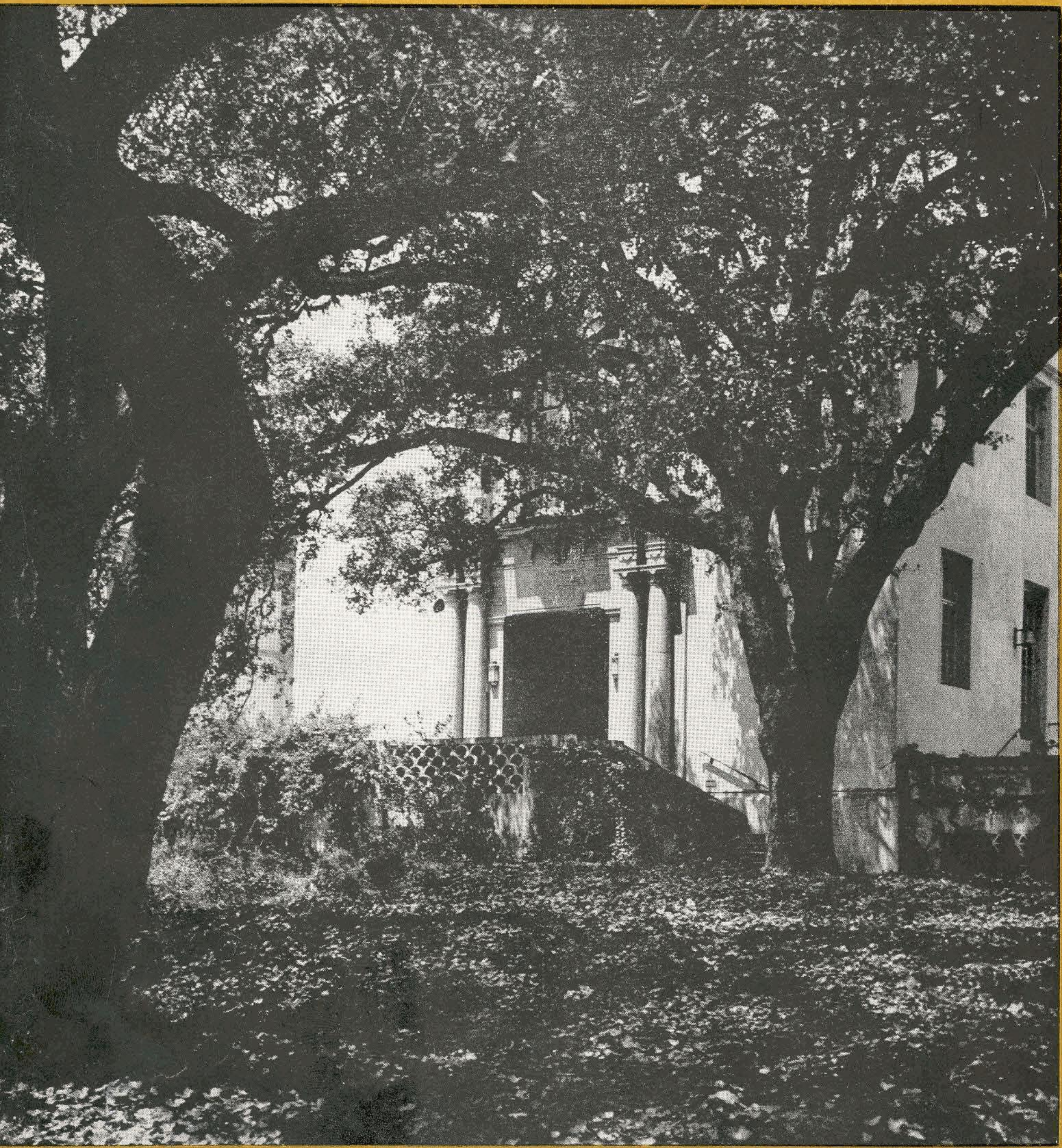
ENGINEERING | AND | SCIENCE

FEBRUARY/1957



Where are you? . . . page 24

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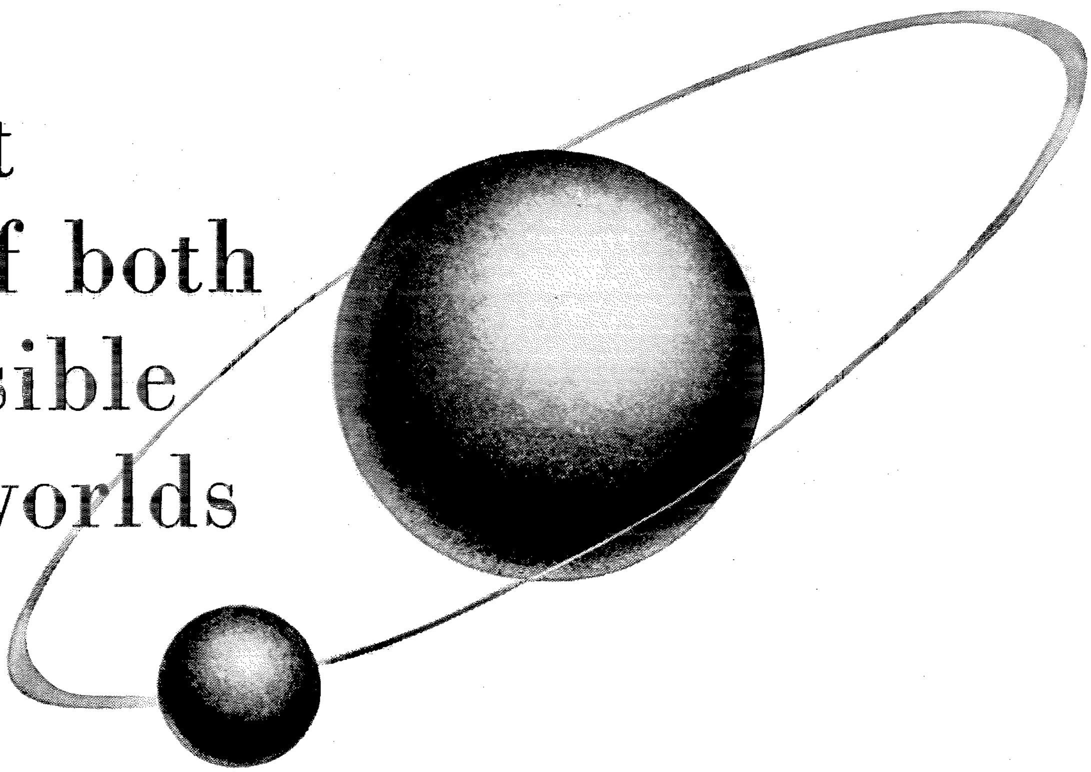

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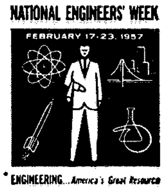

