ENGINEERING | AND | SCIENCE

MAY / 1953

The Size of the Universe . . . page 9

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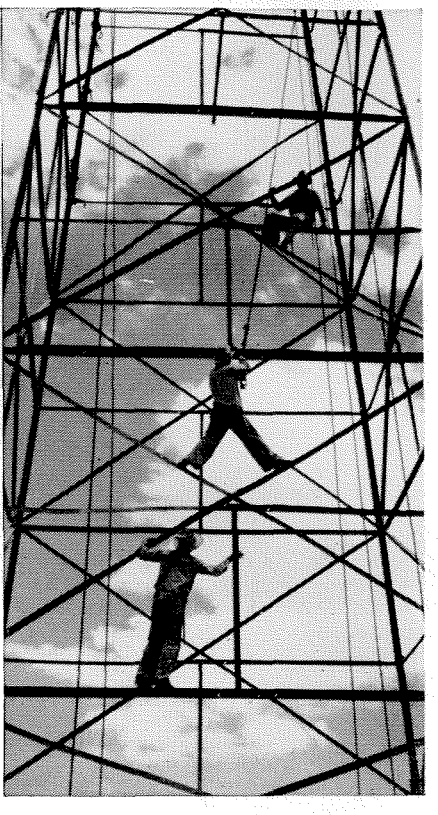

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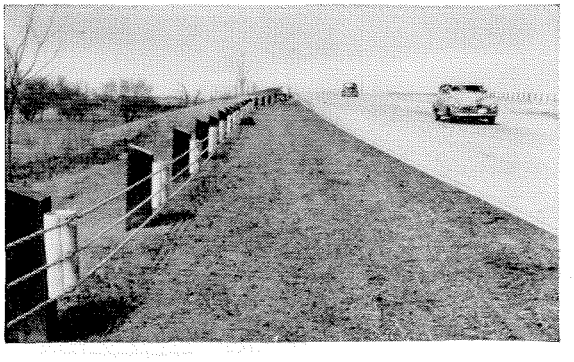

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One day of feeling better doesn't mean you're cured

EVER HAVE FLU, feel better, and go out too soon—only to have a relapse worse than the first attack?

For years the world has been sick. "Something-for-nothing," Welfare State, Socialism, "more-pay-for-less-work"—the disease has different names at different times and places, but it's the same trouble—loss of energy, ambition, faith-in-yourself.

Now much of the world and especially this part of it is feeling better; we think we'll live—as this is written it looks as though more housing, lower prices, lower taxes, and most important of all, less war, are in prospect. BUT—

Don't let's take it too easy too soon. The fever of inflation and debt have wasted the nation's strength and substance which have to be built back. If we continue our tried and true American medicine of hard work, and add the convalescent tonic of thrift, we'll really recover. But as any doctor knows, this first surge of "feeling better" is the dangerous stage:

A relapse could kill us.

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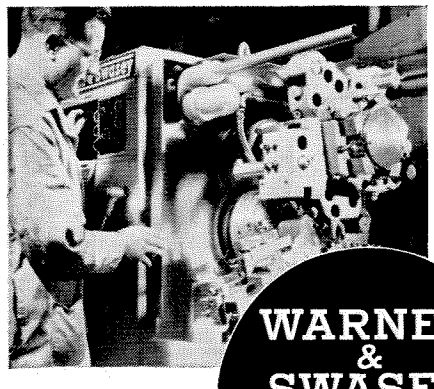

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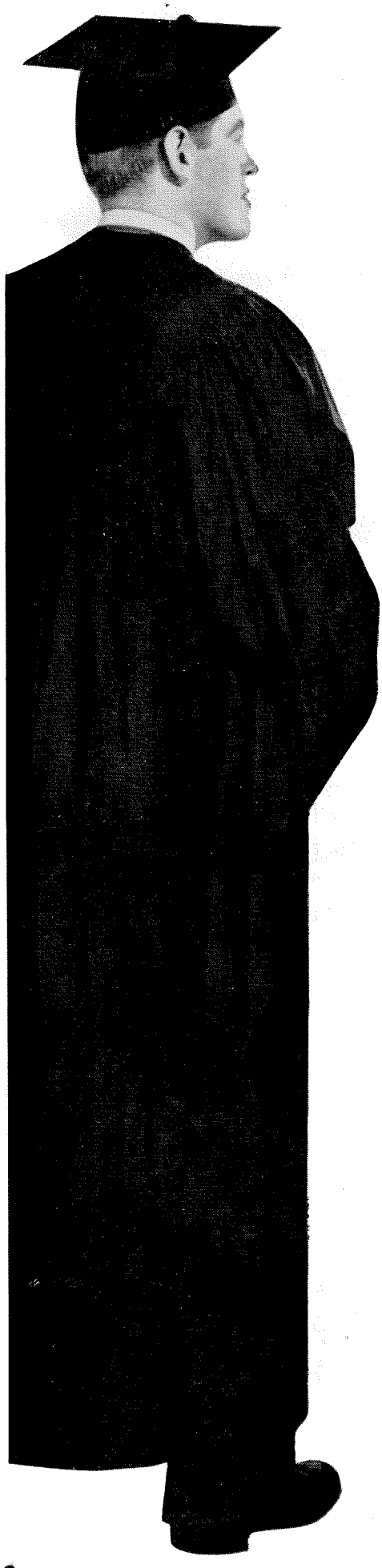

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ENGINEERING | AND | SCIENCE

IN THIS ISSUE

This month's cover picture shows the Andromeda nebula, photographed by the 48-inch Schmidt telescope. Though there's a lot to be said for the 100-inch telescope—and even more to be said for the 200-inch—you've got to admit that the 48-inch Schmidt still takes a mighty pretty picture.

The Andromeda nebula is one of our closest neighbors in space, and the distance to this object is used as a yardstick by astronomers in measuring the distances of all more remote objects. Recent work with the 200-inch telescope, involving remeasurement of this distance has upset a good many of our previous notions about the universe. For one thing, for example, it's twice as big as we'd figured before. The story is on page 9.

In our April issue we had an article by Hunter Mead, Professor of Philosophy and Psychology, on the Caltech student. This month we've given the students a chance to show what they think of the Caltech student—in pictures. You'll find the students' pictures of the Caltech student on pages 13-18.

PICTURE CREDITS

Cover, pps. 10, 11	Mt. Wilson and Palomar Observatories
pps. 12, 21	George S. Stranahan '53
p. 26	J. Allen Hawkins Studio
p. 28	George S. Stranahan '53 Byron Johnson, Jr. '56
p. 38	George S. Stranahan '53

MAY 1953 VOLUME XVI NUMBER 8

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

CONTENTS

STAFF

Publisher.....Richard C. Armstrong '28
Editor and Business Manager.....Edward Hutchings, Jr.
Student News.....Al Haber '53
Staff Photographer.....George S. Stranahan '53
Editorial Consultant.....Professor of English George R. MacMinn

Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena 4, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879.

Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.

LETTERS

Some readers' replies to Fred Hoyle's article, "The Place of Technology in Civilization" (E&S—February).

Sirs:

Most students of social and economic history would agree with Hoyle that the role of technology is very important. Most would dissent from the exclusive dominance over human affairs which he accords to it. When he says that "technology controls civilization" few serious students would go along with him in spite of the majestic simplicity of the idea.

Hoyle's idea is very similar to the well known dogma that "the mode of production" is the dominant factor in social and economic development. As Moritz Bonn once remarked, this thesis appeals to some because it is in itself a convenient labor saving device. Armed with this cliché one does not feel the need to make the effort required really to learn something about history. One's confidence in the mode of production hypothesis or the "technology controls civilization" hypothesis is somewhat shaken however by a historical survey; for example, a survey of the development of Australia and our own West. Could it be that the difference in outcome between these areas was largely due to the difference in ideas and purposes of seventeenth and eighteenth century migrants to America as contrasted with the ideas and purposes of the nineteenth century migrants to Australia?

One of the merits of Hoyle's article lies in the admirable candor with which he sets forth the analogy on which his thinking is based. Society, in his view, being like a collection of molecules in a gas chamber, can be studied with the aid of such intellectual tools as averaging, found appropriate to the study of molecules. Is the analogy valid? Can we agree with Hoyle that it "comes close . . . to the human situation"?

It is interesting to see how Hoyle wobbles as soon as he attempts specific historical analysis. On page 13, regarding the discovery of methods of extraction and use of iron he says: "When the next important discovery was made, it did not come from civilized people at all; centuries of disturbance and fighting so befuddled the wits of civilized man that he became incapable of making further discoveries." Here he recognizes that disturbance and fighting are vitally influential. In a preceding paragraph he says that such matters "count not a jot" but at this point in the article he seems to admit that they do.

Again, on pages 13 and 14, Hoyle makes some remarks about plagues, technology and democracy during the period (say) between 400 and 1400 A. D. Both Hoyle and the historians make technology share the stage with other factors. Hoyle's sequence seems to run: plagues (at some unspecified date), scarcity of labor, followed by technological developments created to economize this scarce labor. Does this support the thesis that technology controls all? Or rather does it not conform to the widely held view that technology is an aspect of social life in which other things play a role, too?

More than technology

Hoyle's observations on "reversal of moral values" and the rebirth of democratic aspirations in the latter middle ages are certainly explained by competent historians on grounds larger than technology. Boissonnade's scholarly analysis, for example, stresses such things as the growth of political order and the development of trade and commerce in explaining democratic movements. However, Hoyle does not stick close to his technology thesis in dealing with this matter. In one place he says that the rebirth of democracy was the "product of Roman anti-democracy"—a curious reflection.

Is it true that, as Hoyle says, changes in the average per capital real income are a "measure" of the

CONTINUED ON PAGE 38

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from James H. Jewell, Vice-President
in Charge of Sales,
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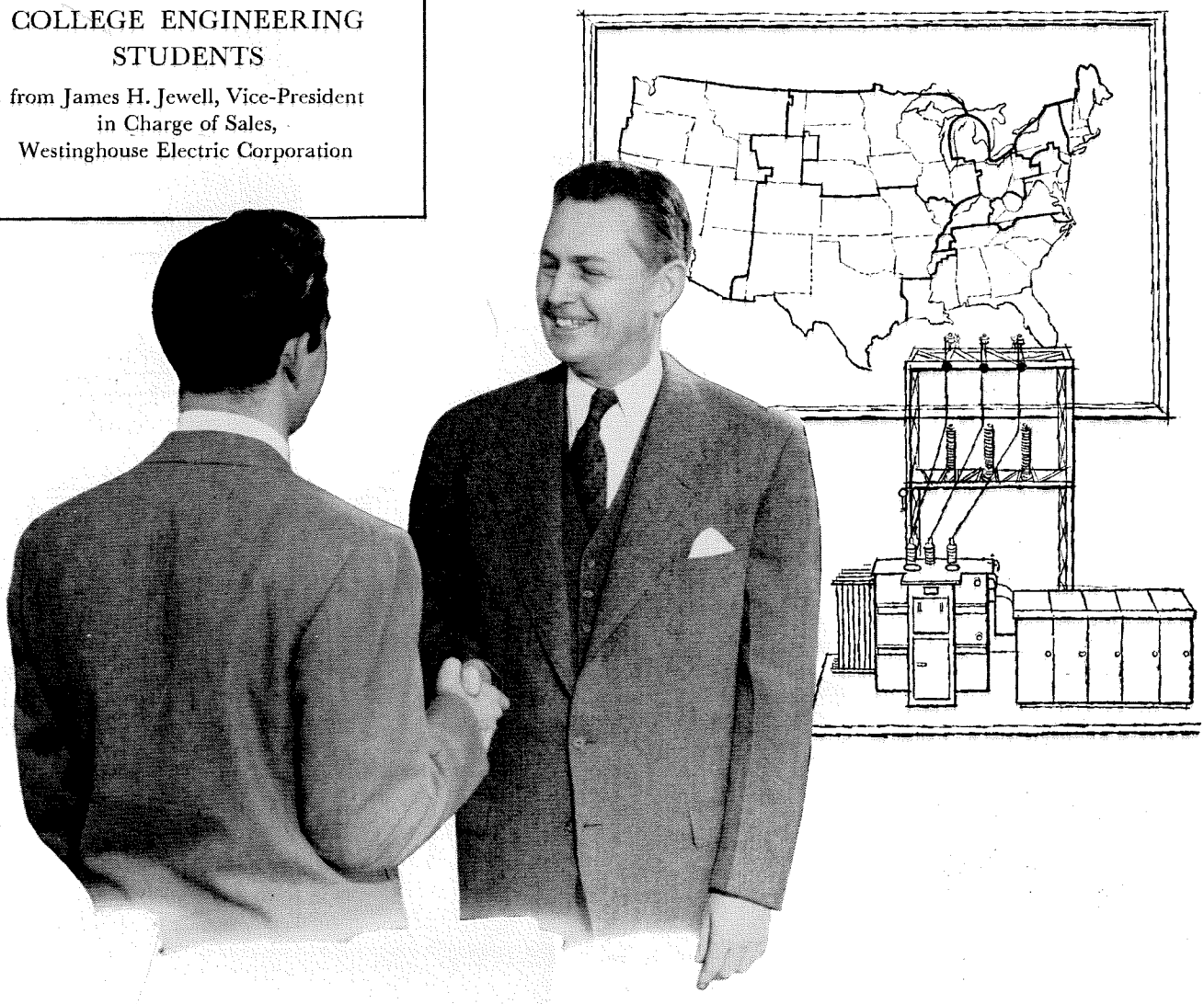

To the young engineer with an eye on sales

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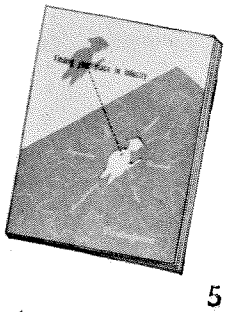

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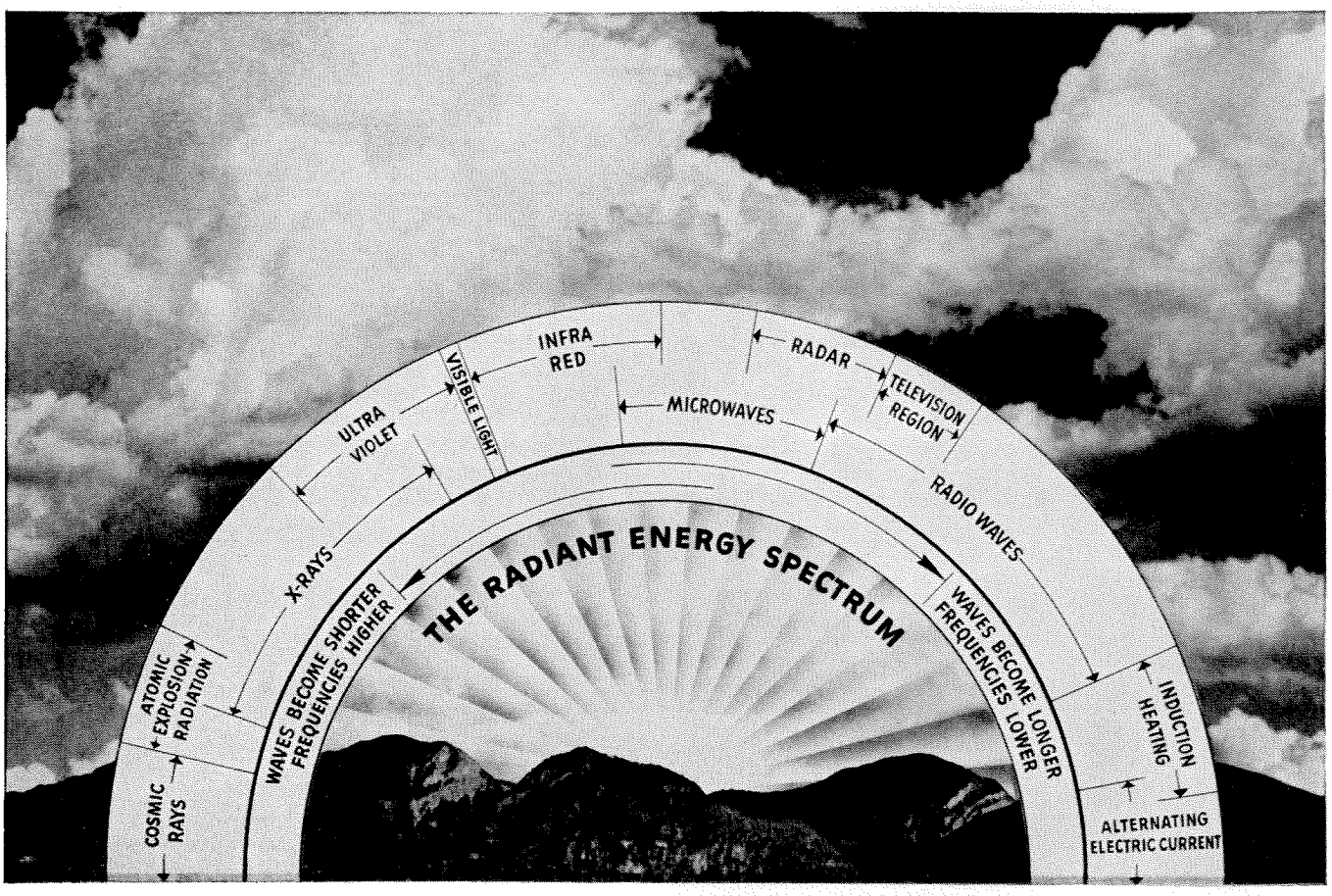

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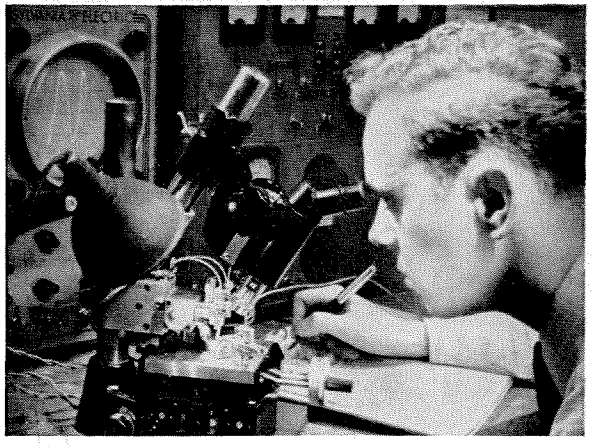

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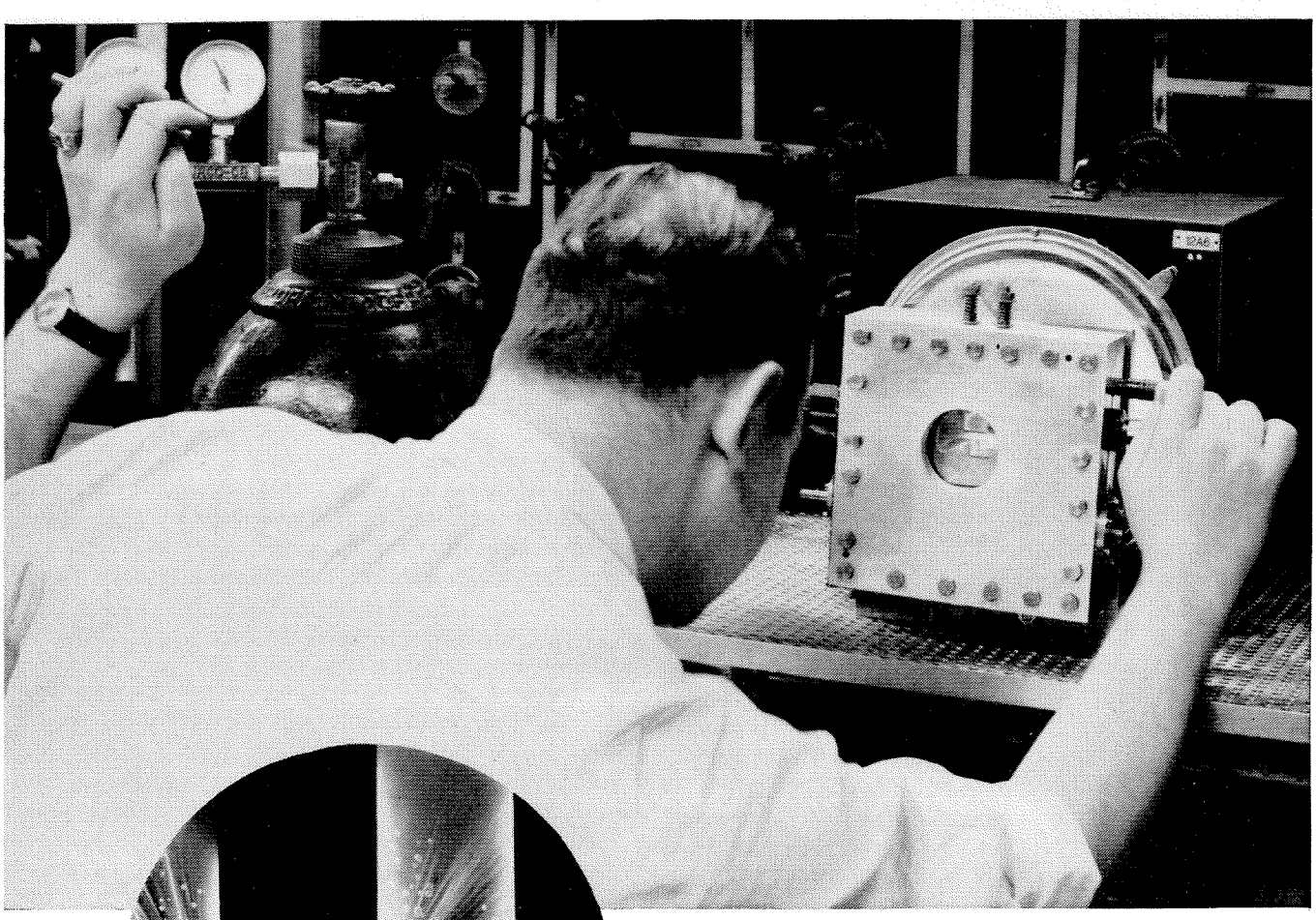

This Sperry engineer is applying the fundamentals of hydraulics to determine oil flow characteristics at high pressure. Here he introduces nitrogen to the hydraulic fluid in a complex valve to make flow patterns visible for study.

