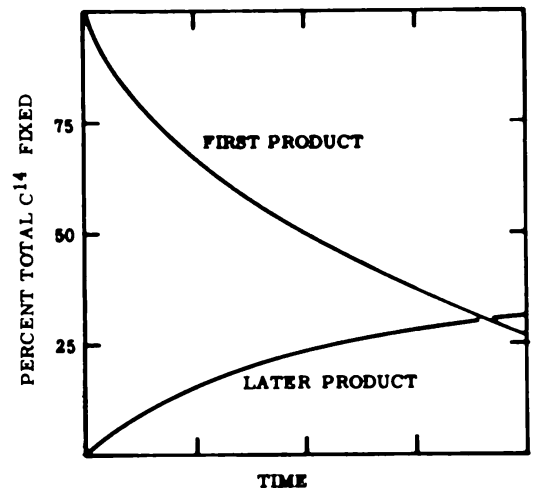


Figure 1. Radioautograph from a paper chromatogram of an extract from barley leaves furnished with C^{14}-enriched carbon dioxide for 10 seconds in the light. The carbon dioxide has been fixed photosynthetically and converted to a variety of compounds during the 10 seconds. Each dark spot indicates the presence on the chromatogram of a compound which has assimilated radioactive carbon. The chromatogram was developed from origin (designated as 0) in direction 1 with phenol-formic acid-water and in direction 2 with ethylene glycol diethyl etherformic acid-water.

The presence of C^{14} in the compounds on the chromatogram is ascertained by placing the dry filter paper chromatogram in contact with a large X-ray film in a dark film holder for a few days. The beta rays emitted by the radioactive C^{14} expose the X-ray film, so that when the film is developed a pattern of dark spots, corresponding to the positions of C^{14}-labeled compounds, appears on the film. Figure 1 shows such a radioautograph of a paper chromatogram. By mapping

[1] Although many have used phenol-water as the first solvent, various solvents have been employed in the second direction. Butanol-propionic acid-water, and collidine-lutidine are popular solvent mixtures, but we have employed a mixture of ethylene glycol diethyl ether (diethyl Cellosolve)-formic acid-water for our second solvent, since it gives good separations, is not particularly noxious and will not esterify the organic acids of the extract.

Figure 2. Hypothetical curves for percent total C^{14} fixed into the first product of photosynthesis and a product formed later in the sequence of reactions.



known compounds on chromatograms it is possible to identify most of the compounds separated from the plant extracts. Verification of the identification can be made by such independent means as inspecting the chromatogram under ultraviolet light, spraying the chromatogram with specific color reagents or extracting the area of paper containing the compound in question and making micro tests on this extract. Paper chromatography separates small amounts of material virtually impossible to separate by other means, and radioautography gives an easy method for locating radioactive compounds on the chromatograms. Together the methods have yielded most of our recent information on photosynthetic intermediates.

The researcher interested in the sequence of reactions following the photosynthetic incorporation of carbon dioxide into plants can trace the carbon with C^{14} and locate it in specific compounds. If he has exposed his plants to C^{14}-labeled carbon dioxide for 10 seconds his radioautographs may show him that 10 or more compounds have incorporated C^{14} in this period. He then is confronted with the question—what is the sequence in which these compounds are formed? Most reports in the literature attempt to establish the sequence of reactions by recording the total radioactivity in each compound. The assumption is that the compound with the highest total C^{14} is the first product of photosynthesis, an assumption that may or may not give the right answer.

A second approach is to determine the specific C^{14} radioactivity of each compound, that is, the radioactivity per unit of compound. If photosynthesis under $C^{14}O_2$ is permitted for a few seconds only, so that there is insufficient time to establish equilibrium in C^{14} concentration among the compounds, then the first photosynthetic product normally should have the highest specific activity. Specific activities give a somewhat clearer picture of the sequence of events than total activities, but even specific activities have shortcomings which will not be recounted here. The determination of the specific activities of the carbon atoms from each position in a molecule (for example, the carboxyl carbon of acetic acid) removes one such shortcoming. In addition, the location of the label in the molecule tells much regarding the mode of formation of the compound.