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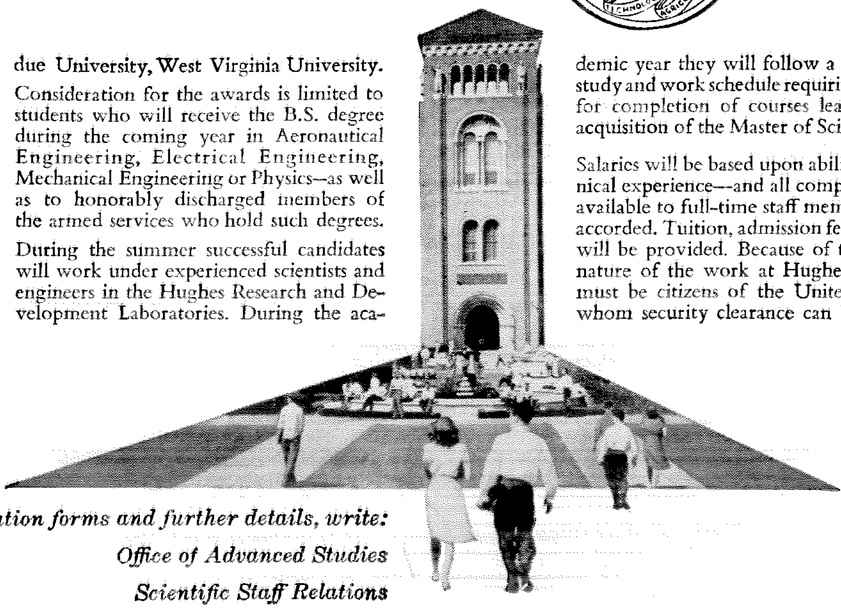

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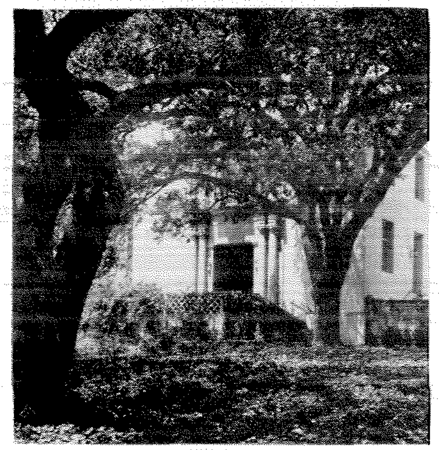
ENGINEERING AND SCIENCE

IN THIS ISSUE



ON THE COVER this month—well, do *you* know what it is? Where is it on the campus? Which way was the camera pointing when the picture was taken?

This is all part of a campus picture quiz produced by George W. Beadle, chairman of the Caltech Division of the Biological Sciences. He began photographing odd corners of the campus about three years ago (and we mean *odd;* the picture on page 6 gives some indication of the lengths to which Beadle went for his material). By now Dr. Beadle has a stack of about 50 color-slides that can baffle some of Caltech's oldest residents.

A number of student and faculty groups have tested their powers of observation on the Beadle quiz. In general, students come up with better scores than faculty, though a few individual faculty members have done spectacularly well (Earnest Watson, for instance—professor of physics and dean of the faculty, who has been here since 1919; and William N. Lacey, professor of chemical engineering, who has been here since 1916). So has Wesley Hertenstein, director of Caltech's Physical Plant department — who

CONTINUED ON PAGE 6

PICTURE CREDITS

pps. 8-10	Graphic Arts, Caltech
pps. 19-23	Ursula Brodfuhrer
pps. 24-26	George W. Beadle
pps. 28, 29	Dennis Paul '59

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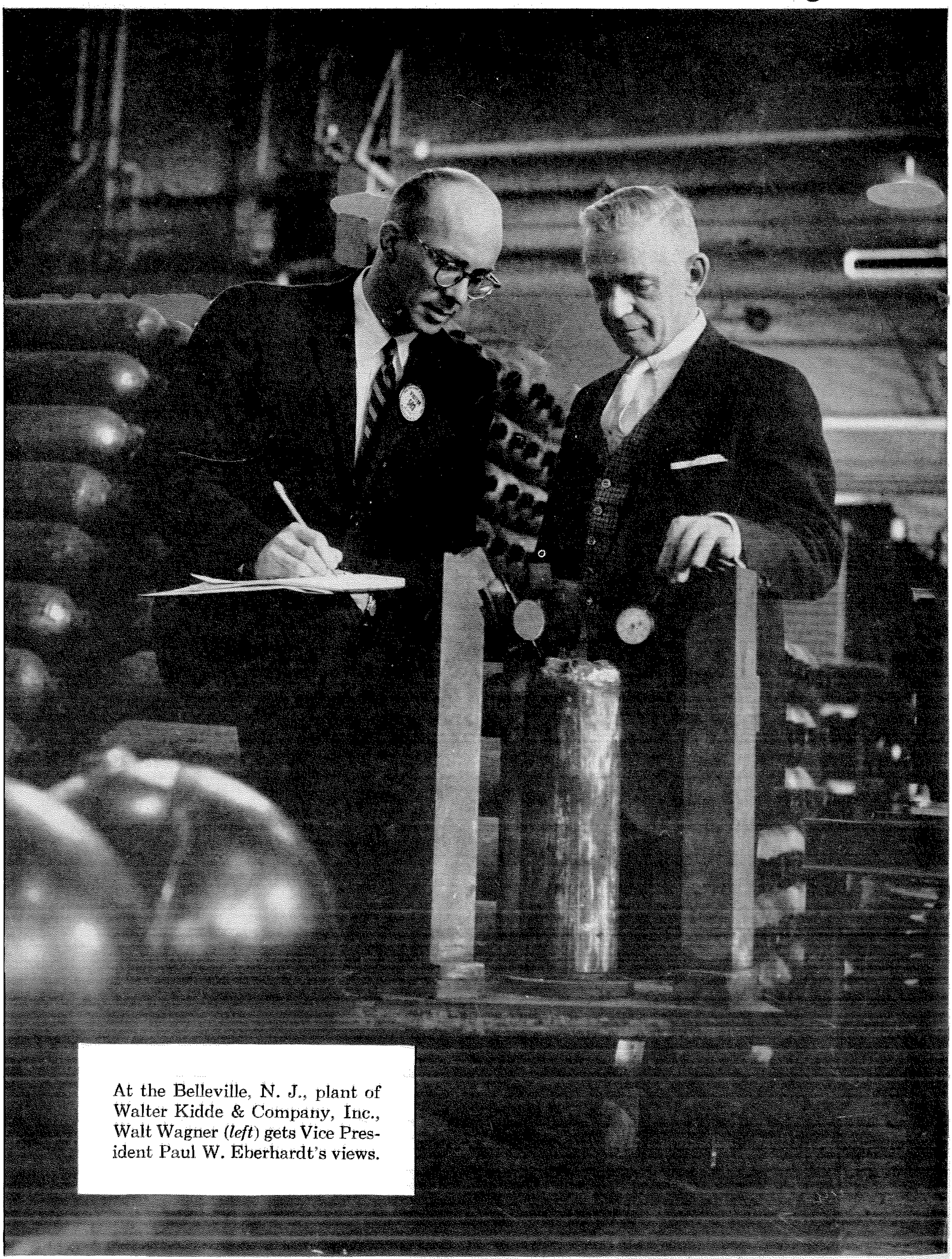
How else can you



At the Belleville, N. J., plant of Walter Kidde & Company, Inc., Walt Wagner (*left*) gets Vice President Paul W. Eberhardt's views.

use your training?

Walt Wagner, MIT '49, Tells How McGraw-Hill Editors Combine Writing and Engineering

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"In 1954 I was appointed Assistant Managing Editor of FACTORY. Today, I work mainly on big engineering stories—play a major part along with another Assistant Managing Editor, the Editor and the Managing Editor in the complete planning of the magazine.