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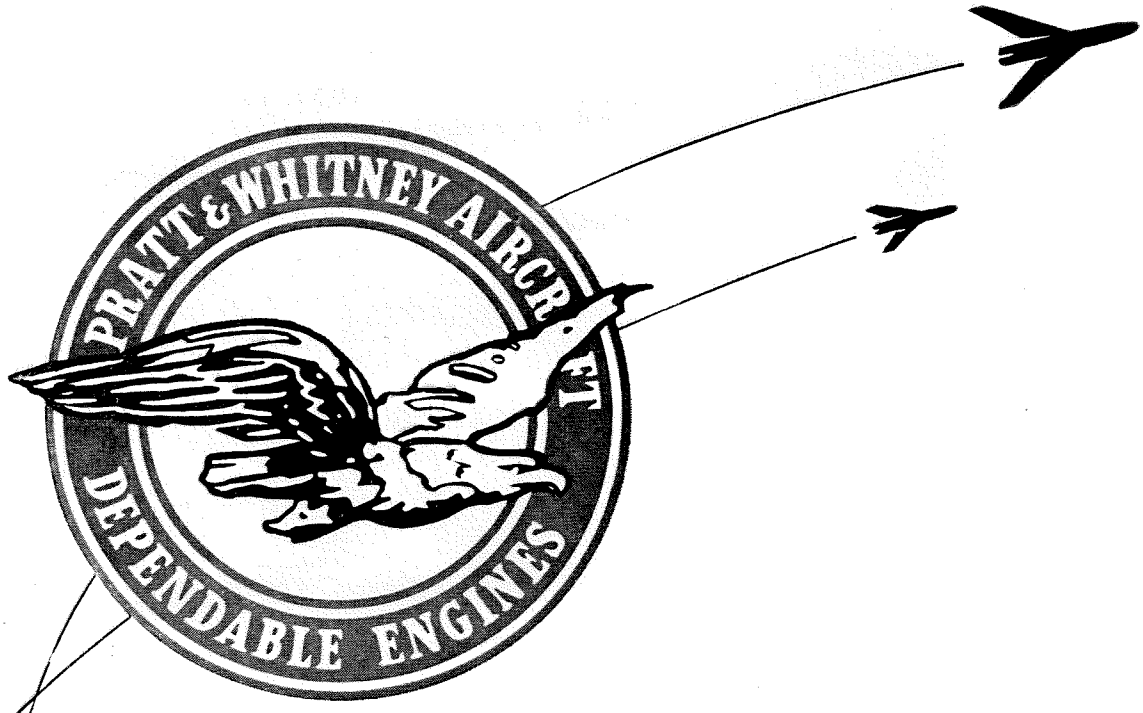

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THE SIZE OF THE UNIVERSE

Research reveals that the range of the 200-inch Palomar telescope is about twice as great as we had thought

IN RECENT YEARS, it has become increasingly apparent that there were discrepancies between the different methods astronomers used for measuring distances. Research done with the 200-inch Palomar telescope has now resolved these discrepancies—and revealed that the observable universe is about twice as large as we had supposed it was before.

This discovery was made by Dr. Walter Baade, staff member of the Mount Wilson and Palomar Observatories, as a consequence of a remeasurement of the distance to the great spiral nebula in the constellation of Andromeda. This distance is a yardstick used in measuring the distances of all more remote objects.

Dr. Baade's findings indicate that the astronomical distance scale was in error by a factor of about two, and further research is expected to refine this figure. Corrections by a factor of two would mean that:

1. The limit of the *observable* universe—as expressed by the range of the 200-inch telescope—has doubled. That range is now about 2,000 million light years. Distance of the Andromeda nebula, one of the nearest to us, has doubled to about 1½ million light years.

2. All the inhabitants of outer space—everything beyond our own galaxy, the Milky Way—are twice as far from us and twice as large as hitherto believed. However, the dimensions of the Milky Way are not affected. These facts remove a discrepancy of long standing—namely, that our galaxy formerly appeared to be twice as big as the biggest extragalactic nebulae which were found in the universe. With the new data, our galaxy is still among the giants, but it is no longer larger than any other.

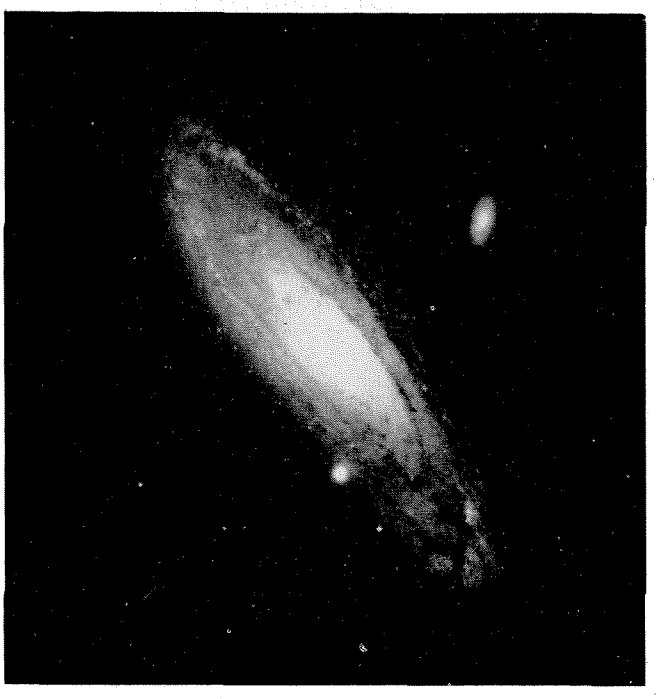
3. The volume of the *observable* universe—that sphere of space which can be scanned with the 200-inch telescope—has increased eightfold because its calculated radius has doubled.

4. The expanding universe—outgrowth of the generally accepted interpretation of red-shifts in the light from distant extragalactic nebulae as velocity shifts—is expanding at half the previously accepted rate. The rule of thumb must now be that for every million light years of distance, the speed of expansion is increased 50 miles per second instead of 100.

5. Estimated age of the universe—based on the expansion interpretation of red-shifts—is twice as great. This age represents the span of time since all the great objects in space hurtled away from a common origin, some of them at great speed and some at lesser. The figure now stands at about 4,000 million years instead of the previously estimated 2,000 million years. This

THREE TELESCOPES

— Three eyes on the universe



48-inch Schmidt telescope photograph of the Andromeda nebula. Remeasurement of the distance to this nebula led to corrections in the astronomical distance scale.

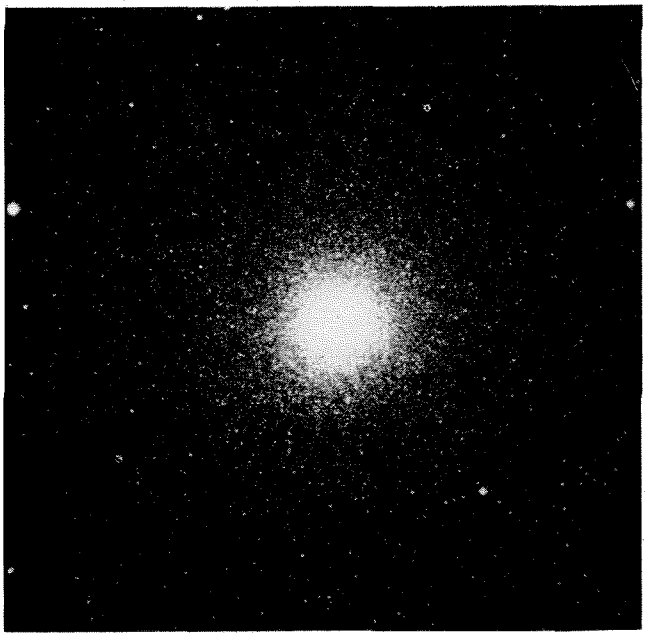
revision eliminates a disturbing disagreement with physicists' estimates—based on the rate of radioactive decay of uranium and thorium—that the earth itself (not the universe as a whole) was created 2,000 to 3,500 million years ago.

The beacons astronomers use to find the distances of far-off stellar systems are Cepheid variables. These are pulsating stars which periodically brighten and dim. Their periods of pulsation range from less than a day to about 50 days and correspond to their inherent brightness ("absolute magnitude"). Astronomers use these absolute magnitudes to calculate distances.

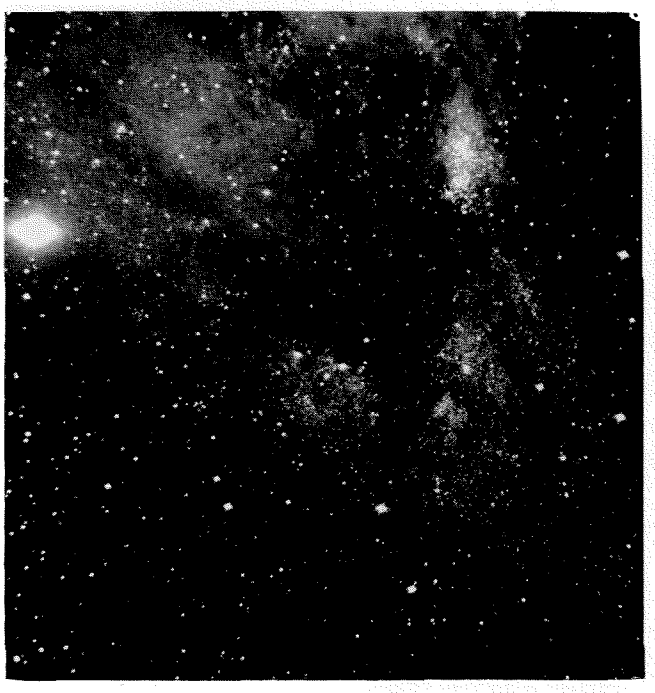
It is now clear that the errors in the astronomical yardstick crept in with the assumption that *all* Cepheids with the same period of pulsation were equally bright. Dr. Baade has shown that they are not. Rather, there are actually two types of Cepheids, one fainter than the other, even though both pulsate identically. Distances calculated on the basis of the old period-luminosity relationship are therefore wrong.

These errors were not apparent until Dr. Baade recognized that there are two kinds of stellar populations in galaxies, each with its own distance indicators.

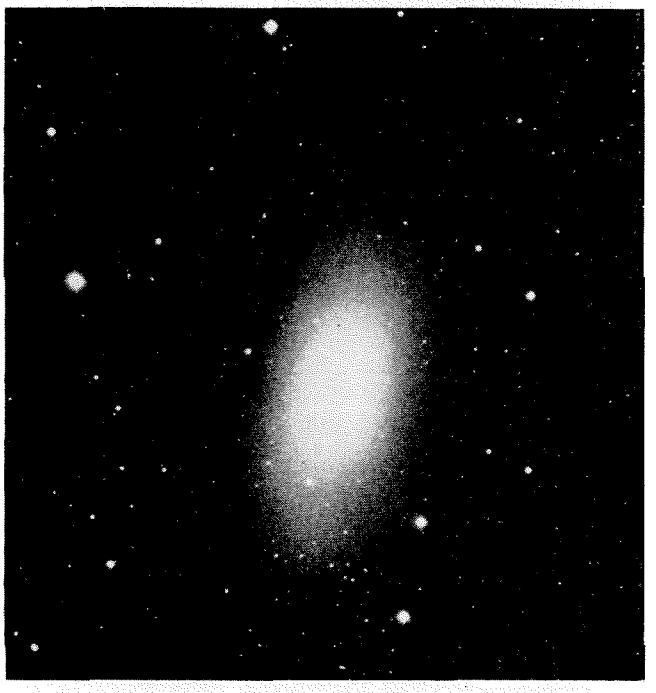
"We know now," he said, "that Cepheids of one type



Cepheid variables — pulsating stars which periodically brighten and dim — are the beacons astronomers use to find the distances of far-off stellar systems. A check of the luminosities of Type II Cepheids in the globular cluster Messier 3, shown at left, played an important role in Baade's revision of the astronomical distance scale.



100-inch telescope photograph of the lower area of the Andromeda nebula. Baade's work with this telescope led to his discovery that there are two stellar populations.



200-inch photograph of Andromeda satellite shown at upper right of picture on p. 10. Work with this telescope proved all previous extragalactic distances wrong.

were used for the distances and dimensions of our own galaxy, while Cepheids of an entirely different type were used for distances outside our galaxy.

"The second group of distance indicators had been wrongly calibrated. This we learned from observations of the Andromeda nebula, its satellites, and globular clusters in the Milky Way. We found all extragalactic distances were in error."

Dr. Baade has been assisted in his research by Allan R. Sandage, staff member of the Mount Wilson and Palomar Observatories, who is to receive the Ph.D. degree from Caltech this June.

Their present work grew out of Dr. Baade's discovery of the two stellar populations during the second world war. Astronomers have hailed that discovery as one of the greatest contributions to our understanding of the universe in recent years.

Using red-sensitive plates, Dr. Baade was able to resolve the central portion of the great Andromeda nebula into stars with the 100-inch telescope on Mount Wilson. This feat had never before been accomplished. This and associated work pursued in great detail by Dr. Baade led him to the discovery of two stellar populations, which he dubbed Populations I and II.

The brightest members of Population I are very hot blue stars, more than 100,000 times brighter than our sun. In contrast, the brightest members of Population II are red stars, only 1,000 times brighter than our sun. If they were side by side, at the same distance from us, the brightest Population I stars would be 100 times more luminous than the brightest of Population II.

Ever since the two stellar populations were recognized, there have been strong reasons to suspect that the pulsating Cepheid variables, although present in both populations, really represented two different species and hence each group of Cepheids had to be calibrated independently.

Dr. Baade has found that the two types do indeed differ. Type I Cepheids (of Population I) steadily brighten and dim. Type II Cepheids (of Population II) brighten, dim a bit, level off and then dim a great deal more before they repeat the process. Although both types include stars whose repeated periods of brightening and dimming range from about two days to fifty, there is another important difference:

Cepheids with periods shorter than one day exist only in Population II, and are exceedingly abundant. These are the cluster-type variables, named for the globular star clusters of our galaxy in which they were first found in quantity. They also are found outside our galaxy.

The two stellar populations exist side by side in the great Andromeda nebula. Population I stars are in the spiral arms and Population II in the central region and between the spiral arms.

The first definite experimental indication of error in the distance indicators came more than two years ago when Dr. Baade tried to find the short-period, cluster-type variables of Population II in the Andromeda nebula.

They should have been visible on 200-inch plates because their median absolute magnitude placed them at apparent magnitude 22.4—one-tenth magnitude brighter than the faintest object the 200-inch can photograph.

They were not visible, however. In fact, only the brightest stars of Population II—which are 1½ magnitudes (or four times) brighter than its cluster-type

Dr. Walter Baade, staff member of the Mount Wilson and Palomar Observatories

variables—were visible, and barely so. Either the cluster-type variables were fainter than had hitherto been supposed—or else the Andromeda nebula was farther away than we thought.

To settle the question, the 200-inch telescope was used to check the luminosities of cluster-type variables in the globular cluster Messier 3 by comparing them directly with stars of solar brightness. This check showed that the accepted luminosity for these Type II variables was correct within about one-quarter magnitude.

This meant, Dr. Baade said, that the calibration of Cepheids of Population II was essentially correct and that the 1½ magnitude error which appeared in the Andromeda work had to be attributed essentially to Type I Cepheids.

These latter had formed the basis for distance determinations on the Andromeda nebula and other extragalactic nebulae, so that when their luminosities are increased by 1½ magnitudes, all the distances and dimensions of extragalactic nebulae have to be increased by a factor of two.

Dr. A. D. Thackeray at the Radcliffe Observatory in Pretoria, South Africa, has found the same discrepancy in the calibration of cluster-type variables in the Small Magellanic Cloud, an extragalactic nebula visible only in the southern hemisphere. The cluster-type variables were expected at apparent magnitude 17.5, but he actually found them at magnitude 19.0—again a difference of 1½ magnitudes. This was the first striking confirmation of the Palomar findings.

Corroboration also came from Dr. Henri Mineur, director of the French Institute of Astrophysics in a recent note to the Paris Academy. The once-puzzling calibration which he reported in 1944, he pointed out, is now understandable in view of the Palomar findings. That calibration agrees with Dr. Baade's, said Mineur, when he allows for the fact that it involves two different distance indicators which correspond to the two sorts of stellar population.