Evidence of the sequence of formation of compounds also may be obtained by analyzing the radioactivity in the compounds isolated from algae or higher plants after various times of exposure to C^{14}-labeled carbon dioxide under standard conditions. Theoretically, after an infinitesimal time, 100 percent of the C^{14} should be in one compound, but as this compound passes the C^{14} to other compounds it will have a decreasing percentage of the total C^{14} fixed. The upper curve of Figure 2 represents the predicted behavior of the first product of photosynthesis. Other compounds in the sequence of reactions should increase with time in their percentage of the total C^{14} fixed, as represented by the lower curve of Figure 2.

As stated earlier, research recently has shown marked progress in defining the path of carbon in photosynthesis, but it is apparent that a thorough analysis to define the specific activities of the individual carbons of a wide variety of photosynthetic compounds and an investigation of the kinetics of incorporation of C^{14} into individual compounds will require much additional effort.

Since most work by others has been done with algae, we have chosen to supplement their information by the use of leaves from higher plants—barley and tobacco. Leaves are exposed to the isotopic carbon dioxide in the light or dark for 5 to 60 seconds, and then are plunged immediately into liquid air or boiling ethanol to inactivate them. Extracts from the leaves are fractionated by paper chromatography and radioautographs are made as described. Then the areas of the paper which, according to the radioautograph, contain C^{14}, are cut out, and these sections are extracted with water. The water extract is dried in vacuum and redissolved in a small, measured amount of water. An aliquot is analyzed for its C^{14} content and another aliquot is analyzed for total content of the compound in question by a specific micro colorimetric method. The color is developed in as little as 0.2 ml of solution, and the solution is transferred to a micro cell with a one-cm light path for measurement in a spectrophotometer. With most of the methods used, compounds can be analyzed in the microgram range. These data permit a calculation of total radioactivity, specific radioactivity and total amount of each compound.

Our measurements of specific activities have indicated the same general sequence of events as the earlier measurements of total radioactivity by others. Apparently as an initial step in photosynthesis a two-carbon compound combines with carbon dioxide to yield phosphoglyceric acid, for phosphoglyceric acid was the most active compound in terms of either total or specific activity. Glucose-1-phosphate, fructose-1,6-diphosphate, fructose monophosphate, triose phosphate and glycolic acid also showed consistently high activity. Malic acid, aspartic acid, alanine, serine and glycine accumulated C^{14} with increasing time of exposure to labeled carbon dioxide.

In addition to the work on specific activities, we are employing other techniques to determine the fate of carbon in photosynthesis. If a leaf is immersed in a solution and the chamber containing the leaf and solution is evacuated, the leaf can be infiltrated with the solution by releasing the vacuum. By such vacuum infiltration we have introduced inhibitors of photosynthesis into leaves; after the leaf has transpired the infiltrated water it still retains the inhibitor. The leaf containing the inhibitor then is supplied C^{14}-labeled carbon dioxide for a short period, and the distribution of C^{14} among the compounds is compared with that observed in the absence of an inhibitor. If an inhibitor blocking at an early step in photosynthesis can be found, it should help in defining the first reactions in photosynthesis. Iodoacetamide, iodoacetate, hydroxylamine, 2,4-dinitrophenol, and phenylurethane have been employed as inhibitors, and certain of them markedly shift the balance of C^{14} among the photosynthetic products.

Infiltration into leaves of C^{14}-labeled compounds which are likely photosynthetic intermediates, followed by a determination of the C^{14} distribution, also serves to verify their role as true intermediates. Our application of this approach so far has been confined to the organic acids. C^{14}-labeled formic, oxalic, glycolic, acetic, malic and citric acids have been infiltrated into tobacco leaves, and after a period of incubation in light or dark, succinic, oxalic, glycolic, malic, citric and isocitric acids have been isolated from the leaves and measured for their radioactivity. Formic acid quickly transfers C^{14} to these other acids, particularly to malic acid. Glycolic, malic and acetic acids are rather rapidly metabolized, but oxalic and citric acids pass their C^{14} to other organic acids slowly. These studies will be extended by infiltrating other labeled compounds and degrading the reaction products to establish the position of the label in the molecules.