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5. '54 — Concurrently, department expands into Electronic Systems Division, where "Ev" steps up as specialist in reducing new concepts and theories in fields of communications to practical circuit designs and devices.

4. '53 — Transfers to newly formed Advanced Development Dept. to engage in theoretical research and development.

3. '52 — Works on analysis of vacuum tube problems.

2. '51 — Joins Sylvania's Buffalo Division; after 3 months orientation period, picks the job he wants — in Tube Applications Department.

1. Everard Book graduates from the University of Illinois with a B.S. in Electrical Engineering, class of 1951.

START HERE for highlights of the career of Everard Book, a young engineer who 5 years ago was where you are today.

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In This Issue . . . CONTINUED

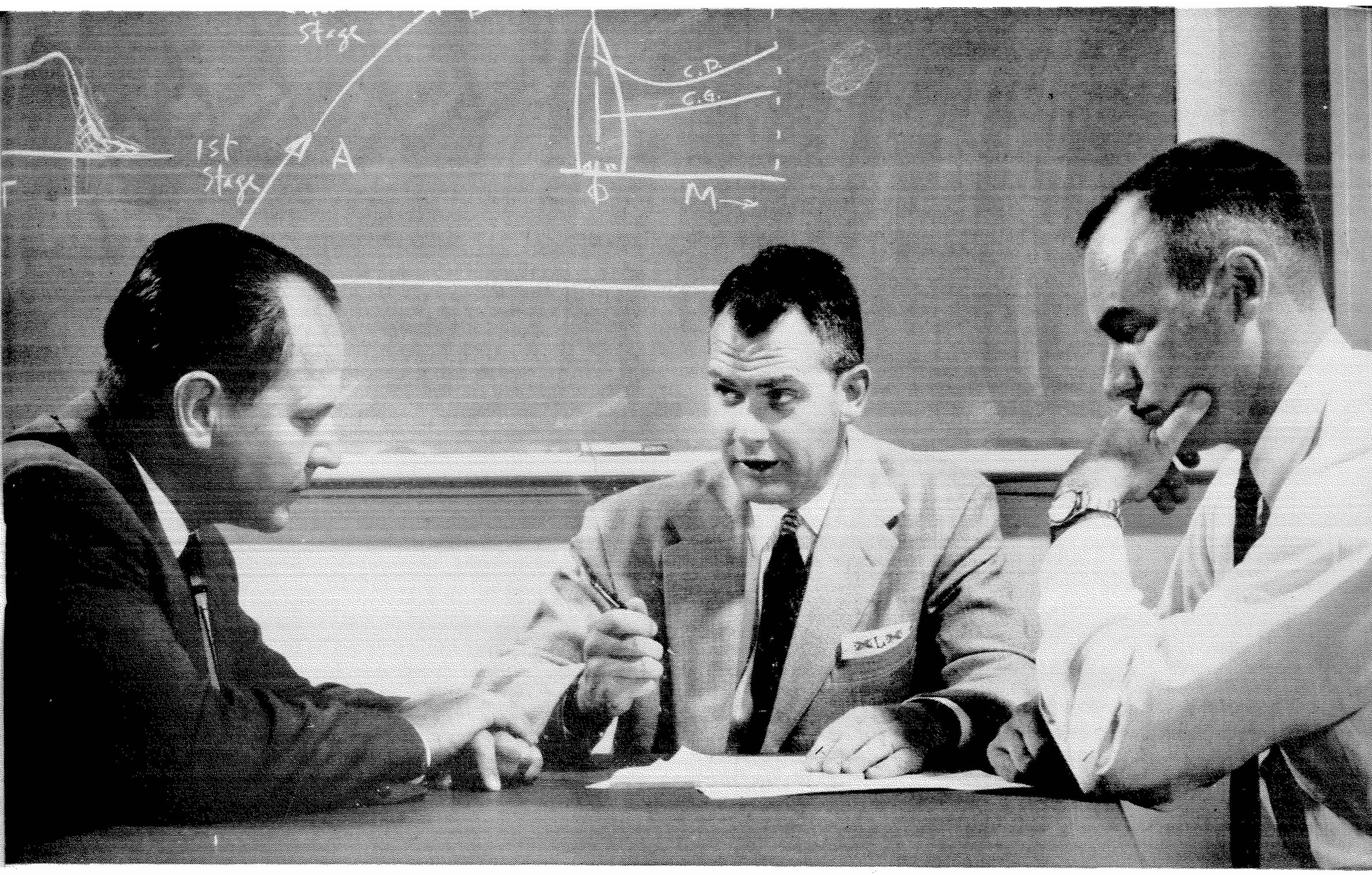
Beadle at work.

should. One of the highest scores of all, though, was made by a faculty wife who walks her dog around campus every day.

The highest score ever made on the 50-picture quiz was 45. Most people get about 25. On pages 24-26 of this issue are 13 samples from the Beadle quiz. Try your luck. If you get 7, you're good.

On the cover this month? The *south* entrance to Arms laboratory, the geology building. Been there for years. Ever since they put up the building.

Lloyd Tevis, Jr., who wrote "Caltech's Roving Laboratory" on page 19, is in charge of the new mobile desert laboratory which operates out of Palm Springs. A research fellow in biology, Lloyd Tevis is a zoology graduate of the University of California at Berkeley. He has managed to work outdoors most of his life—first at UC's Hastings Natural History Reservation in Monterey County; then in the Sierra Nevada, where he made studies of a particular deer herd for the Museum of Vertebrate Zoology at Berkeley; next in the Sierra Nevada and the Trinity River country, studying the influence of rodents on reforestration for the U. S. Forest Service and the University of California at Davis.



L. K. Edwards (center), advanced design and systems analysis department head, discusses launching of a ballistic missile with W. P. Gruner (left), head of weapons systems integration, and Systems Analyst G. W. Flynn.

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CALIFORNIA

GIRLS, GIRLS, GIRLS

A progress report on the female population in the Caltech student body

CALTECH BROKE a long-standing tradition when it admitted its first female student in 1953. There had been ladies in the school in the days when it was a coeducational institution known as Throop University and Throop Polytechnic Institute, of course; in fact, there was even a department of domestic science in those days. But after the move to its present campus in 1910 the Institute began to concentrate on engineering, and science, and men only.

It was an extraordinary situation that caused Dorothy Ann Semenow to apply for graduate work in chemistry at Caltech in 1953—and it took extraordinary action by the Caltech faculty and board of trustees to admit her.

Miss Semenow was at MIT at the time, doing graduate work under the direction of John D. Roberts. When Dr. Roberts accepted a position at Caltech as professor of organic chemistry, Miss Semenow asked to be transferred here with him so that she could continue with her research. It took a change of Institute policy to grant her request.

The admission of Miss Semenow didn't exactly break the log-jam and flood the campus with women; the entrance requirements that were set for female graduate students took care of that. The Institute accepts only "women of exceptional ability who give promise of great scientific contributions," and, before she can enroll, a woman has to get the approval of the committee on graduate study, and of the academic division in which she intends to work. With restrictions like this, it is not surprising to find that only five women graduate

Mrs. Elizabeth Bertani, second woman graduate student to be accepted at Caltech students have been admitted to Caltech to date.