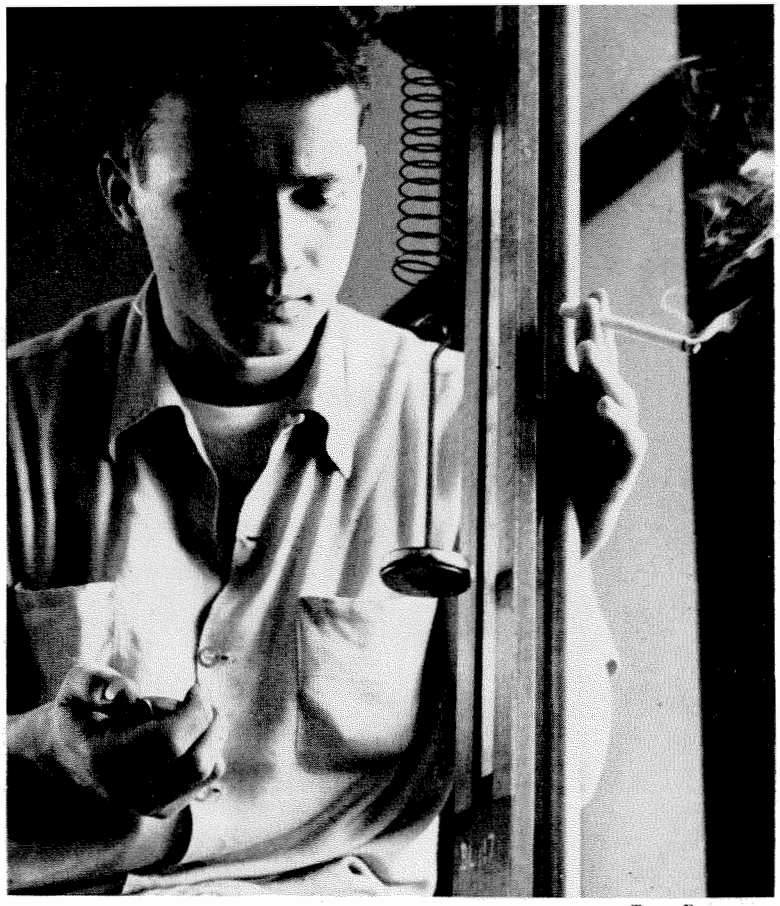
THE CALTECH STUDENT

A Portfolio of Student Photographs by Student Photographers

LAST MONTH *E&S* ran an article by Hunter Mead, Caltech Professor of Philosophy and Psychology, on "The Caltech Student—His Aptitudes and Limitations."

The article was an analysis of the technical student in general, and the Caltech student in particular. Briefly, Dr. Mead allowed that Techmen were exceptionally intelligent, worked harder than most college undergraduates, were top-heavy in what the psychologists call quantitative thinking-ability, and shy in verbal thinking or linguistic ability, had a passion for structure and organization, and a tendency to try to handle people as if they were tools and equipment.

Dr. Mead's analysis, understandably enough, produced some bellows of rage, along with a considerable amount of agreement, from the student body. With due regard for any possible lack of linguistic ability among the students, *E&S* has this month asked the Caltech undergraduates for their ideas on The Caltech Student—in pictures. You'll find a sampling of these on the following pages—the Caltech student as seen by the Caltech student. The pictures speak for themselves.



Tom Bergeman

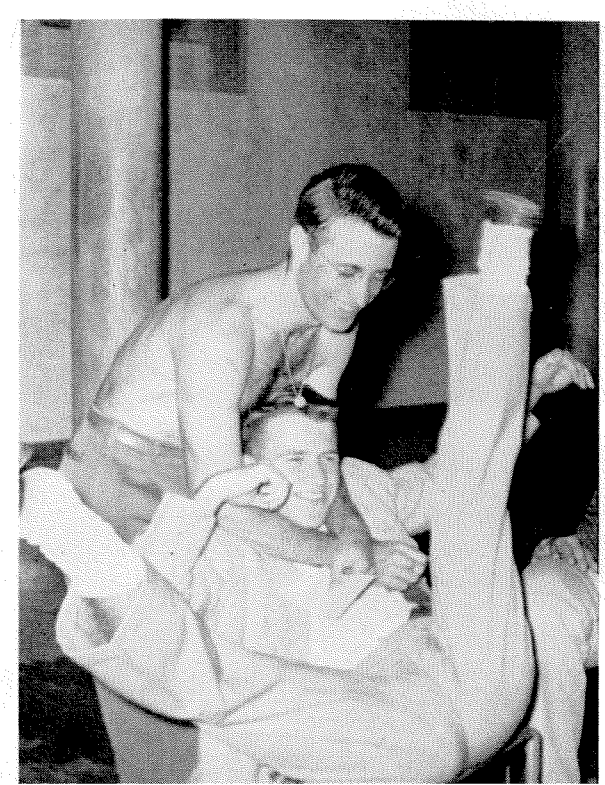
Ed Bryan

Ed Bryan

It takes

all kinds . . .

George Stranahan



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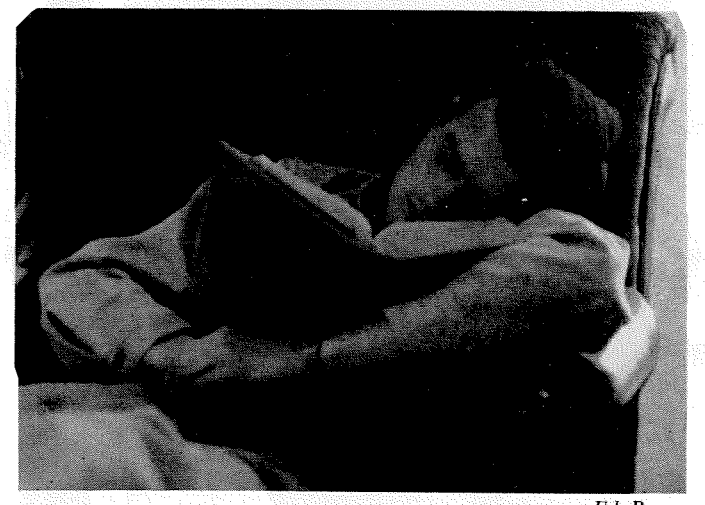

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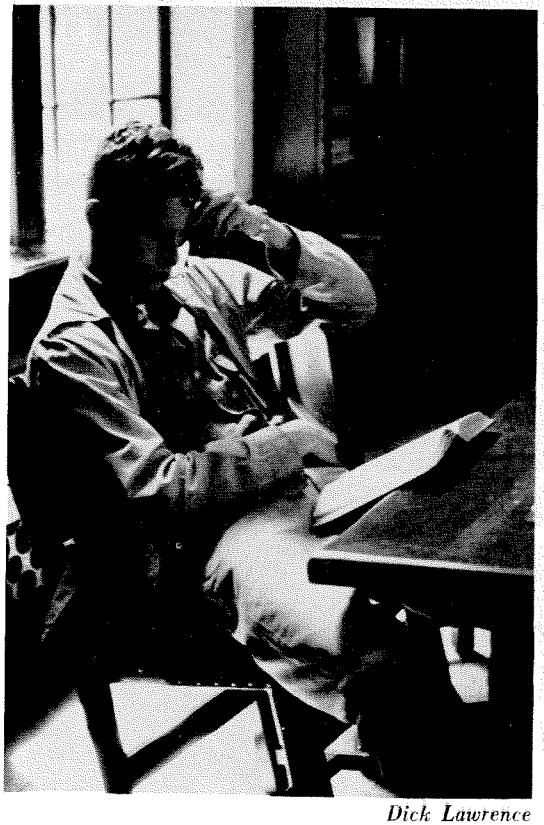

Dick Lawrence

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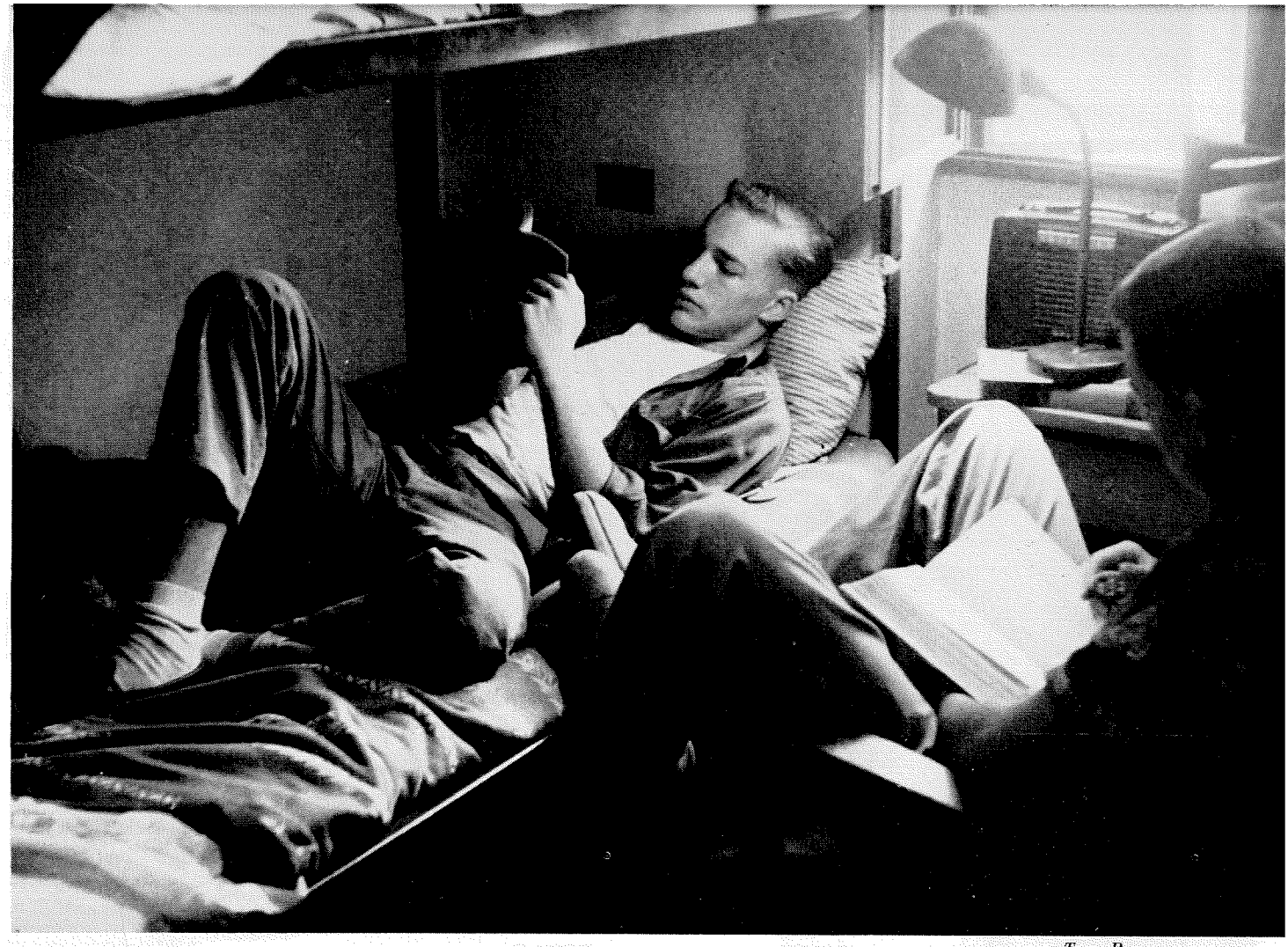
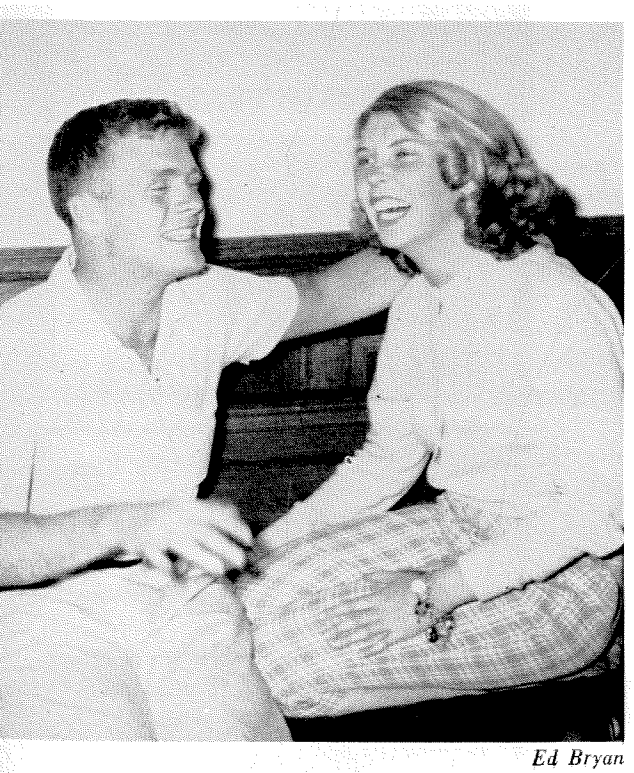


Tom Bergeman



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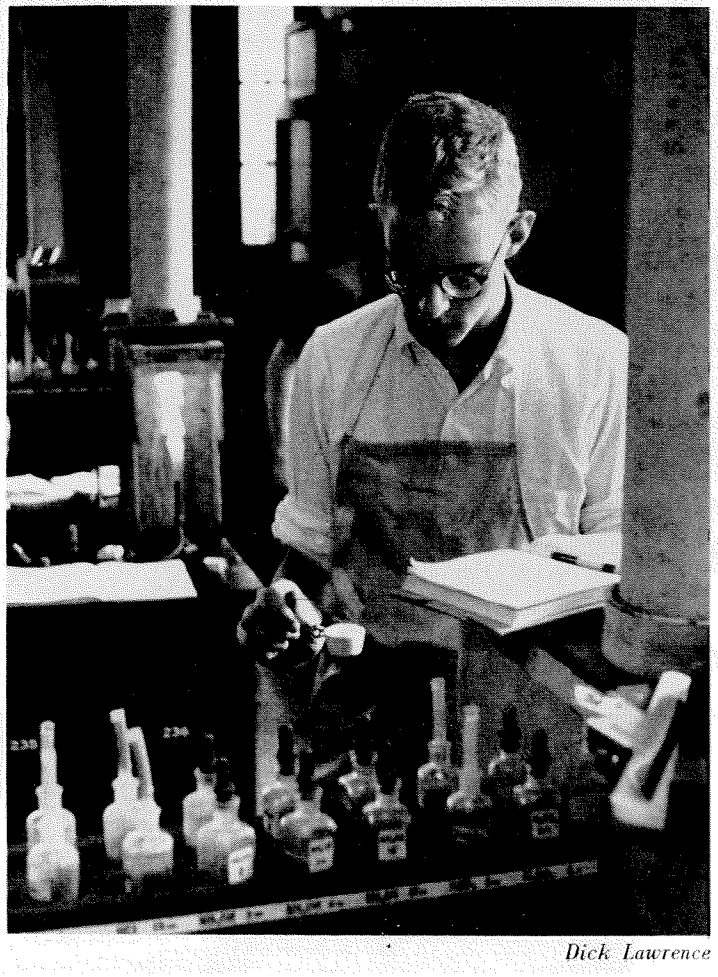
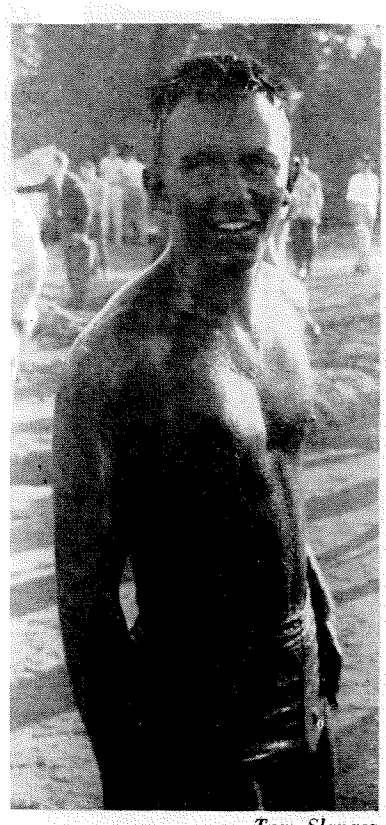
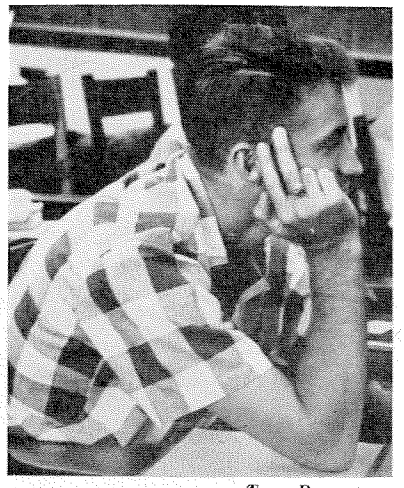


Dick Lawrence

Byron Johnson, Jr.

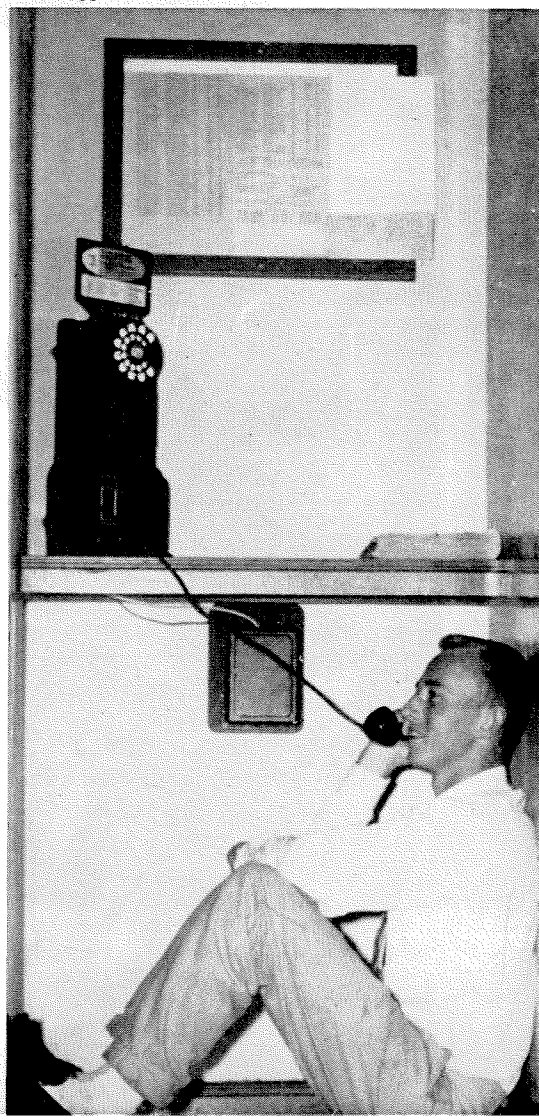


Tom Slanger



Tom Bergeman

Rod Supple



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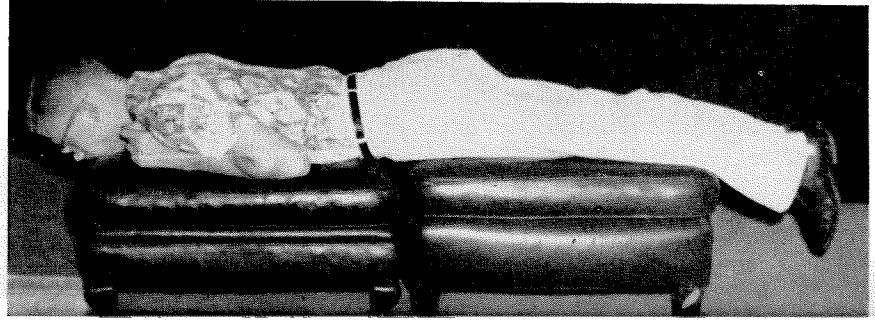


HOARDING

Hamsters do it, rats do it, and human beings do it. But why? Recent studies at Caltech suggest that physiological and genetic factors may be involved.

By JOHN S. STAMM

HOARDING, OR THE collection of more materials than can be anticipated to be needed, can be easily observed with many animals and with men in most cultures. We have all seen the squirrel busily engaged in collecting and burying food; the pack rat is famous for carrying and hoarding many objects; and the hamster is, of course, the prime example of a hoarder. As a matter of fact, in the German language the words for hamster and hoarding are synonymous, and this animal has been known to accumulate such vast amounts of grain that during times of famine in Europe his hoards have been raided to supply human food.