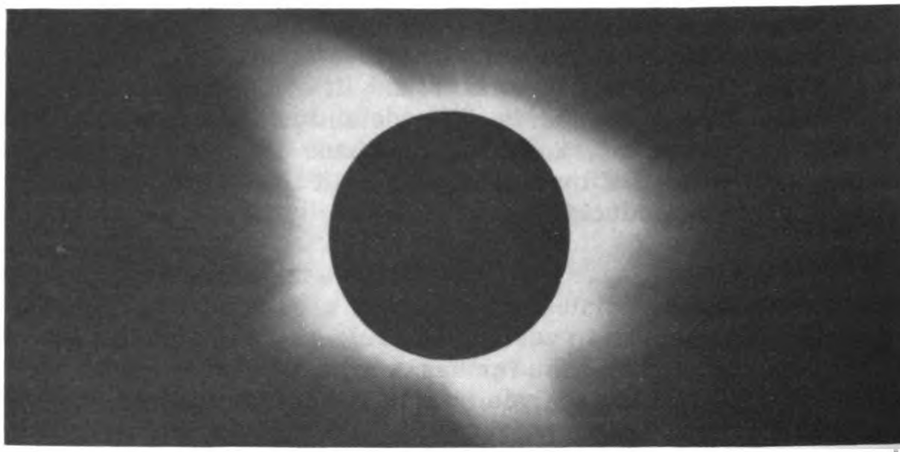
Information from investigation of photosynthetic bacteria and non-photosynthetic autotrophic bacteria has been most helpful to earlier workers in interpreting the photosynthetic reactions of higher plants. In common with photosynthesizing organisms, the autotrophic bacteria can use carbon dioxide as a sole source of carbon. We have studied the hydrogen bacteria as representative autotrophs; they can derive all their energy from the oxidation of hydrogen to water.

The hydrogen bacteria have been grown autotrophically and then we have furnished them C^{14}-enriched carbon dioxide for a short time. Extracts from the cells have been separated by partition chromatography and radioautographed as described. The C^{14} from carbon dioxide is incorporated rapidly into a large number of compounds, and although their identification is incomplete, it is apparent that the distribution of C^{14} is different from that of normal photosynthesis.

The problems of photosynthesis remain numerous and intriguing. A thorough knowledge of the process becomes increasingly important as the world's population expands without a corresponding expansion in food production. A sound foundation of basic information should be of distinct aid in intelligent planning for the solution of the practical problems of increased production of food.

CAPT English New Head of ONR Dental Branch

CAPT James A. English, DC, USN, is the new head of the ONR Dental Branch, replacing CAPT Carl A. Schlack who now goes to the U. S. Marine Corps Air Station at Kaneohe, Oahu, Hawaii. CAPT English was formerly attached to the Naval Medical Research Institute at Bethesda, Md.



Blackout in the Desert

"Darkness at noon" was the order of the day recently at Khartoum in the Sudan, where probably the greatest collection of eclipse talent ever assembled saw the sun obscured by the moon for more than three minutes. One hundred and forty astronomers from 12 nations, including representatives of the U. S. Navy, were on hand to gather data as the blazing light of the desert midday faded into starlit darkness. A very scientific time was had by all, as cameras and electrical equipment clicked away, recording important information which is expected to help in weather forecasting, radio communication and, of course, in building up our fundamental knowledge of the Universe. The Navy expedition, headed by Dr. E. O. Hulburt, the Naval Research Laboratory's Director of Research and Dr. John P. Hagen, Head of the Radio Frequency Research Branch, reported that all their experiments were carried out according to schedule.

The picture above, taken at the time of total eclipse, shows the great fiery halo called the corona, which surrounds the sun. Usually invisible, it flashes into view when the face of the sun is blotted out. Below are shown the various pieces of equipment used by the Navy expedition to record the eclipse.

On the Naval Research Reserve

RADM Bolster Stresses Value of VNRR to Navy At Third Anniversary Meeting of Unit 1-1

Seated (left to right): CDR P. H. Flint; CAPT L. M. Smith; Rear Admiral Calvin M. Bolster, USN, Chief of Naval Research, CAPT F. B. Eggers, CO, ONR Boston; CDR B. Altman, Exec. Officer, VNRRU 1-1. Standing (left to right): LCDR C. P. Cardani; LT L. W. Brown; LT E. L. Cook; LCDR T. J. McLaughlin; LCDR R. K. Stoughton; LCDR F. E. Zimmerman; CDR G. Z. Dimitroff; CDR H. W. Rohrman; LCDR A. H. Healy, Personnel Officer, VNRRU 1-1, ENS R. G. Eldridge, and LT Thomas B. Dowd, Instructor, VNRRU 1-1.