Miss Semenow, who got her PhD in 1955, is now teaching chemistry at Pomona College. Mrs. Ellen Smith Thomas was the second woman to receive a degree. A graduate of the University of Oklahoma (where she got her BS "with distinction" in aeronautical engineering, in 1952) she entered Caltech in the fall of 1955 and received her MS in aeronautics in June, 1956. She is now a designer with the Aerojet-General Corporation in Azusa.

There are three women graduate students at Caltech this year—Mrs. Elizabeth Bertani and Miss Jeanne Mayfield in biology, and Miss Florence Raulf in geology.

Elizabeth Bertani has been here since 1954—which means she was the second woman graduate student to be accepted at Caltech. A native of East Chicago, Indiana, she did her undergraduate work at the University of Michigan, and got her BS "with distinction" in 1953. She started out in college with the intention of becoming an MD. (Her father, and one of her two brothers are MD's; the other brother is a physicist.) Between her sophomore and junior years, though, Betty took a summer job in the bacteriophage laboratory at Michigan, and thereupon decided on a career in virology.

Betty began her graduate study at the University of Illinois, under S. E. Luria, professor of bacteriology. There she met Giuseppe Bertani, a research associate at the University, and a co-worker in the bacteriophage laboratory. They were married in 1954, and when her husband accepted an appointment at Caltech as a senior research fellow in biology, Betty applied to continue her graduate studies here. She is here on a National Science Foundation fellowship, working under Max Delbruck, professor of biology. Her thesis in preparation concerns problems of lysogeny—the study of temperate viruses. If all goes well, Betty should get her PhD this June, after which she hopes to work in the field of basic research on viruses.

Ivan Jeanne Mayfield is the biology division's second woman graduate student. She was lured here, after a year of graduate study at Stanford University, by the work of Roger Sperry and his group in psychobiology.

Jeanne (she doesn't use that first name anymore—especially around here. Ivan, it turns out, is her father's name, but the only reason Jeanne inherited it was that her mother thought it sounded so nice with Jeanne) was born in Whitehall, Montana. The Mayfields moved to California when Jeanne was quite young and she went to Chino High School and to Pomona, where she majored in biology, was elected to Phi Beta Kappa, and graduated summa cum laude.

Jeanne went to Stanford to do undergraduate work in the department of embryology, under Victor C. Twitty. Her studies there were on the development of the nervous system of salamanders, but after spending some time with these creatures, she developed an interest in studying the higher processes of the central nervous system. As a result, she abandoned her durable but dull-witted salamanders and came to work at Caltech under Roger Sperry, professor of psychobiology.

Here, Jeanne maintains a collection of highly intelligent fish. By enticing them with food, she has taught them to tell the difference between different colors and even different patterns. One of her smartest pupils is an *Astronotus*—a tropical fish called Oscar for short—which

CONTINUED ON PAGE 12

Miss Jeanne Mayfield, second woman graduate student in biology

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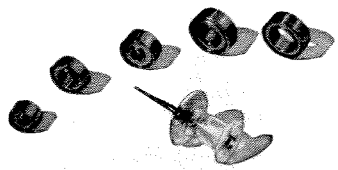

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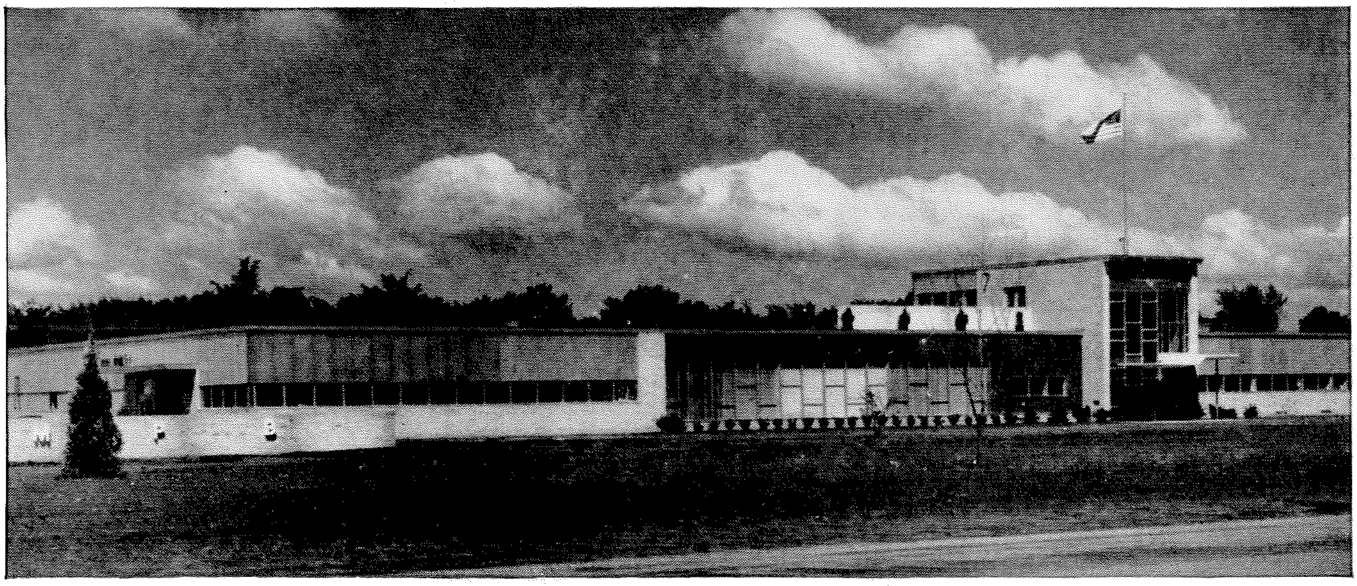

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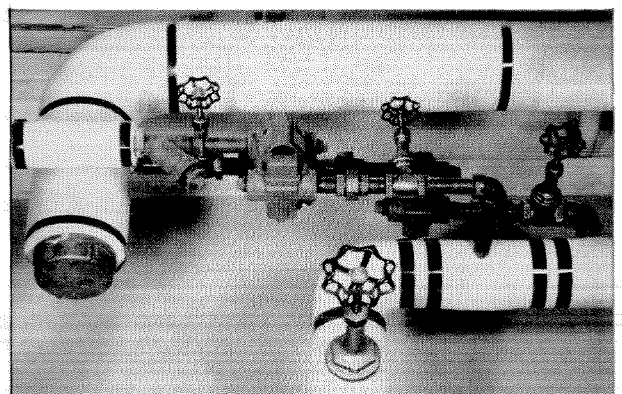

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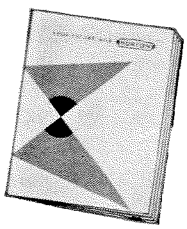

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Miss Florence Raulf, Caltech's first woman graduate student in geology

learned to differentiate between yellow and green in only six days. One of her most willing subjects is a blue gill—a wild fish—which refused to eat for a whole week when he first came to the lab. Then Jeanne put a female swordtail in the bowl next to him. For a few days the blue gill sulked on the bottom of his tank, sullenly watching the swordtail eat regular meals, then finally gave up the fight and started feeding. By now he jumps for food whenever Jeanne comes near his tank.

Jeanne discovered after she got here that she was inadequately prepared in mathematics, so she is plugging away at correspondence courses from the University of California in calculus and physical chemistry. Added to her full Caltech schedule, these courses give her a fairly solid program—i.e., one that would knock out a good many mere males. Though there is hardly time to look ahead right now, Jeanne expects to get her PhD in the spring of 1958, and then to do research in the field of memory.