In our society, all of us are acquainted with hoarders —people who collect food, fuel, valuable objects, or often ridiculous ones, to a far greater degree than they can be expected to be used in the reasonable future. In many, but not all, primitive societies this "irrational" activity has also been observed.

Unfortunately, we do not know much about the conditions which bring about this activity, either in animals or humans. Naturalists and zoologists have little to say about hoarding activity, other than to mention it when it occurs. Similarly, psychologists and anthropologists know little about human hoarding—although they do have a number of theories about it.

Recent investigations at Caltech have been concerned with the biological basis of hoarding. In order to clarify some of the innate mechanisms which underlie hoarding behavior in rats, the physiological and genetic bases of hoarding were investigated. These studies yielded some interesting results about the control of hoarding activity by a specific area of the brain, and about genetic differences in hoarding. Before discussing these findings, however, it may be of interest to describe some of the experimental conditions which have been found to influence the hoarding performance.

I. EXPERIMENTAL CONDITIONS

1. *Apparatus.* The hoarding apparatus has been pretty well standardized. The common one is a "closed" alley —a runway 4 inches wide and about 3 feet long, enclosed by about 8-inch high boards. This connects at one end to the cage, which has a door that can give the rat access to the alley. At the far end is a bin in which the material to be hoarded (usually food pellets) is stored.

2. *Onset of Hoarding.* When a rat is allowed access to this apparatus, it will usually not begin hoarding right away. Even under the most favorable hoarding conditions, several days will elapse before the rat will leave the cage and commence to hoard.

There is always a hoarding schedule which permits the rat a certain period of time daily in the apparatus. This may be one-half hour daily, twice a day, 12 hours daily, or continuously. In all cases pellets are counted at regular intervals and then returned to the bin.

Even though animals may not exhibit hoarding behavior for many days after the experiment has begun, the amazing thing is that once a rat begins to hoard, it does so very abruptly. On the first day of hoarding, it collects many pellets—the number usually depending on how late in the trial it commenced to hoard. On the following few days the hoarding scores reach a peak, and as many as 120 pellets may be returned in a one-half hour period. After this peak has been reached, the daily hoarding scores may decline slowly and then reach an average which will be maintained for a long time.

During this period of hoarding there are often marked day-to-day variations in hoarding scores, but very rarely does a rat stop hoarding altogether.

3. *Deprivation.* One of the most important factors affecting hoarding is deprivation of the material to be hoarded. Although it has been shown that deprivation is not necessary in order to elicit this behavior, it always both facilitates the onset of hoarding and increases the amount of material collected.

Deprivation consists in putting rats on limited feeding schedules. Usually about 15 grams of pellets are given the rat before each hoarding trial. If half an hour is allowed for this feeding period, the rat soon learns to finish eating before the hoarding trial begins. If the rats are not fed immediately before the trial, they will take time to eat the first pellets they return to the cage, in order to satisfy their hunger. Under these conditions, of course, hoarding does not proceed as well as when feeding precedes the trials.

4. *Extinction.* Hoarding may be extinguished or sharply reduced by placing the rats on continuous food supply. The high level of hoarding may persist for several days after the satiation period has been started, but then it will drop off sharply, usually to a lower value.

5. *Recovery.* If, after hoarding experiments have been discontinued for some time, or rats have been under satiation conditions, deprivation conditions are re-established, rats will immediately resume their high hoarding activities. In general, during this recovery period, each rat will duplicate its original hoarding curve. Rats which had high hoarding scores will again have high scores, and rats which hoarded less previously will again do the same.

6. *Pre-hoarding activity.* Very few rats will begin their hoarding activity by running to the bin and returning a pellet. In general, rats will at first very slowly stretch out of the cage, then enter the alley and thoroughly explore it near the cage, during which time they may make many escape trials. Some rats may spend days, or weeks, on this exploratory or on escape behavior, before they actually begin to hoard.

No place like home

7. *Familiarity with the hoarding apparatus.* A rat feels most comfortable, of course, in its home cage, and therefore deposits the hoarded pellets in it. When rats which have hoarded for a number of days are then put into different cages, their hoarding activity is markedly changed. The number of hoarded pellets is greatly reduced; rats were found to hoard only about one tenth as many in a new, strange cage. It was found, however, that they dropped a good many pellets into the alley in front of the cage. Though there was never any alley hoarding when the home cage was available, this was found to be the case in about 58 percent of the trials when the strange cage was substituted.

During the first days after the substitution of a strange alley, rats again spent considerable time in exploring the new alley and consequently hoarded much less. After several days, however, the daily hoarding scores again reached the same magnitude as they had before the substitution.

Even when the pellets in the food bin are changed to new ones, rats will hoard less for one or two days, until they become familiar with the smell of the new pellets. It was found that on the first day after the introduction of new pellets, average hoarding scores dropped to one third—after which they rose again.

These experiments point to the importance of "familiarity" as a factor in hoarding. Although a hoarding drive always exists, the hoarding activity cannot be demonstrated until the animal has become familiar with all elements in the situation. Any change of the rat's environment will therefore temporarily reduce or abolish the hoarding activity.

Behavior patterns

8. *Stereotypes.* An interesting observation is that there is a good deal of difference in the patterns of behavior of individual rats during hoarding experiments *and* that individual rats maintain their stereotyped behavior throughout the experimental period. Some rats, for example, always make a dry run before they begin hoarding during each trial. Another rat may circle the food bin, or sit on the pellets in the bin for a while before hoarding.

The persistence of this stereotyped hoarding behavior is a marked phenomenon, although the amount of hoarding will vary greatly in successive trials.

9. *Preference of hoarding material.* In one interesting experiment rats were deprived of water, but not food, and then were allowed to hoard water-soaked cotton pellets. It was found that water hoarding proceeded in the same manner as pellet hoarding usually does—a maximum number of pellets being hoarded during the first few days of hoarding, and then fewer pellets in every trial.

When comparative groups of rats showed the same hoarding behavior for water and for food pellets, the two groups were alternated for food and water hoarding. All the rats then hoarded more of the material of which they were deprived. However, both groups hoarded about two and one-half times more food pellets than they hoarded water pellets.

When rats were given the choice of hoarding food pellets or saccharine-sweetened mash, which was placed in bottle caps, they all hoarded the sweet mash to the exclusion of the food pellets.

When, however, wooden blocks, which looked and smelled like the pellets, were mixed with pellets, the rats refused to hoard the wooden blocks. And when only blocks were put into the bin, there was no hoarding at all.

10. *Hoarding of the hamster.* The hamster is, of course, a much better known hoarder than the rat, and one may question whether the conditions for hoarding

Dr. John S. Stamm, Research Fellow in Biology

in rats also apply to the hamster. In a number of experiments with hamsters it was found that all the conditions and influences which affect hoarding in rats are equally applicable to the hamster—the only difference being that hamsters hoard more. This fact offers assurance to the experimenter that the findings of experiments with rats—which are experimentally much more flexible—are also valid for other animals.

The experiments which have been reviewed here clearly establish hoarding as an experimental behavior which can be regularly studied. It is a motivated, unlearned, and complex behavior that must compete with other activities which the rat will "instinctively" practice, such as avoiding strange situations (i.e., leaving the alley, exploration, and escape).

II. GENETIC FACTORS

Several investigators, working with different strains of rats, have noted differences in the amount of hoarding done by the rats. At Caltech an investigation has been conducted to determine some of the genetic factors underlying the hoarding activity of rats. Simultaneous hoarding tests were given to three homozygous strains of rats (i.e., each strain has been highly inbred and is known to be different from the other strains). Two of these strains showed marked differences in their hoarding performance; a black hooded strain gave a median score of 47 pellets per rat for each trial, whereas an Irish strain had a median of only 7 pellets (see chart, p. 22).

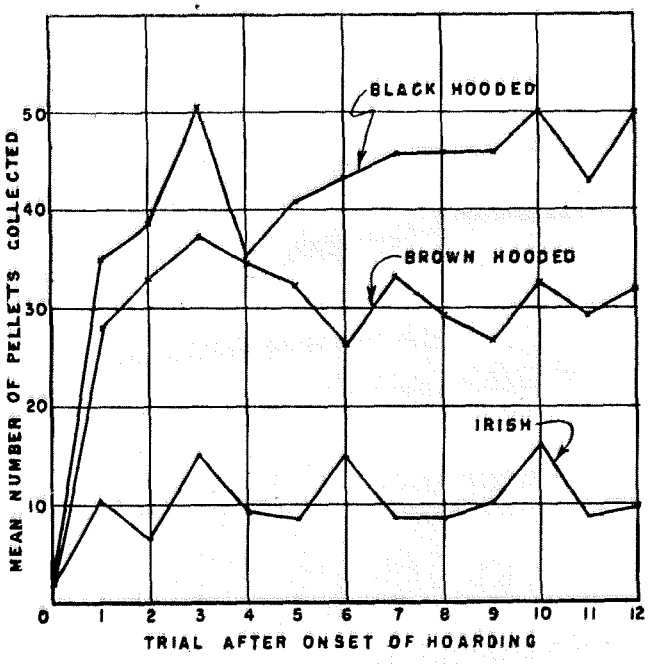
The hooded rats also started to hoard earlier than did the Irish; the median trial for the beginning of hoarding was the fourth day for the hooded and the twelfth day for the Irish rats.

When the hoarding activity was reduced by placing a pile of pellets in the rats' cages at all times, the hooded rats still hoarded some pellets after 16 days, whereas the Irish rats had virtually stopped hoarding on the fifth day.

These results lead to the conclusion that there are indeed genetic factors underlying the hoarding activity. These two strains are now being crossbred, and determinations of hoarding of successive generations will throw more light on the genetic factors underlying hoarding activity.

III. PHYSIOLOGICAL FACTORS

1. *The cerebral cortex and hoarding.* Recent investigations at Caltech on the neural basis for hoarding have yielded some interesting results. By removing small pieces of tissue from different parts of the brain's cortical



Hoarding Scores for Three Pure Strains of Rats

Caltech investigations indicate that genetic factors underly hoarding activity. This chart shows the results of simultaneous hoarding tests given to three homozygous strains of rats. The black hooded strain has a median score of 47 pellets per rat in each test; the Irish strain has a median of only 7 pellets. The hooded rats also started hoarding earlier than the Irish.

surface, the investigator found hoarding activity was greatly reduced when the lesions had been applied to a strip of cortex along the median line of the brain. In one experiment small lesions (averaging about 13 percent of the cortical surface) were applied to a group of 15 rats whose hoarding activity had been determined before and after the operation. As a result of these lesions the hoarding scores (the number of food pellets collected during a series of 20-minute trial periods) of the rats were reduced by an average of 73 percent of the preoperative scores.

As a control experiment, lesions of the same size (13 percent of the cortical surface) were applied to the lateral cortices of 8 rats. There was no appreciable change in the hoarding scores of this group as a result of the operation. When the two groups of rats were compared for other measures, it was found that there were no differences between them. The weights of the rats remained the same. The speed with which they hoarded was the same; it took an average of about 7 seconds for rats in both groups to go to the bin and retrieve a pellet. The latency (i. e., the pre-hoarding period) was also identical for both groups; it took rats in both groups an average of 4.5 days until they began to hoard.

These investigations point to the importance of a restricted cortical area for the control of hoarding activity. The cortical lesions were shown not to interfere with the rats' ability to retrieve pellets. As a matter of fact, since rats were on deprivation feeding, they all had to retrieve a few pellets to their home cages, where they ate them. The chief characteristic of the rats with median lesions were that they would take a few pellets to their cages and eat them there; whereas the control rats, like normal animals, collected a large pile of hoarded pellets in their cages and ate only a few of them.

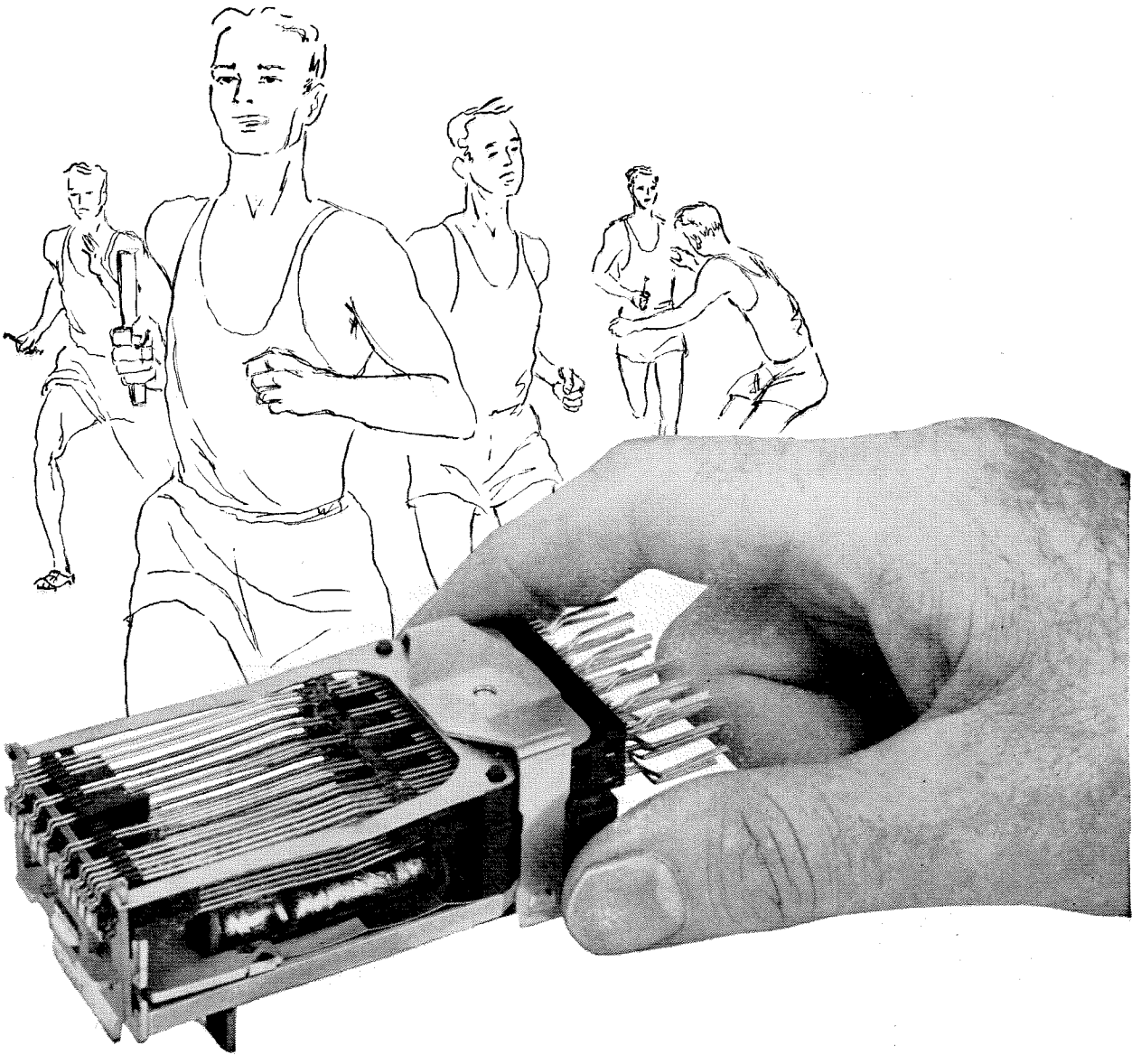
On the basis of these investigations it can therefore be concluded that hoarding—the accumulation of useful material, such as food—is indeed regulated by a specific area in the brain. Removal of this area does not interfere with other observable activities of the animals. The seemingly irrational behavior of hoarding therefore seems to be based on the orderly functioning of the nervous system—at least in rats.

2. *Metabolic factors in hoarding.* It has been observed by other investigators that changes in environmental temperature have marked effects on the amount of pellets collected by rats. Hoarding scores have been found to increase with lowered temperatures and to decrease when it gets warmer. These investigators then altered the metabolic functioning of the animals by injections of epinepherine, insulin, and glucose—none of which altered the hoarding behavior. When the thyroid metabolism was altered by feeding rats thiouracil, injecting thyroxine, or by total removel of the thyroid glands, it was again not possible to show any changes in hoarding activity of rats.

Hoarding—learned and unlearned

We can say, then, that at the present time hoarding can be demonstrated under the proper experimental conditions. It is a relatively complex type of behavior, involving both unlearned responses and learned activity, because the rat has to perform an act which conflicts with other drives, such as avoidance of strange situations and attempting to escape from a restrictive environment.

Hoarding seems to be motivated by some unlearned drive which will persist for a long time and under adverse conditions after it has once been reinforced. This drive is, moreover, related to certain biological factors. The genetic basis of hoarding has been demonstrated by marked and consistent differences between hoarding scores of different strains of rats. Finally, the hoarding drive seems to be controlled by a specific area in the cerebral cortex, removal of which will greatly reduce, or eliminate hoarding altogether.



A NEW RELAY RECORD

RELAYS—which are high-speed switches—are the nerve centers of the dial telephone system. In a split second, they set up a connection and then are off to direct the next call. In a large city, more than 1000 relays are used every time a number is dialed.

Now a new wire spring relay—devised by the Bell Laboratories—is at work. With only 11 instead of 70 parts, it is twice as fast, uses less power, and costs less to make and maintain than its predecessor. Result: calls go through faster and switching is done with less equipment.

Men and women of the Bell System—in operating, manufacturing and laboratory work—continually seek new ways to improve telephone service. Qualified engineering graduates can find well-paid and interesting careers in the telephone business. Your placement officer can give you details about opportunities for employment in the Bell System.

BELL TELEPHONE SYSTEM

THE MONTH AT CALTECH

National Academy Elections

HUGO BENIOFF, Professor of Seismology, and Jesse W. M. DuMond, Professor of Physics at the Institute, have been elected to membership in the National Academy of Sciences. Their election brings Caltech representation in the Academy to twenty-five.

The Academy was created in 1863 by act of Congress to give scientific advice to governmental departments on request. Membership is by election and in recognition of outstanding achievements in scientific research. It is limited to 350 active members who are American citizens and 50 foreign associates.

Dr. Benioff has been a member of the Caltech staff since 1937, when direction of the Pasadena Seismological Laboratory, with which he had been associated since 1924, was turned over to the Institute by the Carnegie Institution of Washington.

He is recognized as an authority on the design of earthquake-recording instruments, and most recent advances in seismology have been based on records made with his seismographs. He has also made many contributions to a better understanding of the processes leading to earthquakes in a series of papers which correlate the pattern of energy release in quake sequences with the known properties of elastic deformation, plastic creep and recovery.

Professor DuMond has been associated with Caltech since he became a teaching fellow at the Institute in 1921. He is considered a leading authority on the precise values of the physical constants and in the field of X-ray and gamma-ray spectra.

He began his career as an electrical engineer in industry and at the National Bureau of Standards, and soon became interested in fundamental physics. In an early contribution he analyzed and published the theory of powerful X-ray spectrometers. He has built several such instruments and used them to make accurate measurements as well as precision studies of X-rays. More recently he has made precision measurements of high energy radiation with X-ray and beta-ray instruments of his own design and construction. Techniques developed by himself and his colleagues are important tools in the Caltech program of precision nuclear spectroscopy, which is providing data required for a better understanding of the atomic nucleus.

New Registrar

DR. FRANCIS W. MAXSTADT, Associate Professor of Electrical Engineering, has been appointed Registrar of the Institute. He will take over the duties previously handled by L. Winchester Jones, Associate Professor of English, who has been serving as both Registrar and Dean of Admissions since 1947.