More than 100 members of VNRRU 1-1, Boston, recently "got the word" on their place in today's Navy from Rear Admiral Calvin M. Bolster, Chief of Naval Research. The occasion was the Unit's third "birthday", celebrated by a dinner at the Officers' Club, Boston Naval Shipyard.

RADM Bolster praised the important work which the Research Reserve is doing in providing a reservoir of manpower for filling specialists' billets, not only in ONR but in other Navy agencies as well. He also pointed out the value of the compact size of the VNRR organization, which enables members to become thoroughly acquainted with each others' special abilities and qualifications.

Other speakers were: CAPT L. M. Smith, CO of the unit; CDR H. W. Rohrman, USNR, Research Reserve Program Officer and Toastmaster for the evening; CDR G. Z. Dimitroff, USNR, Training Officer, ONR Washington; and President L. Carmichael of Tufts College.

Varied Series of Technical Training Courses Open to Reservists at Special Devices Center

Research Reservists who cannot attend the forthcoming seminar at the Special Devices Center can take comfort from the fact that there are many other courses open to them there in the course of the year. SDC conducts a series of courses for Special Devices Officers, Training Aids Officers, Training Officers, and others who are concerned with the use of equipment in training programs. The instructions are designed to indoctrinate students in the training devices programs of the Army and Navy and to assist them in device use and administration.

Topics covered in the courses include the philosophy and history of synthetic devices; organization and operation of SDC; training devices used in aviation, navigation, seamanship, aerology, radar, communications, armament, in surface, undersea, and synthetic warfare, and in visual engineering; material support of devices; TraDevMan personnel; mass training by television; human engineering; device evaluation; and publications and recordings. Not only lectures are included but also demonstrations of equipment and tours of the Center. Moreover, opportunities are provided for group discussion of individual problems, and for visiting operating personnel to check on matters of local or individual interest. Aviation activities are referred to the Chief of Naval Operations' directive (found in Aviation Circular Letter No. 64-47), concerning the application of Special Devices training methods and equipment, the appointment of a qualified training officer as Special Devices Officer, and the indoctrination of officers so appointed.

Requests for training duty at these courses should be routed to the Commandants of Naval Districts via the Commanding Officer and Director, Special Devices Center, ONR, Port Washington, New York.

Courses for the calendar year 1952 which may be of particular interest to the readers of "Research Reviews" include:

(a) 2-Week Course and on-the-job training program for officers of the Volunteer Naval Reserve.

Quota: 15 Officers
Dates: 7-20 September 1952

(b) 2-Week Course and on-the-job training program for Reserve Officers on inactive duty.

Quota: 25 Officers
Dates: 18-31 May 1952 — 13-26 July 1952
15-28 June 1952 — 10-23 August 1952

(c) 2-Week Course and program (Research Reserve Seminar) for Officers of the Volunteer Research Reserve.

Quota: 50 Officers
Dates: 20 April - 3 May 1952

NEW VNRR ID CARDS: SYMBOL OF FELLOWSHIP

by

CDR George Z. Dimitroff
Training Officer, ONR Washington

During my travels to various Research Reserve seminars I have formed one particularly strong impression: that members of VNRR units, even from widely separated parts of the country, have a sense of personal closeness and an awareness of common interests. Many, of course, know each other well—in some cases through professional contacts, and sometimes as a result of their mutual interest in science and the Navy. Fortunately the membership of the Research Reserve is small enough so that a goodly proportion of the officers have the opportunity to mingle with those from distant units under the common fellowship of the seminars.

It was felt that this spirit of unity should be strengthened by every possible means. One step in this direction has been the promotion of a sort of Rotarian spirit which encourages members to visit the meetings of units located in any cities they may visit from time to time. Another was the adoption of an identification card, which, it was felt, would give each officer a tangible symbol of his membership in the organization and his fellowship with other members.