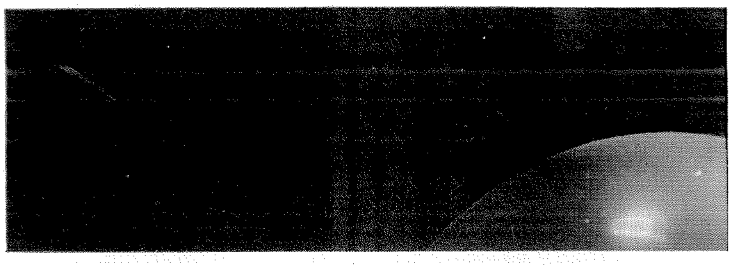
Florence Raulf is Caltech's first woman graduate student in geology. While she was still an undergraduate at Brooklyn College, Florence joined the Air Force with the idea of doing weather forecasting. After three-and-a-half years, she left the service with no further interest in weather forecasting, a solid training in cartographic drafting, and a great enthusiasm for geochemistry. This meant a lot of concentrated science and mathematics, and Florence continued her education in night school all the time she was in the service; then, when her duty was up, she went back to college. She graduated magna cum laude.

When it came to picking a graduate school, Florence concentrated on western ones because she wanted to learn more about West Coast geology. She hadn't given any thought to applying to Caltech though, because she thought it was all-male until she saw a newspaper picture of Dorothy Semenow getting her historic degree. That did it. Florence got a catalogue, found she had the requirements for admission, and entered Caltech last fall. After she gets her PhD in a few years, Florence wants to go into teaching.

A girl geologist is a rarer *avis* at Caltech than a girl biologist or chemist; those departments have always had women research assistants, laboratory workers and so on. As a result, Betty Bertani and Jeanne Mayfield haven't had to waste any time fighting for equal rights. In fact, about the only time Jeanne is aware of this being a male stronghold is on registration day, when the idea is brought home to her rather forcefully as she lines up with the other students. "You feel something like a Martian," she says simply.

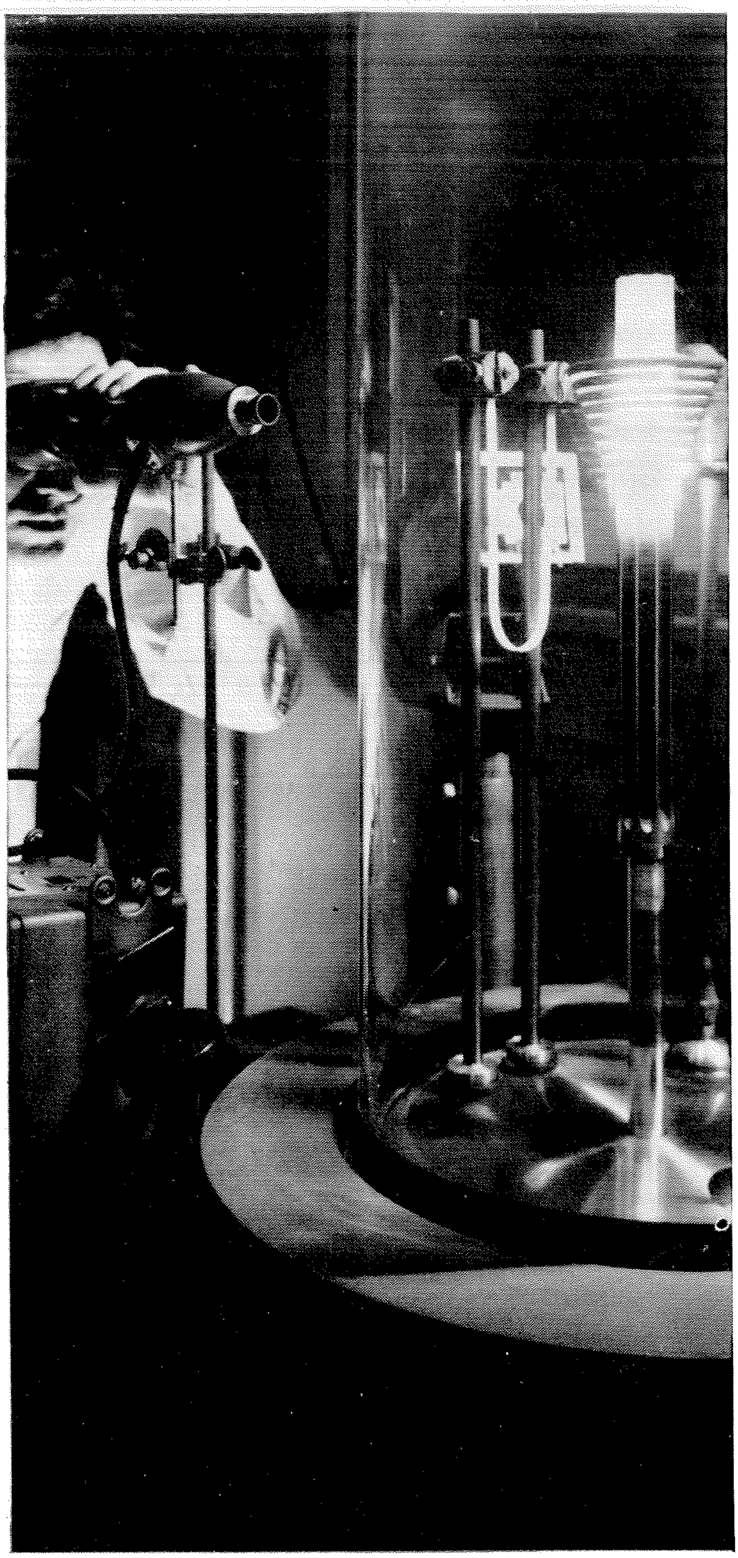
Florence Raulf is having to break the ice for women in the geology division—which has always been pretty flamboyantly male. Probably the thickest ice Florence encounters is on field trips. These are, traditionally, no place for a woman—so, when Florence goes on them, she has to try to haul as much of the equipment and to maintain the same breakneck pace as the other students. The results are something less than spectacular. "On field trips," Florence says philosophically, " I don't see much of the other students—I'm all the time dragging along 50 feet behind them."

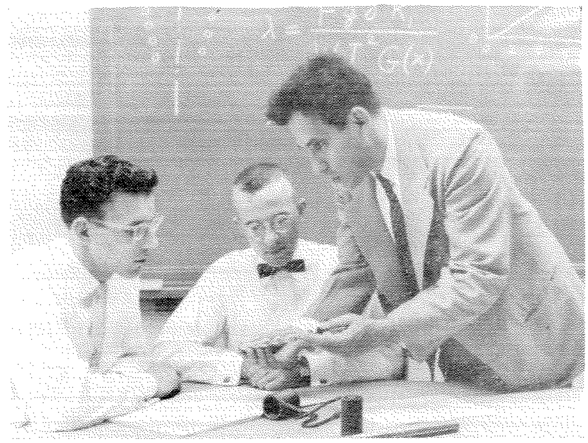
She'll catch up with them yet though. Girls are here to stay.



Refining metals to perfection

...A PROBLEM IN PURITY





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WHAT'S A COLLEGE WITHOUT TRADITIONS?

A Senior takes inventory of Caltech's traditions —and discovers an unmistakable trend

SITTING IN THE LOUNGE in the late afternoon, a magazine lying unobtrusively in his lap, the Senior thought of traditions.