The work of the admissions office has been steadily increasing in recent years, because of the establishment of a number of new undergraduate scholarships, and the increasing attention devoted to improved selection of freshmen students. Professor Jones will continue to serve as Dean of Admissions. Professor Maxstadt's appointment is effective July 1.

Professor Maxstadt has been a member of the Institute staff since 1919. He was graduated from Cornell University in 1916, received the M.S. degree from Caltech in 1925 and his Ph.D. in 1931. He has been active in consulting and testing work on illumination, motor

CONTINUED ON PAGE 26

Dr. Francis W. Maxstadt, Registrar

Developed by RCA Victor, the new "45 Extended Play" record gives music lovers more music for less money plus a perfect medium for playing shorter classical works and multiple popular selections.

Twice as much music on the same size record

Another RCA achievement in electronics:

A challenging question was asked RCA engineers and scientists in 1951. How can we increase the playing time of a 7-inch "45" record, *without using a larger disc?*

Sixteen months of research gave the answer, "45 EP"—Extended Play. Public response confirmed this as *the most important achievement in the new recording speeds.* More than 2 million RCA Victor "45 EP" records were bought in the first four months of their existence!

Research leadership—your guide to better value: the ability of RCA Victor to solve the problem of more music on a "45 Extended Play" record accents the importance of research *to you.* Whether you plan to buy television, radio or any other electronic instrument, research leadership adds more value to all products and services trademarked RCA or RCA Victor.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. ***Also many opportunities for Mechanical and Chemical Engineers and Physicists.***

Secret of "45 Extended Play" is RCA Victor's discovery of a new way to cut a master disc—with an electrically heated stylus. Grooves are closer. Sound quality is cleaner, clearer, more alive.

RCA® *RADIO CORPORATION OF AMERICA*

World leader in radio—first in television

design and mechanical problems, and has acted as an expert witness in patent suits. He has also made contributions to the technique of electric welding. He is a member of the American Institute of Electrical Engineers and Sigma Xi.

Ford Foundation Grant

THE FORD FOUNDATION has awarded a one-year grant of $10,000 to the California Institute of Technology to support the work of the Committee for Aid to War-Stricken Libraries.

The committee is headed by Dr. Fritz Zwicky, Professor of Astrophysics, who started the project more than 12 years ago. Aided by his friends and colleagues, he has collected and shipped to various foreign countries thousands of scientific journals and books. Through the years approximately 100 persons have helped with the collection, storage, packing and shipping involved in the operation.

With the help of the U.S. Navy, they sent 22,000 pounds of scientific literature to Chiang Kai-shek's headquarters in Formosa and another large shipment to the South Korean Naval Academy. Other recipients have included the Scientific Allocation Committee of the Philippine government and various scientific and educational institutions in France and western Germany.

The Foundation grant will be used primarily for shipping costs, since the literature is all donated.

Cancer Grants

THE INSTITUTE last month received $12,000 from the American Cancer Society for research studies in the Caltech Biology Division. Dr. Henry Borsook, Professor of Biochemistry, was awarded $7500 for work on the use of isotopes, and Dr. Arthur W. Galston, Associate Professor of Biology, received $4500 for studies in the chemistry of plant cell aging.

Dr. Galston has also been awarded a two-year grant of $11,000 by the National Science Foundation in Washington, D. C., for research on the effect of light on the growth of plants. With Glenn Todd, a post-doctoral fellow at Caltech, Dr. Galston will study the chemical reactions produced by light which lead to changes in the rate and nature of plant growth.

Dr. Henry Borsook and Dr. Arthur W. Galston receive grants for cancer study from Mrs. Douglas Donath, local chairman of the American Cancer Society. President DuBridge looks on.

N.S.F. Fellowships

SIXTEEN CALTECH students have been awarded predoctoral fellowships for the 1953-54 academic year by the National Science Foundation.

They are among the 556 students throughout the nation who have received N.S.F. predoctoral and post-doctoral fellowships in science and engineering for the coming academic year. First year graduate students receive $1400, students in intermediate graduate study $1600, terminal-year graduate students $1800, and post-doctoral fellows $3400. Additional allowances are provided for dependents, tuition and other normal expenses.

Caltech Fellows are: Leonard A. Herzenberg, Lionel F. Jaffe and Robert L. Metzenberg, Jr. (biology and biochemistry); Gary Felsenfeld, Martin Karplus, Arthur Miller and William G. Sly (chemistry); George W. Sutton (engineering); Robert J. Stanton, Jr. (geological sciences); and Paul L. Donoho, Marshall P. Ernstene, Roy W. Gould, John D. Sorrels, Edward A. Stern, George H. Trilling and Victor A. Van Lint, Jr. (physics).

Lockheed Scholarship

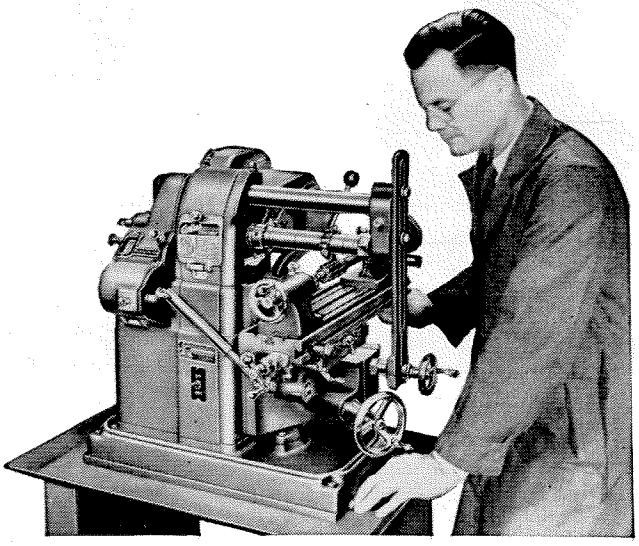
A MEMBER OF CALTECH'S next freshman class will be awarded a four-year scholarship by the Lockheed Aircraft Corporation under a program announced last month which provides for 20 new scholarships annually at various institutions.

This scholarship and 14 more for other participating colleges and universities are provided by a newly-established Lockheed Leadership Fund. Five additional scholarships will be given annually to sons and daughters of Lockheed employees for any accredited schools.

The fund was established to help expand America's industrial horizons, according to Cyril Chappellet, vice-president of Lockheed. "If we are to remain competitive in the air with the rest of the world," he said, "we must attract more college graduates to careers in aviation — particularly those who have qualities of leadership as well as scholastic talent." He added that Lockeed officials hope award winners will seek positions with the company after graduation, but emphasized that they will be under no obligation to do so.

Each scholarship will provide full tuition plus $500 annually for school expenses and an additional $500 for the college or university. The scholarships will be renewed each year if winners meet leadership, character, and academic standards.

Another page for **YOUR BEARING NOTEBOOK**

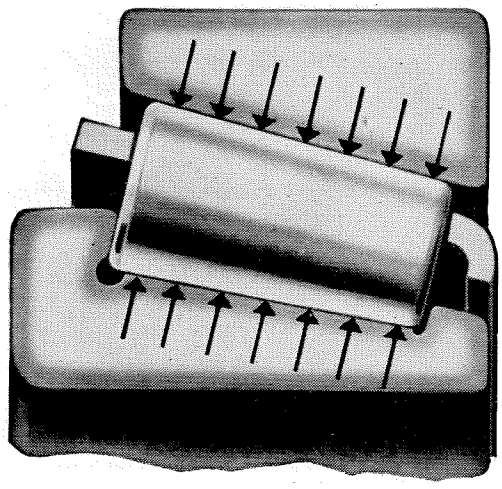


How to give an 8-speed miller greater spindle accuracy

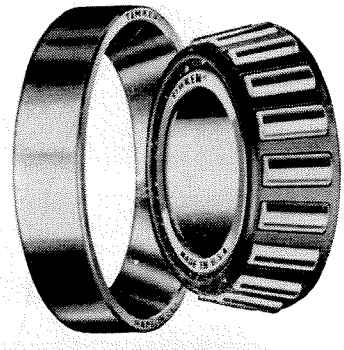
This milling machine has 8 speeds, from 62 to 2870 RPM. To hold the spindle in accurate alignment at these various speeds, design engineers mount it on Timken® precision bearings. Long-lasting milling precision is assured. Spindle accuracy can be controlled because Timken bearings are adjustable. And they provide more than enough capacity for any tool load.

Line contact of TIMKEN® bearings keeps spindles rigid

Because Timken bearings carry the load along the line of contact between rollers and races, they give a wider, more rigid support to the shaft. And the tapered construction of Timken bearings enables them to take radial and thrust loads in any combination. End-play and deflection in the shaft are practically eliminated.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

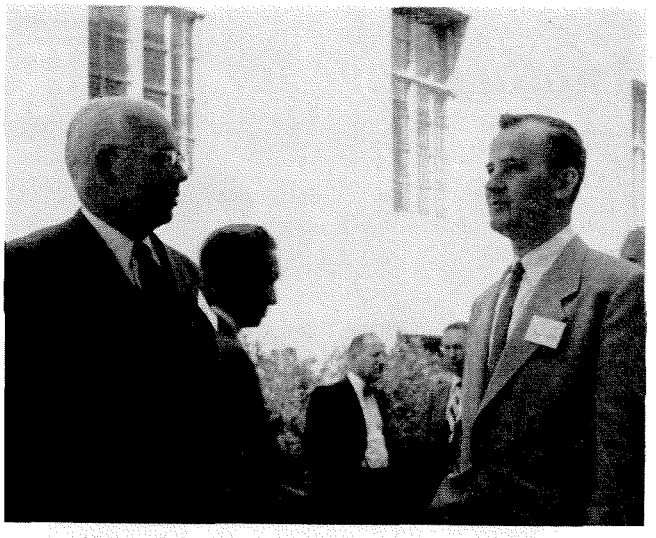


Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken Bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

Full day's program kept visitors on the move



Howard B. Lewis '23 and Ruben Mettler '44

Taking time out to swap vital statistics

SEMINAR DAY

ABOUT 600 ALUMNI, wives and guests visited the campus for the 16th Annual Alumni Seminar on Saturday, April 11.

The daytime program featured a series of eight lectures, and lunch in the Student Houses, and concluded with groundbreaking ceremonies for the $150,000 Alumni Swimming Pool in Tournament Park, made possible by contributions to the Alumni Fund.

The successful day ended with a dinner at the Pasadena Elks Club, where President DuBridge spoke on current developments at the Institute, and Robert R. Dockson, economist of the Bank of America, delivered an address on "Economic Changes and the New Administration."

Prof. Richard P. Feynman and Harry H. Carrick '37

Breaking ground for the Alumni Swimming Pool

to the

ELECTRICAL ENGINEER

or

PHYSICIST

with an interest in

RADAR

or

ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operation.

Here is what one of these positions offers you:

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

THE NEW OPENINGS

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

THE TRAINING

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work with us.

WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

How to apply:

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Scientific and Engineering Staff
Culver City, Los Angeles County, California

See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.

ALUMNI NEWS

Coming Events

THE ALUMNI FAMILY PICNIC will be held this year on Saturday, June 27 at the San Diego zoo. Reservations should be made in the Alumni Office before June 24.

THE CLASS OF '43 holds its 10th reunion this year, and intends to mark this event with a mammoth celebration. So far, the schedule for the "Frolics of '43" lines up something like this:

Wednesday, June 10—Annual Alumni Dinner, 6:00, at the Elks Club in Pasadena

Friday, June 12—Stag Party, following Commencement exercises, 8:30, at the Biltmore Hotel.

Saturday, June 13—Cocktails, buffet supper and dancing, 5:30, at the Lawson Jones home in San Marino.

Amendment to the By-Laws

IN ORDER TO PROVIDE greater consideration by the Board of Directors of nominations to the Board, Section 3.04 of Article III of the By-Laws of the Alumni Association has been amended. The only change is to provide for the appointment of a committee to propose the names of members to the Board of Directors for nomination. The Board continues to act as a nominating committee and the privilege of other nominations by petition of members is retained.

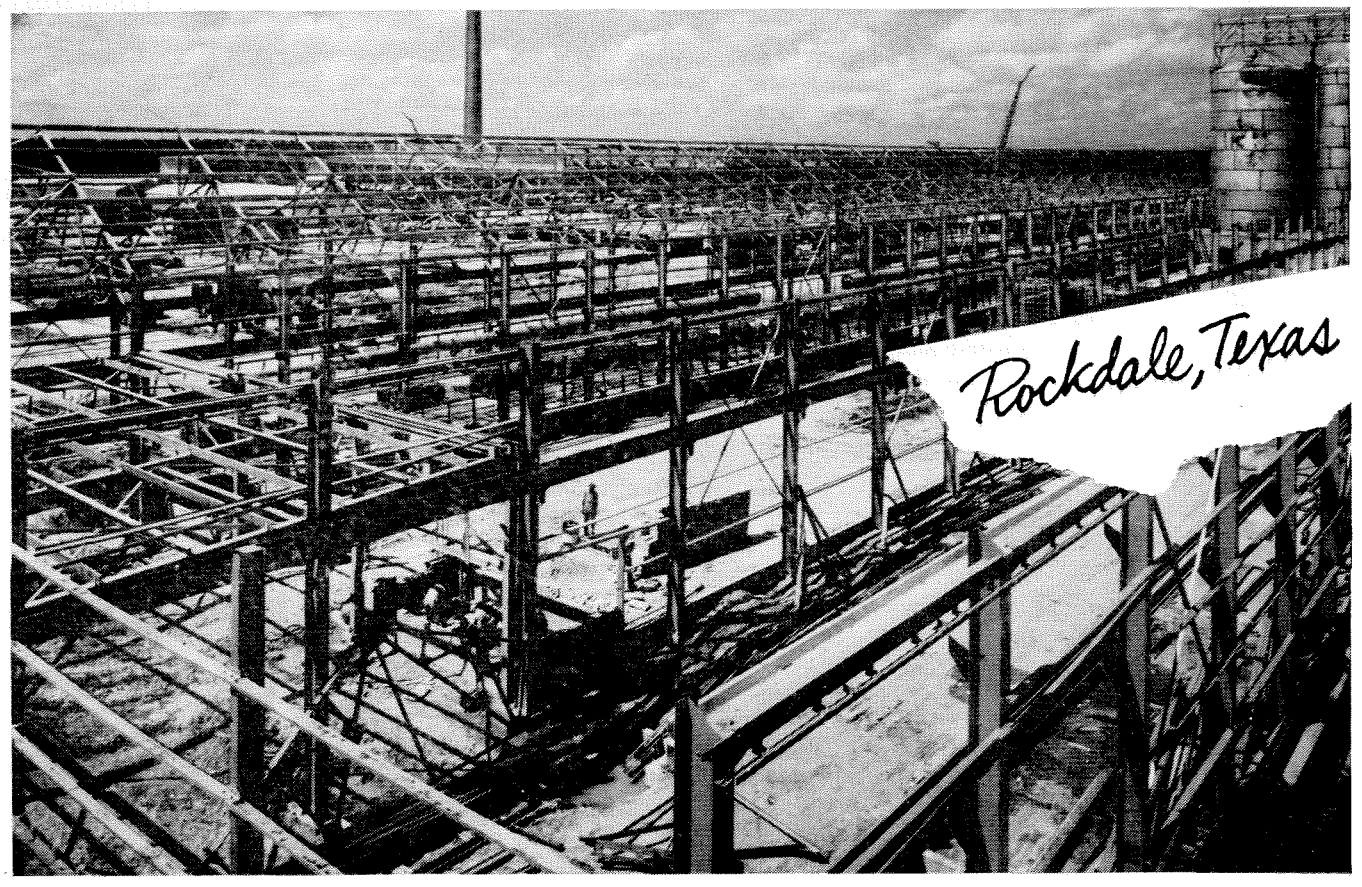
Heretofore, the method of election of officers by the Board of Directors has been inconvenient. The Board was required to hold a meeting on the day of the Annual Meeting of the Association for the purpose of electing officers. To provide a more businesslike approach and to require greater consideration and planning, Section 3.08 of Article III of the By-Laws of the Association has been amended.

These amendments were passed at the meeting of the Board of Directors on April 21, 1953, in accordance with Article X of the By-Laws. These amendments are published here for the information of the members.

SECTIONS 3.04 Nominations
Not later than December fifteenth, the President shall appoint a committee consisting of three members of the Association who may be Directors; the President shall be ex officio member of this committee. It shall be the duty of this committee to propose the names of members for nomination for each Director to be elected with alternates. This proposal shall be presented to the Board of Directors in January for discussion. Not later than March first, the Board shall meet and make one nomination for each Director to be elected. Such nominations shall be published in a publication of the Association, or in a special notice, sent to each member not later than April first. Additional nominations may be made by petitions signed by at least ten (10) regular members in good standing, provided that the petitions are received by the Secretary not later than April fifteenth.

SECTION 3.08 Election of Officers
Not later than May twentieth, the President shall call a meeting of the retiring Directors and the Directors-elect for the purpose of making nominations for officers of the Board to be elected as specified in Article IV of these By-Laws. Not later than June first, the nominations shall be placed before a meeting of the hold-over Directors and Directors-elect for election of officers as specified in Article IV of these By-Laws. The retiring President shall preside at this meeting for which due notice will be sent to each member of the newly formed Board.

—Donald S. Clark, Secretary

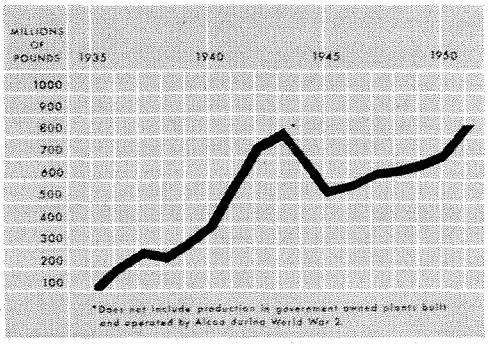


Is part of your future being built here?

Here you see the beginning of another addition to Alcoa's expanding facilities. This plant, at Rockdale, Texas, will be the first in the world to use power generated from lignite fuel and will produce 170 million pounds of aluminum a year. This and other new plants bring Alcoa's production capacity to a billion pounds of aluminum a year, four times as much as we produced in 1939. And still the demand for aluminum products continues to grow. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart—shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.



Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places," get in touch with us. Benefits are many; stability is a matter of proud record; *opportunities are unlimited.*

For more facts, consult your Placement Director.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

THE 1953 ECONOMY RUN

THIS YEAR, Caltech students were again given the opportunity to act as official observers on what is now generally termed the second greatest annual automobile classic. The 1953 Mobilgas Economy Run was a contest sponsored by the General Petroleum Corporation and supervised by the American Automobile Association, in which arbitrarily selected stock models of 1953 cars were driven under nearly identical conditions for a distance of 1206 miles. Winners of the contest were judged on the basis of greatest ton-miles per gallon on the trip.

The 26 cars in eight competitive classes also had to maintain an average speed of 44.7 mph for the entire run. This average is ten percent higher than in previous years. Since 126.5 miles of the trip was through cities and towns where there were posted speed limits of 20 to 25 mph, the cars had to be driven at maximum speed limits between towns.

Sun Valley, Idaho, was again chosen as the destination of the run. The route this year, however, was the toughest yet. Competing cars drove through Fresno, Merced, Stockton, Sutter Creek, Placerville, Carson City, Reno, Winnemucca, Jordan Valley, Oregon, Boise, and Twin Falls. Altitudes ranged from 19 feet to 7,383 feet above sea level.

Dr. Peter Kyropoulos, again designated as Chief Observer by the AAA, started selecting student observers five weeks before the actual run. A number of students were deputized to act as observers during the break-in runs. The cars were allowed a maximum of 2,000 miles for break-in before a deadline date. Final selection of the observers was determined by participation in the break-in runs, and correct interpretation of the required duties as evidenced by a true-false test and a short essay.