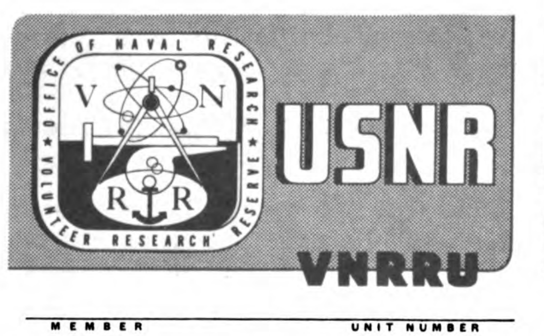
The identification card is pictured at right. Plans have been made for its rapid distribution to the various units. Designed by CDR Viktor Schreckengost of VNRRU 4-8 (who incidentally is well-known in the world of art), the card bears on one side the signature of the member and that of his CO, and on the other a list of all Research Reserve units and their location. When signed and countersigned with indelible ink, it becomes a personalized identification as well as a reminder to members to visit other units when they are away from their home ports.

It is hoped that this little card will serve as a real bond between Research Reserve members and will open to them new avenues of friendship that can be of value both to the Navy and to its officers.

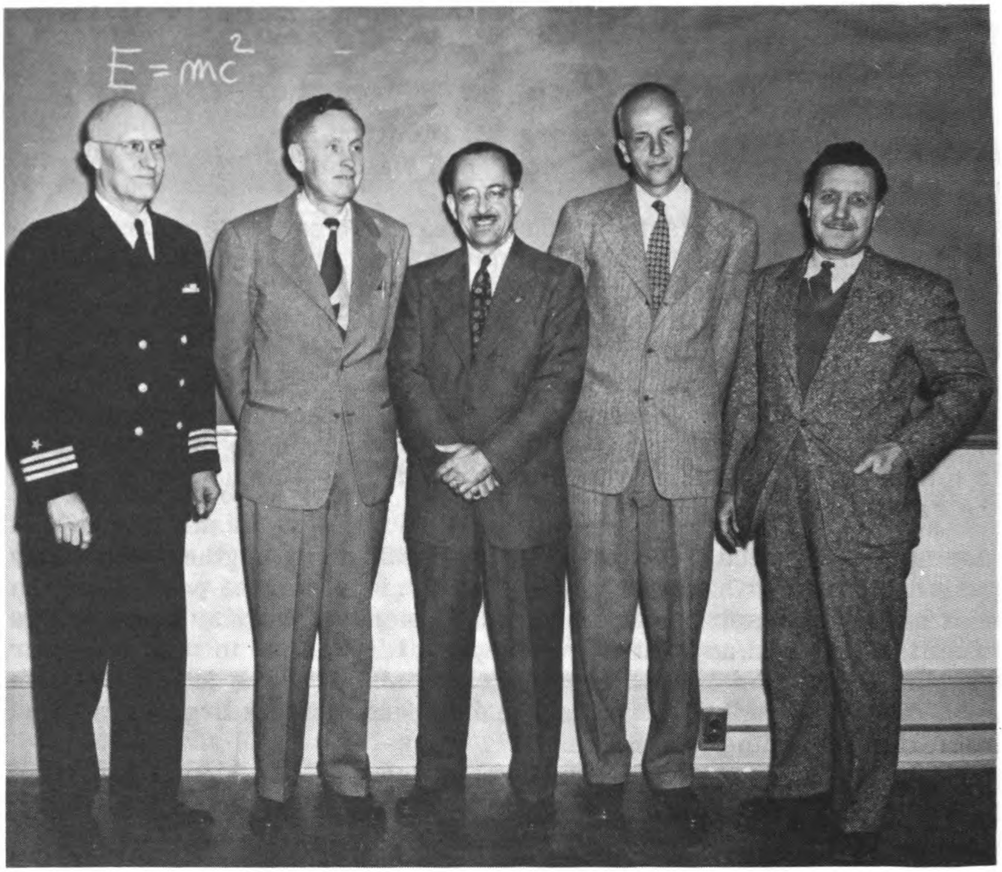
1-1 Cambridge
1-2 Providence
Kingston (S. U.)
Woods Hole (S. U.)
1-3 Amherst
1-4 Orono
1-5 Worcester
1-7 Hanover