It was a natural thing to be thinking about after what had just been going on a moment ago. There had been a freshman, reading the same magazine, wearing cords. The frosh, who was a pretty good boy at that, had been the only freshman in the lounge at the time, and had read along, completely oblivious of the small knot of upperclassmen which began to form around him.

The upperclassmen, in a group effort to be subtle as well as funny, talked among themselves in loud voices. "Some guys around this school just don't have any respect for traditions." "Isn't that the truth?" "Freshmen especially. You'd think they didn't care at all." "What's a college without traditions?"

Gradually the little group of upperclassmen grew, all of them staring at the unfortunate freshman, who still read, in blissful ignorance of his impending fate. More and more upperclassmen chimed in with comments that became more and more explicit about the value of old traditions.

Suddenly their victim became conscious of the circle that had formed around him; in a belated flash of insight, he realized that they were talking about him.

Well, the conclusion of the episode was swift and simple. His cords resting intact but unoccupied in the upper branches of the courtyard tree, a freshman learned the value of old traditions.

But several little details of the incident had started the Senior to thinking.

In the first place, it turned out that the frosh had never even *heard* of a tradition about only seniors wearing cords.

In the second place, when, two years earlier, one of his classmates had tried to wear cords to lunch in the house, the Senior had been helpless to protect his buddy as a swarm of at least 20 then-seniors had fallen upon him and torn the pants into little pieces. The contrast was evident.

To the Senior the whole thing was symptomatic of a trend which seemed to be sweeping the campus and the students, wiping clean the old rough, rowdy, goofy, devil-may-care Caltech life and replacing it with a kind of scientific sterility, based on certain logical premises: don't do that, somebody might get hurt; don't do that, somebody's trying to study; don't do that, somebody's going to have to pay for it.

When the Senior had been a freshman, he had been part of a screwy, reckless student body that had an individuality which could neither be predicted nor suppressed. He and his buddies had played tag with the police for a week, stealing boxes from grocery stores at night, then marching down Colorado Street in their pajamas; they had waterfought, room-stacked, and election-rallied with men who knew that some of their number were going to flunk out but who thought it was worth it, with men who believed that self-expression was sometimes worth the price of ostracism, and—he had to admit it—with a lot of men who never actually thought much about it but just went out to have a blast.

Now the Senior felt a gnawing away at this old way of things, felt a different spirit in the student body, a spirit which he had heard some philosophical friends of his call the symptom of the decay of America, the spirit of don't-might. Don't be noisy; somebody might be trying to sleep. Don't go raise hell over at Oxy; you might flunk out. Don't steal boxes; you might get caught. Don't do this; you might be sorry. Don't do that; somebody might not like it.

Of course, there *was* always somebody trying to sleep; there *was* always somebody flunking out, and so on. It was a question of values.

Mentally, the Senior took a little inventory of the old traditions.

There were still waterfights, although somebody had tried to pass a rule that upperclassmen couldn't participate. There was still room-stacking and lock-picking, although most of the experts had graduated. There was still a Ditch Day, although there were a lot of rules now about preventing property damage, which the Senior had to admit was a pretty good thing—especially for him. There was still a brake drum and there was still a brass spittoon, both having survived periods of near-disaster. There were still barn dances, with crew and flamers. There was maybe going to be a Throop Club Stag this year.

But the Pajamarino was as dead as last year's bonfire, as completely forgotten as last year's basketball scores. The night raids on orange-crate stockpiles were extinct. The poker game had graduated. There was hardly a single veteran living in the houses. Everybody except seniors, it seemed, used the Senior Bench; sophomores didn't know what it was. And the frosh didn't know about cords.

The trend was unmistakable and its progress was irresistible. This year they were going to clean up the election rally. Next year might be the last year they raided the Oxy bonfire, or the year that they abandoned the mountainside T to be overgrown and disappear, or the year that the seniors decided that Ditch Day wasn't worth it. The year after that might be the year the brake drum was permanently retired, or the year that waterfights were outlawed.

To the Senior, the old recklessness had always called up a conflict in values. It was the individual vs. society, so to speak. As society, he wanted it quiet in the alleys after 10:30; as an individual, he wanted to screw around when he felt like it. As society, he didn't believe in stealing boxes; as a minority group, he wanted to have a bonfire.

Usually, though, this little idea of the spirit of don't-might would be the basis of his decision. It was better to live in a society where people could screw around at midnight if they felt like it (at least occasionally!), even at the price of a little lost sleep. It was worth it to live in a society where kids could have bonfires, even at the price of quite a few boxes.

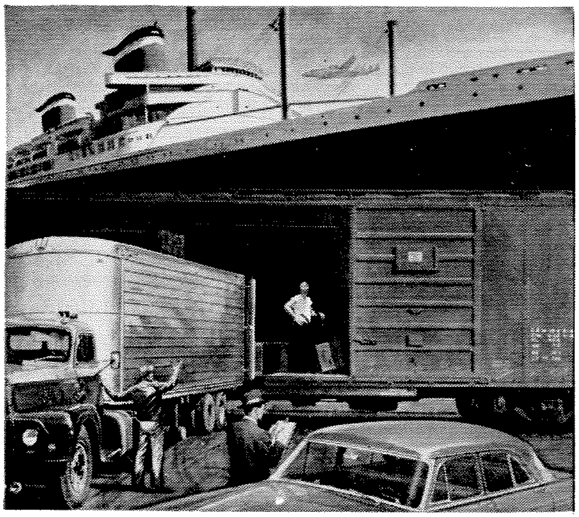
This was the *hard* way to look at it, because it meant that there were no set rules for conduct, no fixed list of things not to do. The spirit of don't-might was the *easy* way out, but the Senior was afraid to think of where it ultimately led.

The Senior put the magazine away and walked up to his room to dress for dinner, wondering what he'd do the next time some frosh was wearing cords.

—*Marty Tangora '57*

INDUSTRIES THAT MAKE AMERICA GREAT

TRANSPORTATION... FREEDOM'S GIANT



We sometimes become so bemused with its astronomical facts and figures that we are apt to regard the transportation industry as an end in itself.

But transportation has grown into a giant because it represents the translation into reality of some basic precepts of democracy . . . freedom to think, freedom to buy and sell, freedom to move about as we please. The resultant interchange of ideas, people and goods has inevitably led to the development of large-scale, efficient transportation. It is thus no accident that history's greatest democracy should also have history's greatest transportation system to serve it.

The transportation industry itself has never lost sight of its basic origins. Cognizant of its responsibility to the nation, it has always reinvested large amounts of its earnings in plant expansion, in engineering, in research—all for the development of better and more efficient methods, machines and conveyances. That is why American cars, planes, ships and trains are able to supply their services so efficiently and abundantly.