In order to provide more efficient and reliable observing, two students were assigned to each car this year. All classes and options, including graduate students, were represented among the observers. In addition to the 52 riding observers, there were two others who assisted Dr. Kyropoulos in providing very efficient handling of observers' luggage, transportation, hotel rooms and meals. The students assigned to a particular car had to get weighed in at the official impound area and completely familiarize themselves with their car.

The cars were driven in a convoy with Caltech observers and a motorcycle escort to the G. P. garage in Los Angeles for final impound and fueling the day before the run. On Sunday, April 19, at 9:30 p.m. the 54 observers, dressed in bright yellow windbreakers and red visor caps, boarded two special busses bound for L.A. in a light rain. The observers obtained the keys, observing kits, and box lunches for their cars; and then remained with the assigned car as it was manually pushed into starting position. The first car was started at midnight; others followed at two-minute intervals.

The first scheduled stop was at a refueling station in Merced. The observers had to record how long, and at what time and mileage the car stopped, the even number of gallons of fuel taken, and the fuel price and temperature—while simultaneously taking on doughnuts and coffee, watching the local high school talent displayed, and trying to heed certain metabolic processes. After all this, it was a pleasure to get moving again. Between stops only one observer was necessary to see that the driver obeyed all posted speed limits and traffic laws. The relief driver helped the driver keep track of the allowable running time. Whenever possible, the observers were also required to watch other competing cars.

The second stop was for a 30-minute brunch near Sutter Creek. The cars continued to climb through the beautiful mountain country along the American River, and then descended to Lake Tahoe. The second refueling stop was at Carson City. Arriving at Reno in the middle of the afternoon, the weary Tech students turned in their reports, and had a few hours' sleep before dinner.

After a hasty recovery from the previous 15 hours, the wandering scientists and engineers took full advantage of Reno's noted culture and General Petroleum's generous hospitality. Following a good night's rest, all cheerfully awoke at 3:15 the next morning, ate breakfast, and were back at the impound at 5 a.m. The frost-covered cars were started at two-minute intervals.

The observers soon thawed out, riding with all windows closed (to reduce air drag) under a hot desert sun. The next stop was at Winnemucca, for brunch and refueling. It was here that one car accidentally got off the elaborately specified course, and went ten miles before realizing the error. This mischance caused the drivers to run out of gas a few miles from Boise; and to be disqualified. Allowable running time for the 431.5 miles from Reno to Boise was 9 hours and 15 minutes.

Assembled school children and state police had waved at the cars all along the route, but Boise really turned out for the Economy Run. The cars finished the second day's run in front of Boise J. C., and were greeted by the mayor, coffee and doughnuts, and a very impressive (or impressed) crowd. Some anonymous AAA official, speaking over a p. a. system, assured the crowd that "these boys won't cause much disturbance in Boise tonight; they're all too tired." Tired or not, the drivers, observers, and other officials weren't given much of a chance to disturb the town—since it is the only place

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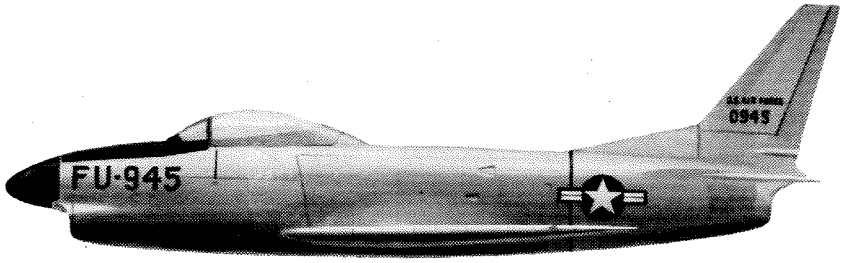

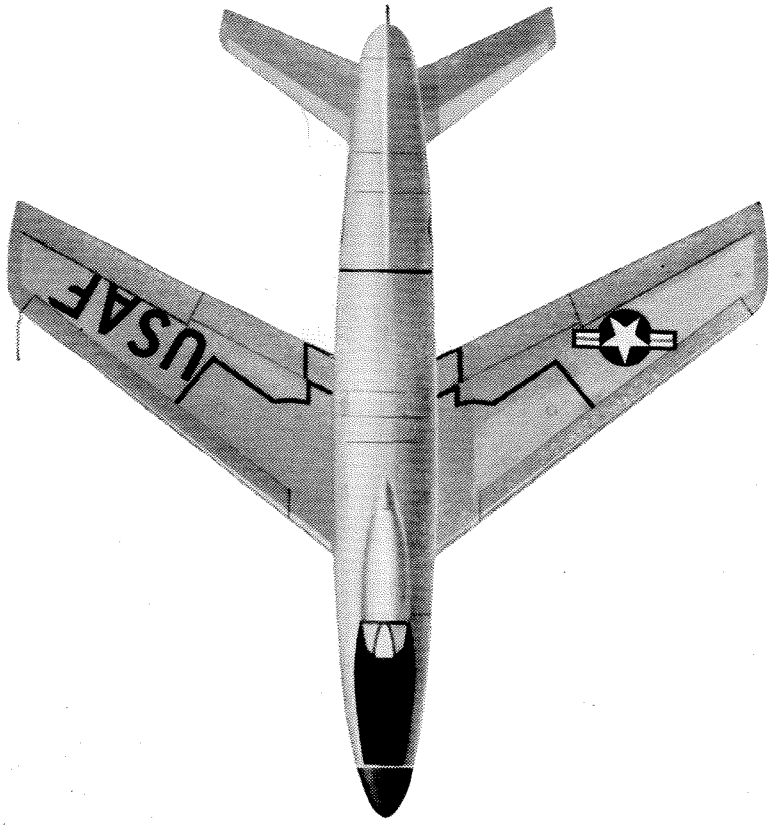

YOUR IDEAS

Will Keep Planes Like This On The American Team

What makes great planes like North American Aviation's F-86D and sister *Sabre* jets? The answer is new ideas . . . young ideas. And just as the ideas of young engineers of a decade past helped perfect the plane you see above, so will the ideas of today's engineering students—your ideas—perfect tomorrow's F-???. That's why North American Aviation always has challenging career opportunities for bright, young graduate engineers.

Today, North American is developing projects of a new era—aircraft, guided missles, rocket engines, rockets, electronics, atomic energy. If you'd enjoy the challenge of pioneering in these advanced fields, consider looking to the future with North American when you complete your engineering training. In the meantime, feel free to write for information concerning a career in the aircraft industry.

Your student placement office will be glad to supply you with more detailed information. Or if you prefer, write direct, including your name, address, placement preference and personal data. Please address your reply to:

D. R. Zook, Employment Director, 5701 W. Imperial Highway, Los Angeles

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STUDENT LIFE . . . CONTINUED

north of Pasadena that seems to roll up its sidewalks when the sun goes down.

The Techmen were up at five the next morning, ready to leave on the last, and most important leg of the run. The last day's route was along the Snake River past Thousand Springs, Twin Falls, and across the Big Wood River. Slow farm tractors moving down the main thoroughfare of towns along the route made life interesting for the economy-minded and time-conscious drivers. Three or four cars encountered one of the most dreaded of all hazards — a large herd of sheep crossing the road. Two cars carefully plowed through, but a third had to come to a stop to avoid running up the expense account with mutton. Observers had soon learned that one of the major factors of gasoline economy is a steady throttle. Hence, stops and starts were not at all desirable.

A large crowd greeted the cars at their sunny destination early Wednesday afternoon. Exclusive of their last fuel stop, five hours and zero minutes was allowed for the 226.3 mile run from Boise to Sun Valley. It was both interesting and dramatic that six cars finished with less than a minute to spare! One car had vaporlock a half mile from the finish line — but managed to throw snow on the fuel pump, and roar across the finish with an uncomfortable 1.6 seconds to spare! A few hours after their arrival the carefully guarded cars were towed to a special refueling stand, where the fuel tanks were accurately topped off to determine total gas consumption.

The Ford-Six was awarded the sweepstakes trophy at the colorful awards presentation on Thursday morning. The two observers who, in the opinion of AAA officials, had done the best job were awarded watches.

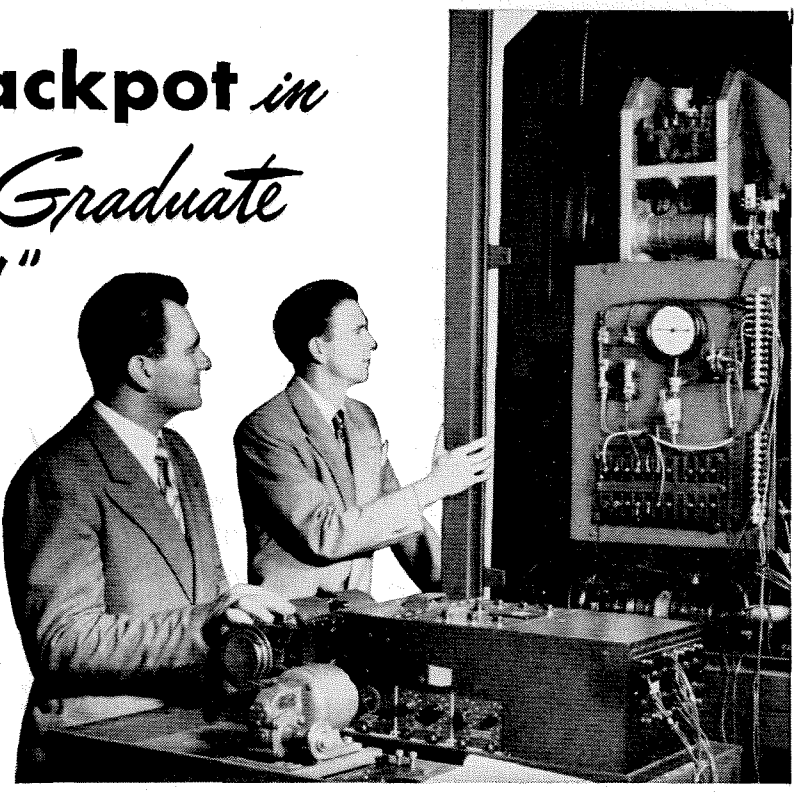
During their 32-hour stay at Sun Valley the observers and hundreds of others enjoyed the gracious hospitality of General Petroleum and the Union Pacific Railroad. There was ample time for swimming, bike-riding, bowling, billiards, and riding the scenic ski lift — aside from eating, resting, and attending a big cocktail party Thursday evening. The seasoned observers boarded busses at 11 p.m. Thursday for the train at Shoshone.

The monotony of the 30-hour train ride back to southern California, via all possible desolate wastelands, was lessened by card games in the two special C.I.T. Pullmans, and by 15-minute stops in Salt Lake City and Las Vegas. The yellow-jacketed observers, feeling conscious of all that they had missed back at Tech, arrived in east L.A. at 6:30 Saturday morning.

It seemed hard to believe that the observers would also be paid $50 for the five days. Aside from monetary gain, the Mobilgas Economy Run offers the Tech student an opportunity to learn how to drive economically, and to live briefly in a manner to which he may not be accustomed.

—Jim Wyman '53

"We Hit the Jackpot *in* Allis-Chalmers Graduate Training Course!"



say N. W. MORELLI

Oregon State College, B.S.,M.E.—1950

and

E. R. PERRY

Texas A. & M., B.S.,E.E.—1950

WHILE taking the course, two engineers developed a revolutionary new circuit breaker mechanism.

"Our experience shows what *can* happen if you work with people open to suggestion. We found men of this kind at Allis-Chalmers, and it has given us a special pleasure in our job.

"We started out like most other graduates with a hazy idea of what we wanted to do. After working in several departments, we requested that part of our training be at the Boston Works of Allis-Chalmers, where circuit breakers are made."

New Design Principle

"Circuit breakers soon became an obsession with us, and we got the idea of designing a hydraulic operator and triggering mechanism for these breakers. Most operators for big breakers are pneumatic.

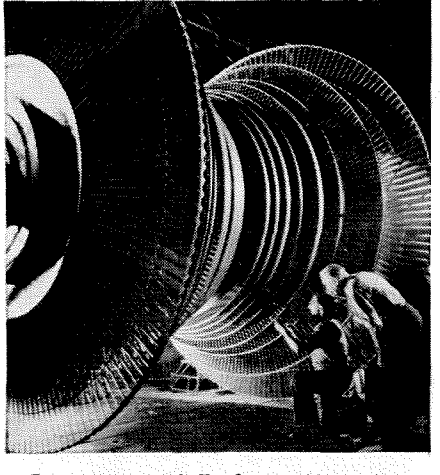
"Unsuccessful attempts had been made in the past by all circuit breaker manufacturers to build hydraulic operators. The important thing is that no one at Allis-Chalmers said, 'Don't try it—it won't work.' "

Start New Era

"To make a long story short, our study of the problem led us to the hydraulic accumulator and high speed valves being used by the aircraft industry. These had not been available when earlier attempts were made to build a hydraulic operator. With these highly developed devices to work with, we were able to build an operator that combined the best features of pneumatic and hydraulic operation. We call it the *Pneu-draulic* operator. Engineers are saying it starts a new era in circuit breaker actuation.

"This fact is important to us, but it is even more important to know that Allis-Chalmers Graduate Training Course is full of opportunity . . . and as we found out, there's opportunity right from the start."

Pneu-draulic is an Allis-Chalmers Trademark.



Low-pressure spindle for a 120,000 kw steam turbine generator. Said to be one of the largest ever built in the United States, this spindle is nearing completion in the Allis-Chalmers West Allis shops.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, or specialized equipment with which he will work, such as: steam or hydraulic turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

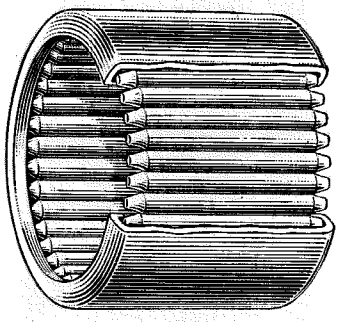
7. For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

C-5675

The Torrington Needle Bearing

. . . shaft hardness determines effective load capacity



The economy of the Torrington Needle Bearing is due in part to the fact that the shaft usually serves as the inner race. Thus, since the shaft is an integral part of the bearing, its load capacity limits the capacity of the bearing assembly. In order to obtain the full rated load capacity of the Needle Bearing, it is necessary that the shaft be at least surface-hardened to the equivalent of Rockwell C-58.

Loads and Speeds Related to Shaft Hardness

Because of material or design limitations, it is sometimes desired to run Needle Bearings on shafts softer than the recommended Rockwell C-58. This can be done safely providing the bearing loads and speeds are not too severe. However, the capacity of the bearing assembly is only as great as the load capacity of the shaft, regardless of the rated load capacity of the bearing as indicated in the catalog. The shaft capacity decreases very rapidly as the surface hardness is reduced below the recommended Rockwell C-58 minimum hardness.

Figure 1 shows this very clearly. It can be seen that reducing the shaft hardness to Rockwell C-52 gives a resulting load factor of .5. In this case, the catalog rating must be multiplied by .5 in order to obtain the true capacity of the bearing assembly.

Unheat-treated, cold rolled shafting will only carry 2%-3% of the bearing's rated load capacity.

The speed of the application is also important in determining proper hardness to assure satisfactory shaft life. The chart in Figure 2 illustrates this effect.

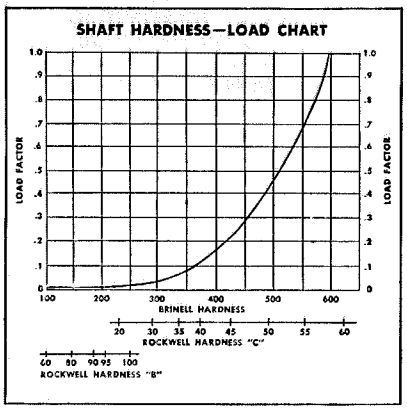


Figure 1. If the surface hardness of the shaft, its tensile strength, or the per cent of carbon is known, the load factor can be read either right or left from the intersection of the curve. The load factor, multiplied by the rated capacity of the bearing, will give the shaft capacity and the capacity of the application.

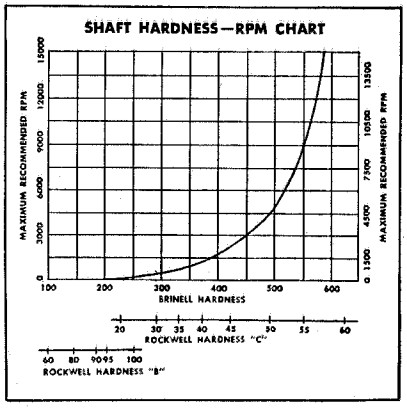


Figure 2. As the speed increases, it is desirable to increase the shaft hardness. For a given rpm, read across to the curve and down to the proper hardness. Conversely, if hardness is known, read up to the curve and across to the maximum rpm for that shaft.

Hardened Inner Races Available

When it is either impossible or impractical to harden the shaft, it is necessary to use an inner race which will provide the required surface for Needle Bearing operation. Inner races are available for all sizes of Needle Bearings. When used, inner races should be securely fastened to the shaft by clamping against a shoulder, by snap ring, or by press fit.

When designing Needle Bearings into a piece of equipment where shaft hardness is a question, the economics of using inner races as compared to a properly heat treated shaft should be carefully analyzed. When all factors such as inner race cost, securing devices, and actual assembly time are considered, it is usually found more economical to heat treat the shaft.