3-1 New York
3-2 Long Island
3-3 Buffalo
3-4 Rochester
3-5 New Haven
3-6 Syracuse
3-7 Scotia
3-8 New York
3-9 Upton
4-1 Princeton
4-2 Philadelphia
4-3 Pittsburgh
4-4 College Station, Pa.
4-5 Wilmington
4-6 Bethlehem
4-7 Columbus
4-8 Cleveland
4-9 Dayton
W-1, 2, 4, 5 Wash., D. C.
5-1 Charlottesville
5-2 Blacksburg
5-3 Frederick
5-4 Baltimore
5-5 Richmond
6-1 Atlanta
6-2 Auburn
6-3 Oak Ridge
6-4 Gainesville
6-5 Gulfport
6-6 Chapel Hill
Durham (S. U.)
Raleigh (S. U.)
6-8 Orlando
6-9 Athens
6-10 Coral Gables
W. Palm Beach (S. U.)
8-1 New Orleans
8-2 Baton Rouge
8-3 College Station, Texas
8-4 Houston
8-5 Austin
8-6 Galveston
8-7 Albuquerque
8-8 Bartlesville
Stillwater (S. U.)
8-9 Los Alamos
8-10 Las Cruces
8-11 Orange
8-12 Dallas
9-1 Chicago
9-2 Urbana
Peoria (S. U.)
9-3 Ann Arbor
Houghton (S. U.)
9-5 Ames
9-6 Minneapolis
Brookings (S. U.)
9-7 Lafayette
9-8 St. Louis
Louisiana (S. U.)
9-9 Rolla
9-12 Fort Collins
Boulder (S. U.)
9-13 Des Moines
9-14 Madison
Appleton (S. U.)
9-15 Midland
9-16 East Lansing
9-17 Laramie
9-19 Iowa City
9-20 Lawrence
9-21 Detroit
9-22 Lincoln
Omaha (S. U.)
9-23 Chicago

11-1 Pasadena
11-2 Pasadena
11-3 Los Angeles
11-4 San Pedro
11-5 San Diego
11-6 Phoenix
11-7 Tucson
12-1 San Francisco
12-2 Berkeley
12-3 Stanford
12-4 Fresno
12-5 Berkeley
12-6 Davis
12-7 Salt Lake City
13-1 Seattle
13-2 Richland
13-3 Pullman
13-4 Portland
13-5 Corvallis



New ID card, back and front views. Signatures should be written in indelible ink, which will etch the plastic surface.



VNRRU 12-8 Off to Good Start

The forecast seems to be "smooth sailing" for members of the newly activated VNRRU 12-8 in Monterey, California. They got an encouraging preview of the organization's activities at its opening meeting, held recently at the U. S. Naval Postgraduate School in Monterey.

One of the interesting features of the initial meeting was a discussion of aerology by CDR William D. Duthie, USNR, a member of the unit. CDR Duthie is well able to discuss the military implications of the subject, for in civilian life he is a professor of Aerology at the Postgraduate School's Aeronautics Department.

CAPT George J. Higgins, CO, discussed the aims of the organization and invited all persons qualified in any field of naval research to join.

The unit is fortunate in that it starts off with officers experienced in Research Reserve activities. It was actually founded by officers formerly active at the unit in Annapolis, Maryland, and on the faculty of the Postgraduate School when it was located there.

Other members of the unit and their scientific specialties are: LCDR George H. McFarlin (chemistry); CDR G. Robert Giet, (electronics); CDR Harold M. Wright (mechanical engineering); CDR Lawrence E. Kinsler (physics); CDR George Marshall, Jr. (metallurgy) and LCDR Jesse G. Chaney (electronics).

Launching of New Unit

At left: Organizational officers of the newly activated unit pictured, appropriately enough, with Einstein's famous equation, and CAPT Ralph A. Jack, Program Officer of the Twelfth Naval District. Left to right, the officers are: CDR Jack; LCDR Gilbert F. Kinney, USNR, Personnel Officer; CAPT George J. Higgins, USNR, CO; CDR Willard E. Bleick, USNR, Executive Officer; and CDR Henry L. Kohler, USNR, Program Officer.