The science of steam generation for power, processing and heating in the transportation industry has likewise kept pace with the demand for greater efficiency. B&W, whose boiler designs power such giant vessels as the *S. S. United States,* continues to invest large amounts of its own earnings in research and engineering to discover better ways to generate steam for ships and trains, for power plants and factories. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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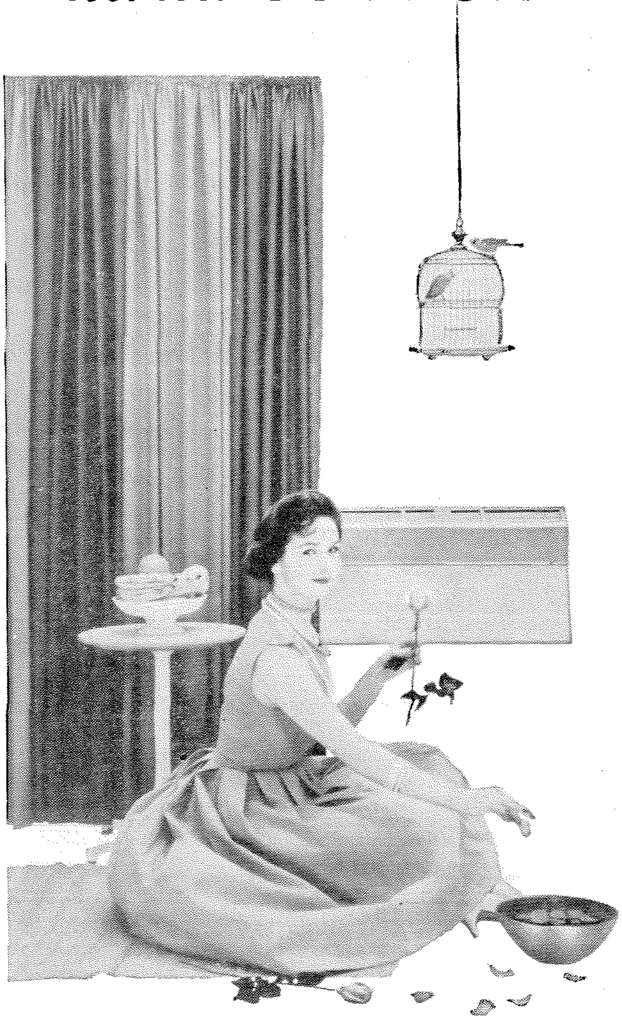

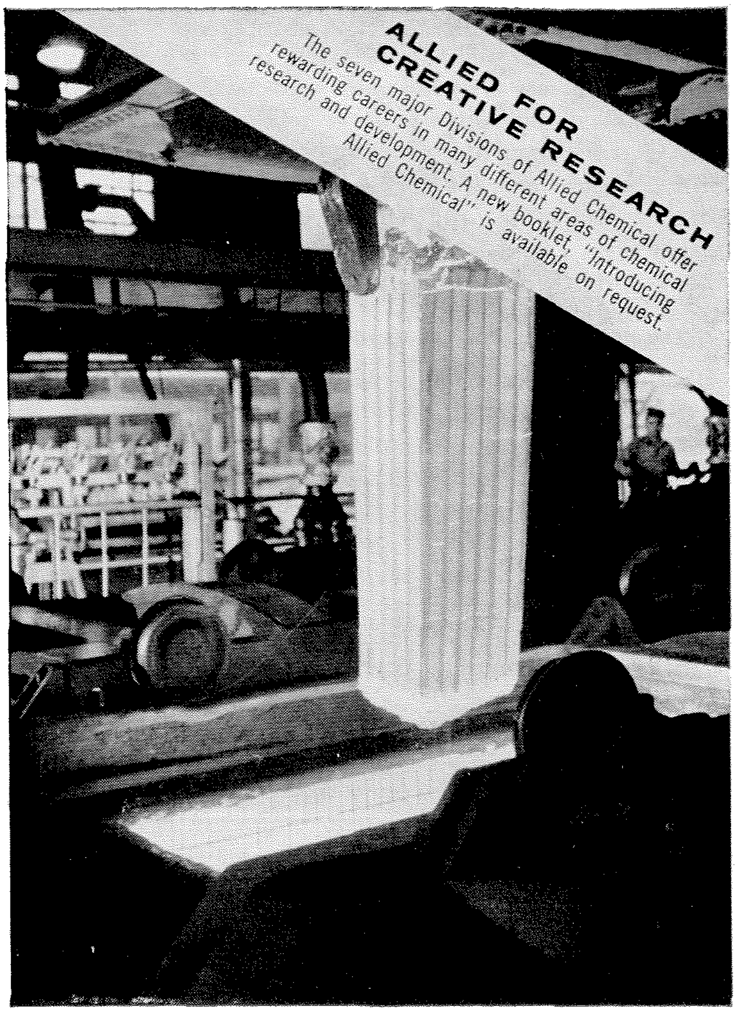

HERE'S HOW THEY'RE ALLIED

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AN HISTORIC MOMENT IN PHYSICS

by RICHARD P. FEYNMAN

Experiments at Columbia University have now proved one of the basic laws of physics to be false—the principle of reflection symmetry. Herewith, some comments by a Caltech physicist on the importance of this radical reversal.

THE MOST USEFUL generalizations and the most appealing to the human mind are principles of symmetry. So the physicist holds very dear the principles of symmetry which he has discovered in the basic laws of nature. One of these is the principle of reflection symmetry. It says this: If an apparatus is built and operates in a certain way, then another apparatus built in every respect reflected (that is, bearing to the first in all its parts the relation of right to left hands) will behave in precisely the corresponding reflected way. So, if Alice really went through the looking glass, she would find the world in no respect changed.

Another way of putting this is to say that in physical laws there is no way to define absolute right or left. Of course one can use local geography (facing San Francisco from Los Angeles the ocean is on the left)—but imagine trying to tell a being on another planet (who—suppose—can see nothing we can see or point to) which side your heart is on.

You might object that right hand rules are used in magnetism, for example. The north pole of a magnet formed by a coil through which a current flows can be determined by using a rule involving one hand. Alice in the looking glass would call it a south pole, but that makes no difference, for if she went on figuring which way wires would be moved by the magnet, she would have to use her rule again and would come out correctly. In other words, north and south magnetic poles cannot be defined absolutely either (except by geography again). In the reflection symmetry the pole names would be interchanged.

All the laws discovered until a few weeks ago conformed to the principle—electricity, magnetism, gravity, atomic physics, nuclear physics, etc. But recently two experiments have been performed to show that it is false.

Miss C. S. Wu, at Columbia University, in collaboration with Ambler, Hudson, and Heyward of the low temperature laboratory of the Bureau of Standards, detected electrons which were emitted by radioactive cobalt nuclei (of atomic weight 60) when these nuclei, which act as little magnets, were lined up in a strong magnetic field at low temperature. They found more electrons were emitted toward the north pole of the magnet than the other way around! This permits an absolute definition of the north pole of a magnet, namely that toward which Cobalt 60 emits its electrons preferentially. It violates reflection symmetry.

We can tell our being on the other planet to try the experiment and find the north pole of a magnet. Then, if he has made a model of a man and wants to know where to put the heart, we tell him this way: Set the model so the cobalt emits the electrons foot to head (so that the magnetic field goes head to foot), then let a current of electrons in a wire go from the face to the back of the head. The wire will be pushed to the left, where the heart goes.

Another experiment performed by Garwin, Lederman, and Weinrich with the cyclotron at Columbia shows the same breakdown of reflection symmetry a little more indirectly. They measured electrons emitted by mu mesons (a particle 210 times the mass of the electron) and found a similar directional effect. But here the mesons weren't lined up by a magnetic field—they must have been produced spinning around an axis in their direction of motion. In this case the production process (the disintegration of another particle, the pi meson—276 times as heavy as an electron—yields the mu meson) must also violate reflection symmetry. So, in the last weeks we have found three processes which are not symmetric for reflection—the disintegration of Co 60, the disintegration of pi into mu, and of mu into electron.