THE TORRINGTON COMPANY

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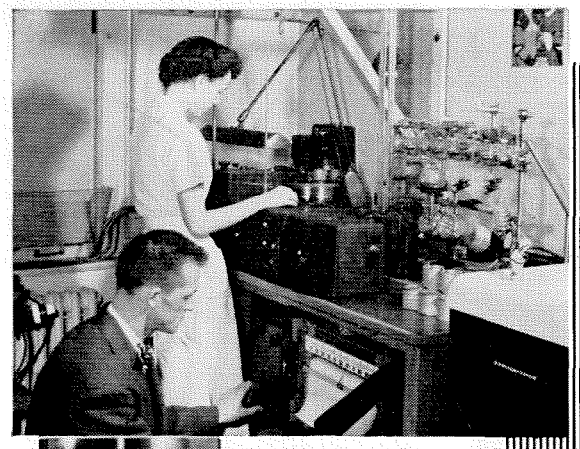
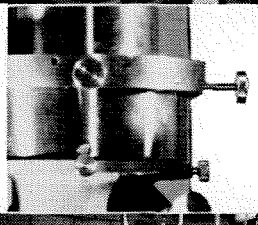
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

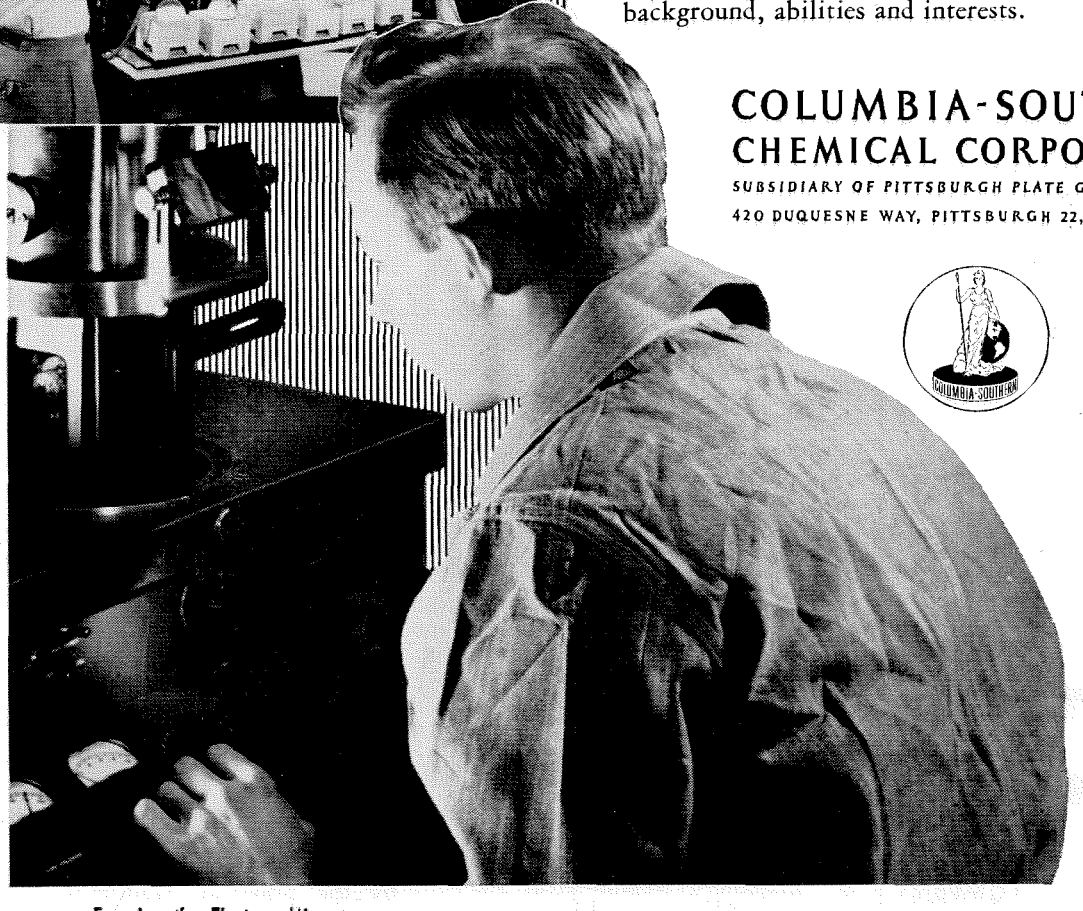
NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS





Making an analysis with the infra-red Spectrophotometer.

Testing action of Perchlorethylene on various metals.



Focusing the Electron Microscope on a chemical sample to be photographed.

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needs men with creative imaginations

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Columbia-Southern is one of the most rapidly-expanding chemical companies. It needs promising young graduates of scientific, engineering, and business schools. Opportunities exist at Columbia-Southern in research and development, sales, plant design, mining, construction and maintenance, and chemical production. Opportunities for technical and non-technical graduates also exist in accounting, transportation and related service fields.

Monthly sales at Columbia-Southern are now five times as large as they were only ten years ago, and the potentials are even greater for the future.

Columbia-Southern is a wholly owned subsidiary of Pittsburgh Plate Glass Company. It thus presents the *individual opportunities* of an expanding chemical corporation, plus the stability in being an integral part of a larger and diversified organization.

ACT NOW! Send for comprehensive booklet outlining the "Nationwide Opportunities in Varied Technical Fields at Columbia-Southern." Or send your application for employment to the personnel manager at our Pittsburgh address or any of the plants. Please give a clear, complete account of your background, abilities and interests.

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Fred Hoyle

LETTERS . . . CONTINUED

rise and fall of civilization? What does civilization mean? Has the word been used by even the most single-minded of economic men to mean only goods and services? Is not Hoyle's view the *coup de grace* that will at last remove the arts and humanities from our sight?

How is it possible that so distinguished an astronomer presents us with meditations of this sort? An intellectual plague of our day is the use of oversimplification when trying to understand the tangled state of the contemporary political and social scene. Experiments in and out of the psychological laboratory suggest that there is a general human propensity to simplify and (in the bad sense) to rationalize events which are hastily learned and perceived in scanty detail. This suggests that it is not always wise for men of intellectual preeminence to venture too far from their own field of expertness. Plato suggests that a good citizen does well to mind his own affairs. A citizen whose business is "the starry fields of heaven" need not feel under-employed in focusing his energies upon them rather than casting a hasty glance and an even hastier formula at our troubled earth.

Walter B. Smith
Claremont Men's College

Sirs:

Mr. Fred Hoyle's article presents an imbalanced technological interpretation of history, and I would like to examine some of his arguments.

Mr. Hoyle is concerned to explain the course of human events in terms of technological development; and not only are the significant aspects of human history presumably explained, but the only important individual or social incentive is found in technology. Mr. Hoyle argues that the other common concerns of individual men and many concerns of the community are unimportant.

Thus it is said that scientific knowledge and its expansion are the primary things that should be important to us; they determine the character of all else in our lives, and our other concerns cancel each other out. Technology determines production, which determines our average share, on the increase of which civilization rises.

This is similar to the familiar theme that the stages and characteristics of civilization are determined by the mode of production. The argument continues: if we seek a rise in civilization, what we must go after is technological knowledge (the only important concern of civilization). . . . This implies that there are other factors that motivate men and that are significant factors accounting for the rise of civilization, since they influence the growth and use of technological knowledge. But this implied content in the conclusion contradicts the premise (that technology is the only explanatory factor) from which the conclusion is presumably derived.

Mr. Hoyle's ideas could be related constructively to the thesis that no civilization and no form of social organization is guaranteed survival. Technological knowledge and other factors determine, for example, whether a democratic way of life will persist or even have any practical relevance at all. The intellectual capacity of those living in a social organization, the availability of materials for the satisfaction of even minimal needs, the ability to compromise and to maintain a spirit of magnanimity in a social context of individual variety and diversity of perspectives, hopes and ideals, temperaments, practical occupations, and needs for association are, among other factors, important determinants as to whether or not you have a democratic society.

Thus one of the factors making civilization possible is the group of practical techniques men have devised to mediate the conflict of competing interests. Civilization requires cooperation, but conflict is generated by the practical conditions under which men can bring their diverse

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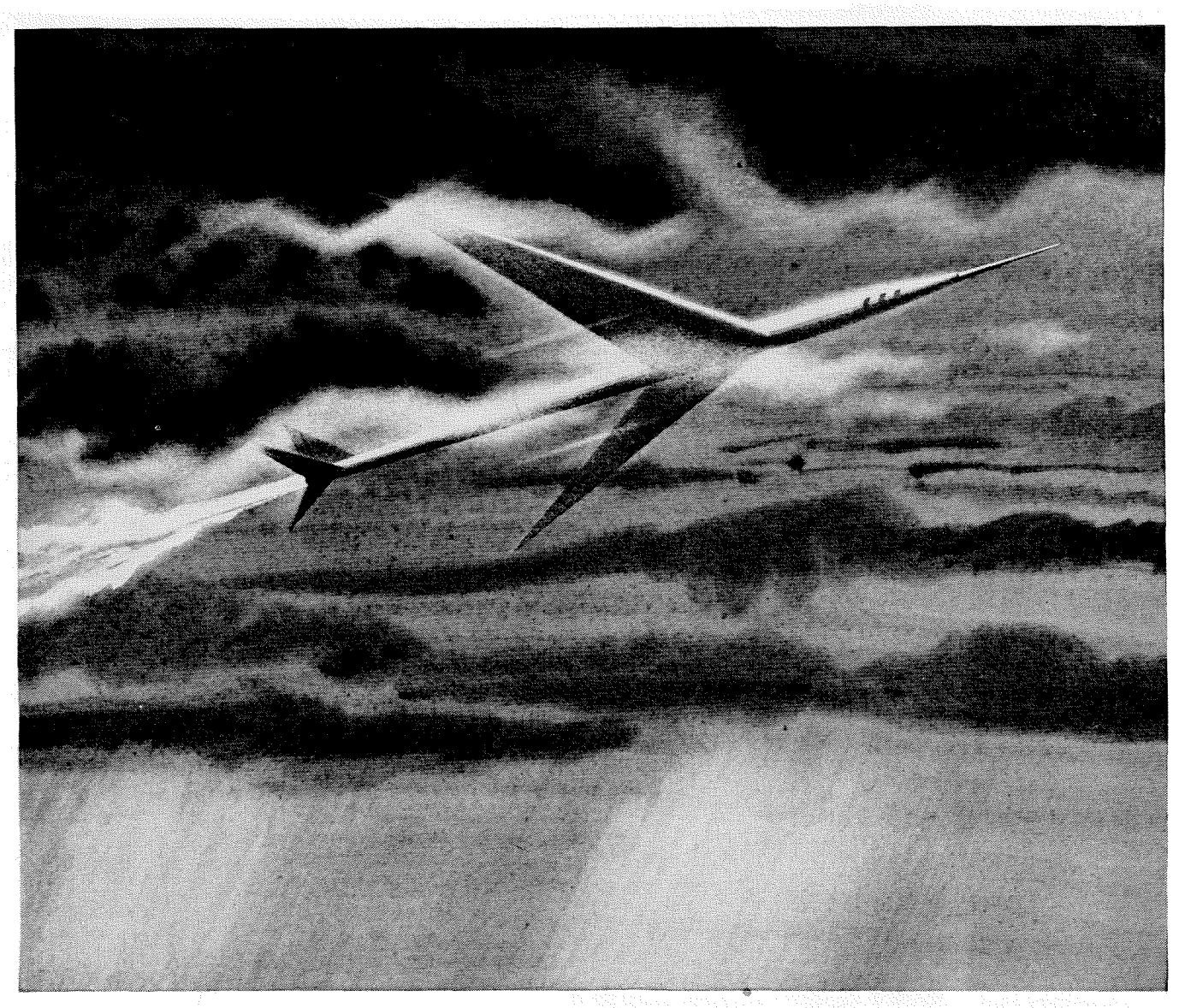

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and varied excellencies into a cooperative interrelationship. Participation in a particular kind of activity involves a narrowing of perspective and understanding of the needs and demands of those engaged in quite different activities. Indeed, there may be a complete lack of sympathy for those in some other activity (supporting other ends) which is as vital in maintaining the balance of our civilization as is our particular contribution.

Most simply, to do one thing prevents you from engaging in other activities, attaining other ends, especially where long training and special attention are required. Then consider the influence each activity has on its practitioners: the activity generates goals, ideals of achievement, and criteria of excellence in dedication that are always beyond what men attain, and so spurs them on while decreasing their sympathy for other activities. And so our professional pursuit (for example) narrows each of us so that we tend to neglect other equally relevant and needed aspects of our lives (family, religion, politics, and so forth) and other relevant and necessary types of activities that go to make up the whole of civilized ways.

Competition and cooperation

Add to all this the competitive excellence of others that drives each of us further toward a narrowing of our lives. Consider also that each person is different, and so the factor of individual variety and diversity (mentioned earlier) completes a picture of the conflicting interests engendered within human cooperative association.

So we see that much of civilization depends upon the artistry of practical techniques that mediates an inevitable conflict of interests and so attains cooperative action. These techniques are cultivated through practice encouraged by example and exhortation, and they are transformed as each person gives them a form peculiar to his personality and objectives and his trials and errors in the course of assimilation.

No man achieves this ability merely through scientific knowledge, however important science is in civilization. And in so far as a man lives in a society where these techniques are practiced, then to the degree this cooperation is realized it is also a social achievement; no man attains this by himself, no matter how intelligent he is or however much he sees the need for these techniques.

Continual cultivation, as well as eternal vigilance, is the price of liberty. And technology, as we should know these days, can be used on either side of the issue of liberty. Civilization demands many kinds of excellencies of men. The glory and achievement of civilization is not solely in that kind of human activity at which we individually happen to be proficient.

Gerrit Daams '40, MS '41
Jamaica, New York

William R. Parlett, Cornell '48, Sets Sights on Executive Sales Job

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PERSONALS

1930

Homer B. Wellman, Ph.D., announced the arrival of Suzanne Margaret on March 19, 1953. The Wellmans live in San Jose, California.

1933

Robert D. Fletcher, M.S. '34, Ph.D. '35, worked as a meteorological consultant with the U.S.A.F.'s Air Weather Service from October '50 to October '52. His work took him to U.S.A.F. bases in Europe, Japan, Korea, the Philippines and various Pacific Islands. Last fall he was appointed to the position of Director of Scientific Services, Headquarters Air Weather Services in Washington, D. C. He is also a U. S. delegate to the World Meteorological Organization of the United Nations. Bob says he frequently sees *Col. George Taylor*, '29, M.S. '31, Ph.D. '33, and *Major General Don Yates*, M.S. '39, and recently attended a meeting with his old CIT roommate, *Greg Hartmann* '33.

1934

James W. McRae, M.S., Ph.D. '37, was one of three research administrators selected to address the Electronic Components Symposium held at the Shakespeare Club in Pasadena April 29 to May 1. Jim is vice-president of the Bell Telephone Laboratories.

1935

Gordon R. Ewing now has two children —Ellen, age 7, and Gordon Richardson, Jr. (better known as Ricky), born March 15, 1952. The Ewings live in Crawfordsville, Indiana.

1936

Bruce L. Hicks, Ph.D. '39, resigned from the Ballistic Research Lab at Aberdeen Proving Ground, Maryland, to take a new job in March in the Control Systems Laboratory of the University of Illinois. He has thus deserted combustion for electronics. Bruce says Champaign-Urbana is noted for its tornadoes—which always come *by* but not *through* the cities. His two boys, 7 and 9, are at the stage, he says, where they keep games (from chess to baseball) and music going thirteen hours per day.

1937

David Pressman, Ph.D. '40, and Dr. Leonhard Korngold, both of New York's Sloan-Kettering Institute, announced what the newspapers referred to as "a possible new cure for cancer" before the American Association for Cancer Research, in Chicago last month. The process involves making radioactive antibodies seek out and smash cancer cells, and has proved effective in some animal experiments.

1938

Henry K. Evans, highway transportation specialist, recently completed a two-week jaunt through Idaho, Oregon, California, and Illinois—holding parking clinics in conjunction with the local Chambers of Commerce.

Hank also recently participated in the *Time-Life* Urban Traffic Round Table in New York and had an article published in *Nation's Business*, entitled "R_x for Parking Ills." He is also back on the air now with his ham radio station—on 40 meter band with W3PZT call. Just to take up the slack in his spare time, Hank still has a dance orchestra in Washington, D. C., which plays club and hotel dates on weekends.

1939

Keats A. Pullen was one of a number of Caltech graduates presenting papers at the Winter National Meeting of the Institute of Radio Engineers.

1940

Miller Quarles, Jr., M.S. '41, is chief geophysicist for the Precision Exploration Company in Houston. He addressed the April meeting of the Dallas Geophysical Society at Southern Methodist University on "A System of Character Correlation on Seismograph Records."

1941

Col. Oliver K. Jones is now Inspector General for the Air Weather Service but expects to leave this job soon to become Director of Personnel of the Air Weather Service in Washington, D. C. Oliver's got no new members in his family to report—says six (6) kids are enough for awhile.

1943

Arnold Nevis married the former Newlin Ashmore of Tallahassee, Florida, last Sept. 6. They met while Arnold was interning at the Stanford University Hospital in San Francisco, where Newlin was a nurse. Arnold is now at M.I.T. on a fellowship studying biophysics. *John Mason* '47, Ph.D. '50, their best man, visited them in Cambridge for a few days recently. John is now with Airesearch in Los Angeles.

CONTINUED ON PAGE 44

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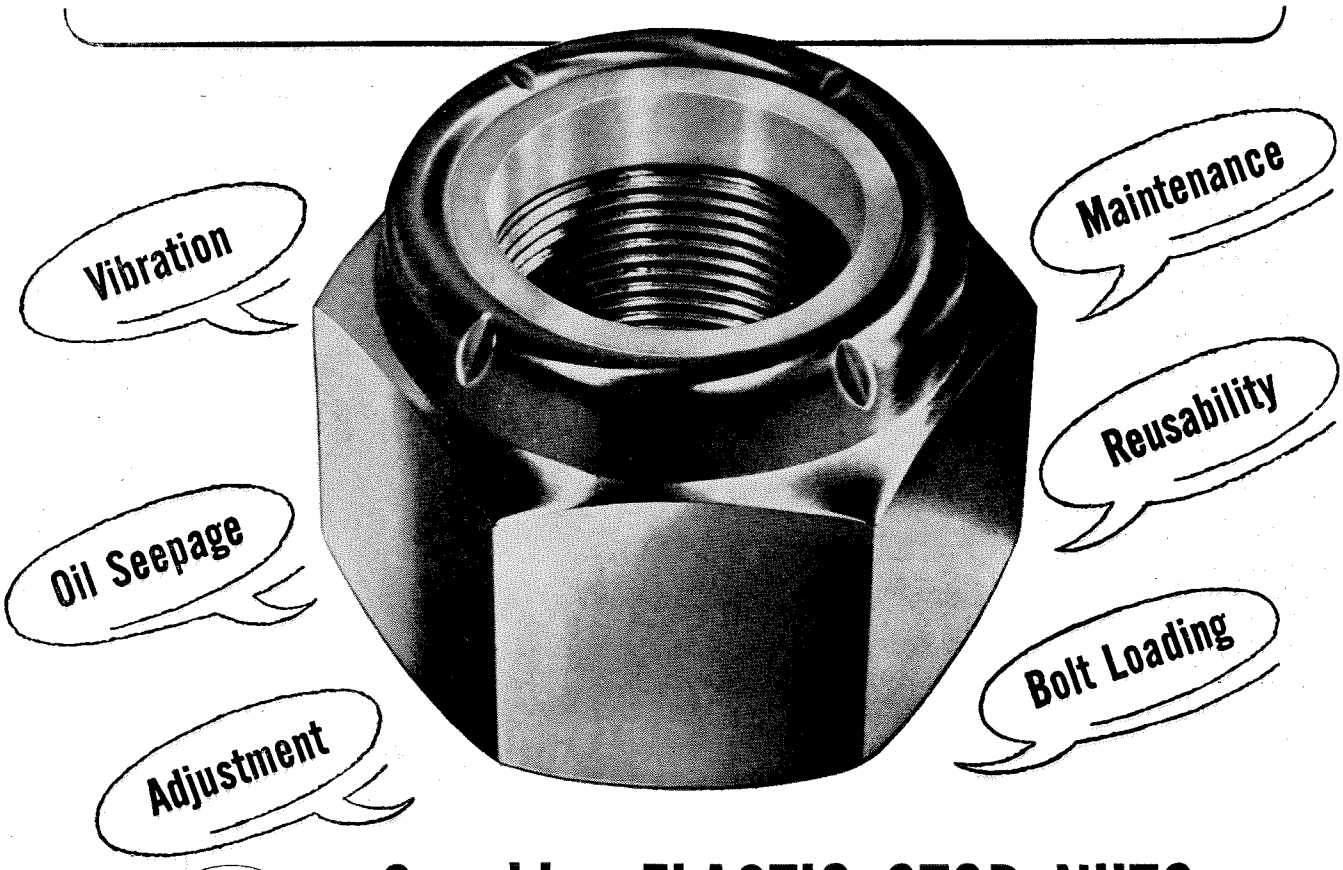

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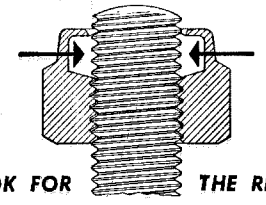

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DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS

PERSONALS . . . CONTINUED

1944

Sureyya Rafet Tanyildiz, M.S., is Chief Engineer at the Arms Plant of the Mechanical and Chemical Industries at Ankara, Turkey—a state enterprise consisting of 16 different plants located in different parts of Turkey. It's been seven years since he left the states, during which time he says he has heard very little about the Institute, and would welcome news of his classmates and professors.