At right: CDR Jack delivers orders activating unit to CAPT Higgins.

Below: Members of the unit listen intently as CDR William D. Duthie, Professor of Aerology in civilian life, illustrates his discussion of that topic.

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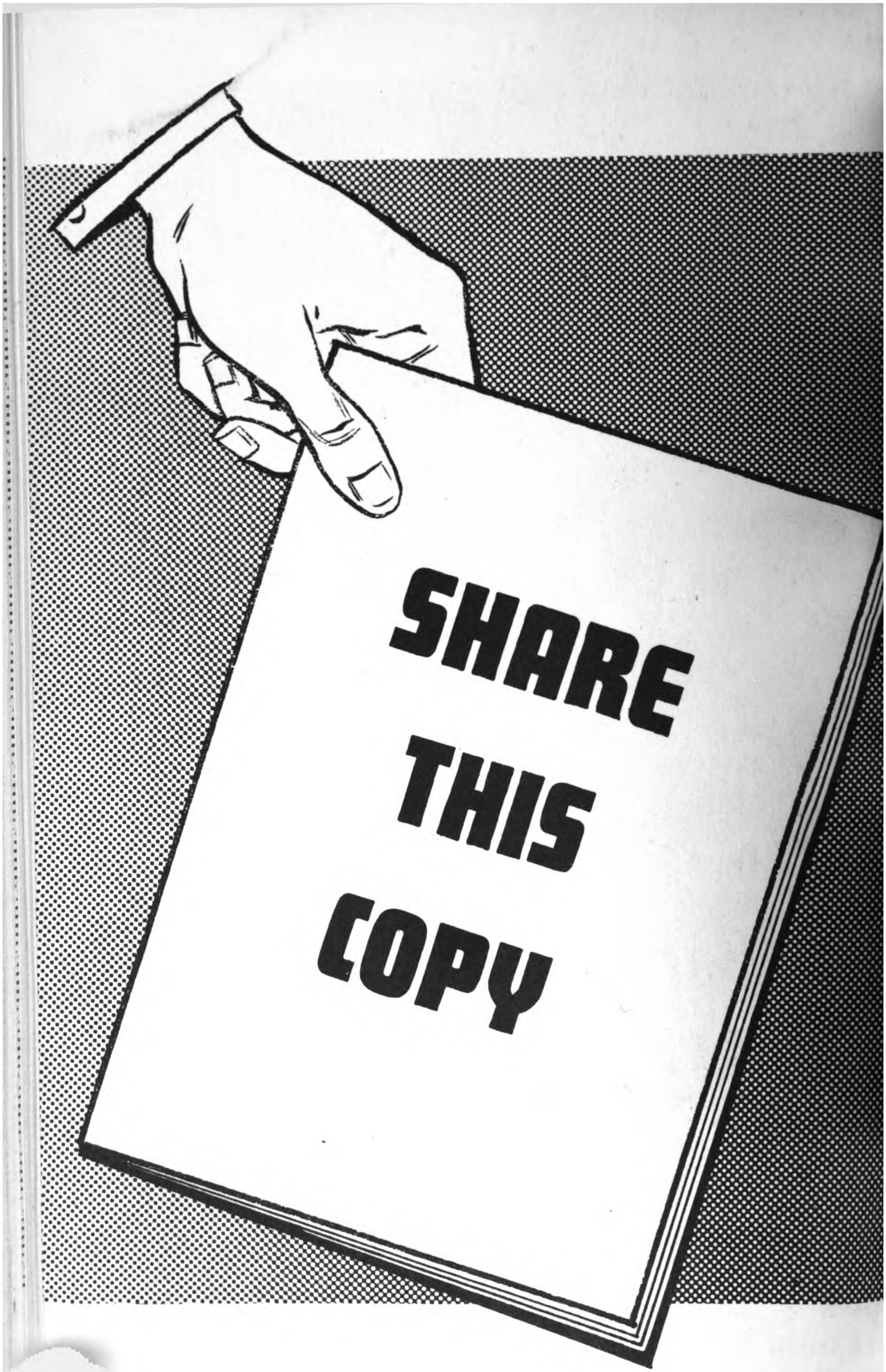
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