Jack Kettler, M.S. '46, is still working at Airesearch in Los Angeles on small gas turbines. He is now a senior development engineer in charge of production gas turbine compressor units. On February 14, 1953, he married Patricia Prichard of Aurora, Illinois, a U.C.L.A. graduate. They are currently living in Redondo Beach.

Others working at Airesearch are *Homer Wood*, 38, assistant chief engineer in charge of Turbomachinery; *Carlton Paul* '39, project engineer; and *Lyle Six* '47, M.S. '48, *Dick Robinson* '48, *Don Furst* '46, M.S. '48, *Paul Stein*, M.S. '48, and *John Dannon, Jr.* '48— all working on gas turbines and other pieces of turbomachinery.

1945

Joseph F. Hook is a mechanical engineer in the Guided Missile Laboratory at the Hughes Aircraft Research and Development Laboratories in Culver City, Calif.

James D. Burke, M.S. 48, A.E. '49, now has a son and a daughter—Susan having arrived on April 11. Jim is in the design and development department at Caltech's Jet Propulsion Laboratory.

1946

Lt. F. Miles Day writes that he has just been advanced to Lieutenant—so the Days can now eat hamburgers instead of hot dogs, and the jalopy now has new shocks. Children #1 and #2 are in good health —with #3 apparently on the way. Miles continues in the material control division of the Bureau of Ships in Washington, D.C., and expects to fight the battle of repair parts there for about another year. He is also the president of the Washington Alumni Chapter.

Ben Bovarnick and his wife have a 21-month-old daughter, Deborah. Ben is a physicist at the Watertown (Mass.) Arsenal, and was recently assigned as Chief of the Sintered Metals and Ceramics Section.

1948

James G. Wendel, Ph.D., is an Associate Professor of Mathematics at Louisiana State University in Baton Rouge. The Wendels now have three children—Nancy, born in '51 and Robert and Peter (twins) born in '52.

1950

Don Lamar is now training at Fort Ord, California. He married Irene Cruze on April 18 at the Holy Redeemer Church in Montrose, California. Don came down from Fort Ord at 6:00 a.m. on Saturday for the ceremony and reported back to camp the following day.

James Hendrickson sends word from Cambridge, Mass., that he "wishes to abdicate formally from his renowned and revered office of Pope Emeritus to Blacker House in view of the inconsistency of that celibate position with his forthcoming nuptials in May to Sybil Pardee of Cambridge. He wishes to exhort his successors in that noble hierarchy to carry on its noble offices. He wishes also to warn his California associates of his expected voyage to the citadel of science in July that they may prepare the fatted calf."

1951

Stan Boicourt and his wife June have a new baby, Kathy Lynn, born on March 12. The Boicourts live in Aberdeen, Mississippi, where Stan's working for the Western Geophysical Company.

Robert F. Connelly reports that his fourth child, Gary Duane, was born on April 20. (He also advises us that Gary's godfather, *Duane C. Neverman* '51 is doing fine.) This makes three boys and a girl for the Connellys. Bob works as a chemist at the Bray Oil and Chemical Company in Los Angeles. Other Caltech men employed there are *Clarence L. Haserot* '27, sales manager; *Richard P. Schuster, Jr.*

CONTINUED ON PAGE 48

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But I haven't majored in aeronautical engineering

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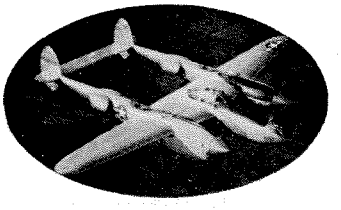

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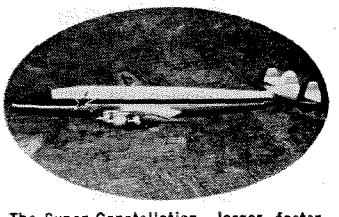

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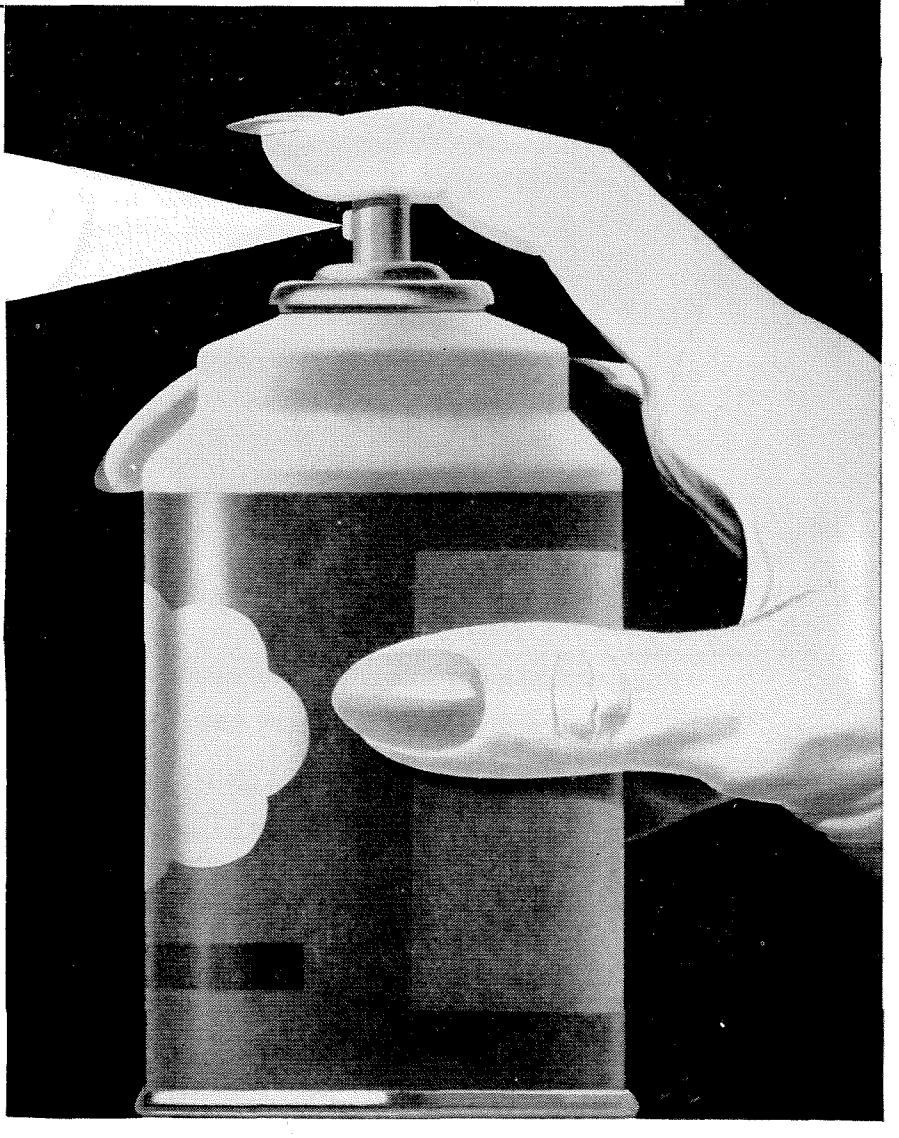

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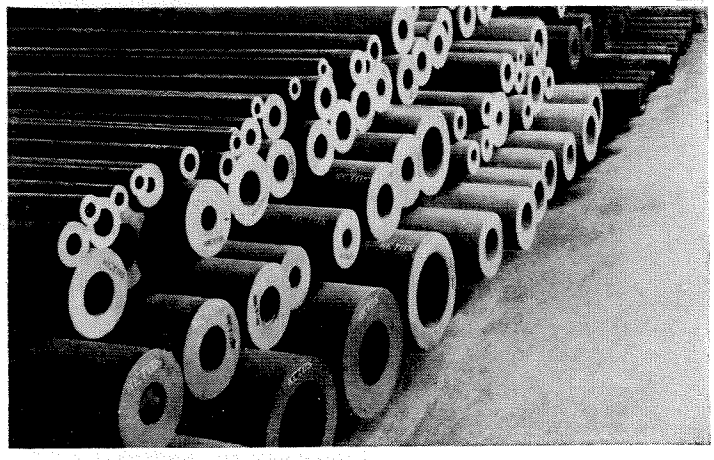

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3¼ O.D. x 1¼ I.D.	x	x	x
3¼ O.D. x 1½ I.D.		x	
3½ O.D. x 1½ I.D.	x		
3½ O.D. x 2 I.D.	x	x	x
4 O.D. x 1½ I.D.			x
4 O.D. x 2 I.D.		x	x
4¼ O.D. x 1¾ I.D.			x
4½ O.D. x 2 I.D.	x		x
5 O.D. x 2 I.D.	x	x	x
5 O.D. x 2½ I.D.		x	x
5 O.D. x 3 I.D.	x	x	
5½ O.D. x 1¾ I.D.			x
5½ O.D. x 2 I.D.		x	
5½ O.D. x 2½ I.D.	x		x
6 O.D. x 1¾ I.D.			x
6 O.D. x 2 I.D.		x	
6 O.D. x 3 I.D.	x	x	x
6½ O.D. x 3¼ I.D.			x
6½ O.D. x 3½ I.D.		x	
6½ O.D. x 4 I.D.			x
7 O.D. x 2¼ I.D.			x
7 O.D. x 3 I.D.	x	x	
7 O.D. x 3½ I.D.			x
7 O.D. x 4 I.D.	x	x	
7½ O.D. x 3 I.D.	x	x	
7½ O.D. x 3½ I.D.	x	x	
7½ O.D. x 4 I.D.			x
8 O.D. x 3½ I.D.	x	x	
8 O.D. x 5 I.D.	x	x	x
8¼ O.D. x 3½ I.D.			x
8½ O.D. x 5¼ I.D.	x	x	x
9 O.D. x 4 I.D.	x	x	
9 O.D. x 5 I.D.		x	x
9 O.D. x 6 I.D.	x		
10 O.D. x 4 I.D.		x	
10 O.D. x 5 I.D.	x	x	
10 O.D. x 6 I.D.	x	x	x
11 O.D. x 4 I.D.	x	x	
11 O.D. x 6 O.D.	x	x	
11 O.D. x 7 I.D.		x	x
12 O.D. x 5 I.D.	x	x	x
12 O.D. x 6 I.D.	x	x	
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13 O.D. x 9 I.D.		x	
14 O.D. x 7 I.D.	x	x	x
14 O.D. x 10 I.D.		x	
15 O.D. x 9 I.D.		x	x
15 O.D. x 10 I.D.		x	
16 O.D. x 10 I.D.	x	x	x
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National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

Printed in Pasadena PP 6

PERSONALS . . . CONTINUED

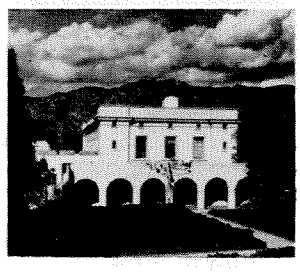
'46, plant superintendent; and *David C. Banks* '45, now on leave with the Navy.

Bill Whitney and his wife Evelyn are spending their second year in Cambridge, Mass. He says they're still somewhat confused by the idiosyncrasies of New England weather but are enjoying it there immensely. Evelyn works in the Admissions Office at M.I.T. and Bill is in the Low Temperature Laboratory, putting together apparatus for a liquid helium experiment. He hopes to have his Ph.D. work completed in another year or two.

1952

George L. Ellman, Ph.D., has been working for the Dow Chemical Company in Midland, Michigan, ever since leaving Caltech. He says he was recently "volunteered" for the local ACS section's radio committee. But George's *real* news is the announcement of the arrival of a daughter, Judith Francis, last February 28.

CALTECH CALENDAR



MAY **1953**

ATHLETIC SCHEDULE

BASEBALL

May 16, 2:15 p.m.
Caltech at Occidental

May 16, 2:15 p.m.
Frosh vs. Occidental
at Caltech

TENNIS

May 15, 1:30 p.m.
Varsity and Frosh
Conference Tournament
at Caltech

May 16, 9:00 a.m.
Varsity and Frosh
Conference Tournament
at Caltech

GOLF

May 15, 1:30 p.m.
Caltech vs. Whittier
at Brookside

May 22, 9:00 a.m.
Varsity Conference
Tournament at Pomona

DEMONSTRATION LECTURES

Friday Evenings — 7:30 p.m. — 201 Bridge

May 15—"Emergency Substitutes for Blood Plasma," by Dr. Jerome Vinograd
May 22—"Upside-Down Volcanoes of Sonora, Mexico," by Professor Richard H. Jahns

PHOTOGRAPHY AT WORK No. 2 in a series:

Knitting mill solves help shortage, attracts and keeps full staff

Hand Knit Hosiery Company of Sheboygan, Wisc., knitters of Wigwam Socks, found many potential employees resisted jobs simply because they didn't know the sort of opportunities offered.

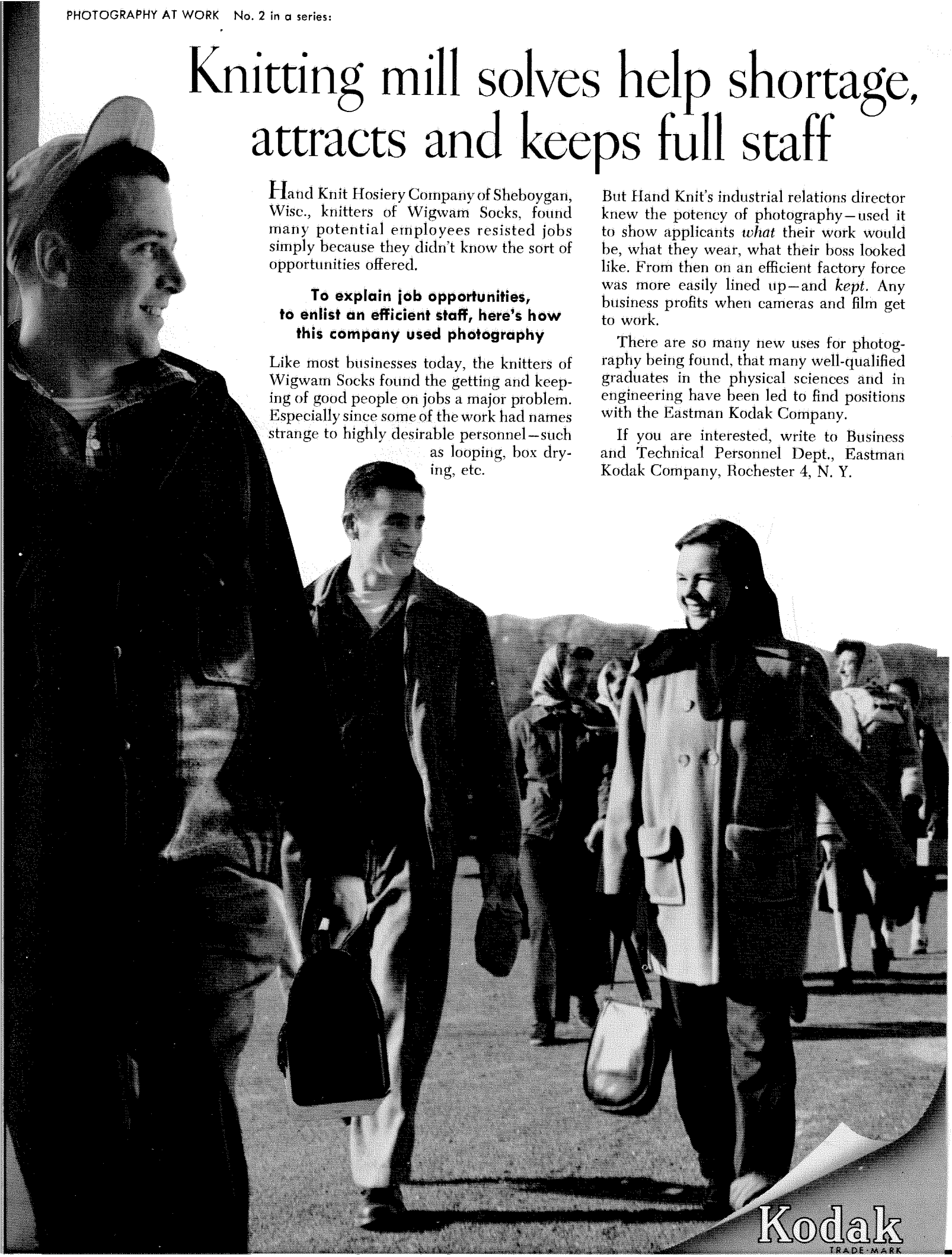
To explain job opportunities, to enlist an efficient staff, here's how this company used photography

Like most businesses today, the knitters of Wigwam Socks found the getting and keeping of good people on jobs a major problem. Especially since some of the work had names strange to highly desirable personnel—such as looping, box drying, etc.

But Hand Knit's industrial relations director knew the potency of photography—used it to show applicants *what* their work would be, what they wear, what their boss looked like. From then on an efficient factory force was more easily lined up—and *kept*. Any business profits when cameras and film get to work.

There are so many new uses for photography being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.



Kodak
TRADE-MARK

6 WAYS TO BEGIN A SUCCESSFUL CAREER

TEST ENGINEERING PROGRAM—offers engineering graduates opportunities for careers not only in engineering but in all phases of the Company's business. Includes rotating assignments plus opportunities for classroom study.

BUSINESS TRAINING PROGRAM—open to business administration, liberal arts, and other graduates . . . for careers in accounting, finance, administration, and other fields. Includes on-the-job training plus classroom study.

CHEMICAL AND METALLURGICAL PROGRAM—provides rotational assignments in chemistry, chemical engineering, and metallurgy. Also offers graduate-level courses stressing solution of practical engineering problems through application of basic principles of physical chemistry and unit operations.

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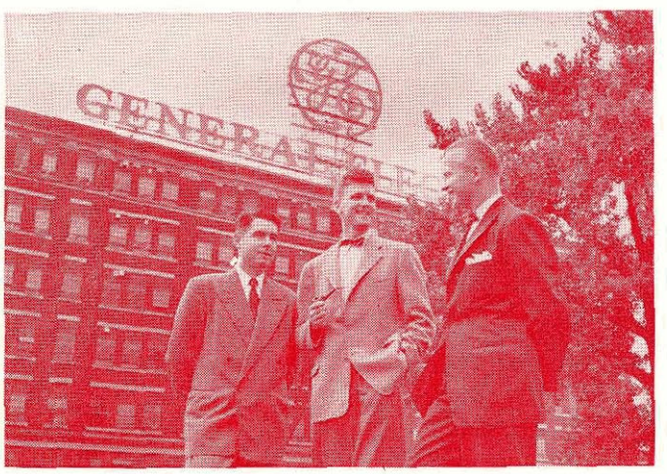
ADVERTISING TRAINING COURSE—offers graduates career opportunities in all phases of advertising, sales promotion, and public relations work. Includes on-the-job training and a complete classwork program.

PHYSICS PROGRAM—offers physicists rotating assignments in applied research in many fields of physics plus ample opportunity for organized classroom study. Program graduates have gone into such fields as research, development, manufacturing, design, marketing.

FEW companies can offer as broad a range of career opportunities as General Electric. Whether a young man is interested in science or engineering, physics or chemistry, electronics or atomic energy, plastics or air conditioning, accounting or sales, employee relations or advertising, drafting or jet engines . . . he can plan for himself a G-E career.

The training programs summarized here are only a few of the "open doorways" that lead to successful careers in a company where big and important jobs are being done, and where young people of vision and courage are needed to help do them.

If you are interested in building a G-E career after graduation, talk with your placement officer and the G-E representative when he visits your campus. Meanwhile, for further information write to College Editor, Dept., 2-123, General Electric Co., Schenectady 5, New York.



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