The story behind these experiments is interesting. Among the new strange particles recently found there were two—one called the tau, which disintegrated into three pi mesons; the other called the kappa, which disintegrated into two pi mesons.

The tau and the kappa had the same charge, the same mass within the accuracy of measurement (2/10 percent), the same lifetime before decay, and were always produced in the same proportion. This series of coincidences could easily be explained if the tau and kappa were actually one and the same particle, but this possibility was disproved by invoking the law of reflection symmetry. In quantum mechanics it has a consequence called the conservation of parity, and it would violate this law if the same particle could disintegrate, in the manner found, into three and also into two pi mesons.

Repealing the law

At a conference on these matters last April in Rochester, Martin Block, an experimenter from Duke University, made the suggestion that all these miraculous coincidences would disappear and the (apparently) two particles could be one by giving up the cherished law of reflection symmetry. In the intervening months, C. N. Yang of the Institute for Advanced Study at Princeton University, and T. D. Lee of Columbia University studied this possibility extensively and proposed a number of experiments to test it. These were two of the proposed experiments. Parity is not conserved; reflection symmetry is indeed untrue.

Yang and Lee and, also, L. Landau in Russia, have made a special suggestion to describe the way that the symmetry may be lost. They point out that in each case (Cobalt 60, the pi decay, and doubly in the mu decay) a neutrino is emitted. Perhaps the culprit is the neutrino. Neutrinos carry spin angular momentum and previously (to preserve reflection symmetry) were assumed to be capable of spinning right or left around their direction of motion. Yang and Lee suggest that they can in fact only spin one way (say clockwise, as they approach). So far, all of the data of Wu et al, and of Garwin and Lederman, can be interpreted this way. Soon further tests will be made.

But this cannot explain all cases of the failure of the law, or otherwise we are back where we started, for there is no neutrino involved in the decay of the tau (or kappa).

What next?

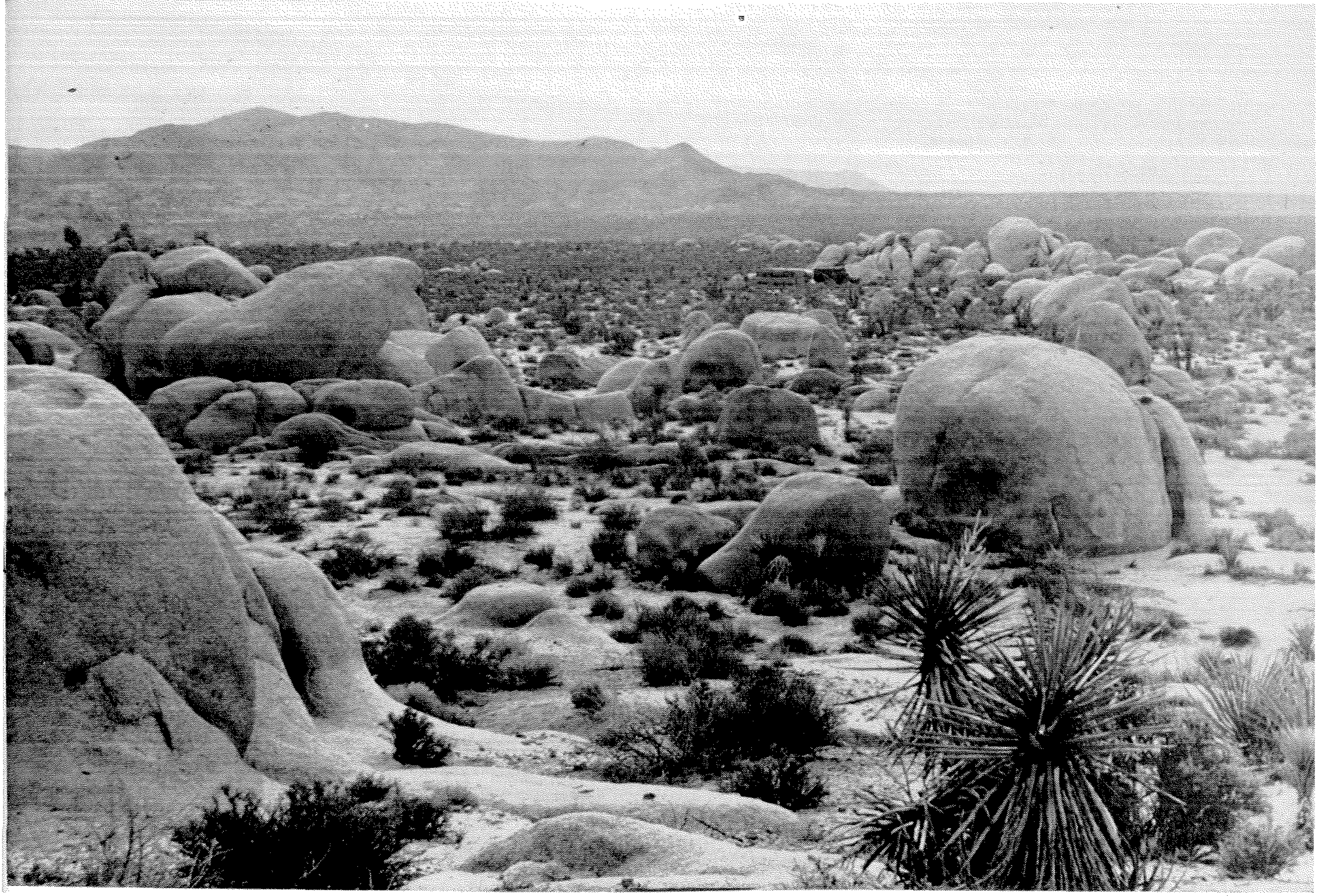
Where do we go from here? We have many symmetry laws, and all become suspect now. We recently had a confirmation of one (called charge symmetry) with the discovery of the anti-proton. Each particle has a counterpart in nature, with all properties the same but with some signs reversed (for example, electrical charge). When the two meet they annihilate each other.

Electrons have, as counterpart, positrons—discovered by Carl Anderson here in 1932. Protons and neutrons have anti-protons and anti-neutrons, respectively. Corresponding to ordinary atoms one can imagine anti-atoms (with the protons, neutrons and electrons replaced by anti-protons, anti-neutrons and positrons), and ordinary matter should have a counterpart in anti-matter. The law of charge symmetry says that any apparatus built entirely of anti-matter should behave the same way as its counterpart built of ordinary matter.

Previously we had four possibilities, all behaving alike—the original apparatus; its mirror image; the apparatus of anti-matter; and the mirror image built of anti-matter. All should have behaved the same, but we have now learned that the first two differ. The last two must now differ too, but which corresponds to the original?

The preliminary experiments all indicate that there is still one element of symmetry left: the original apparatus and the mirror image of anti-matter should agree. That is, the being on the far planet would get the heart on the correct side if he is made of the same stuff as we, but if he is made of anti-matter, he will make his model with the heart on the wrong side if he follows our directions. And there is no further way to tell him whether he is made of the same kind of matter as we, or of anti-matter. We shall see how long this symmetry principle lasts.

This is an historic moment in physics. During the last three decades we have been learning about many new things; but not, until now, that an old thing was wrong. Now we have to give up a cherished symmetry, and nature looks more complicated to us than ever. But the great progress always starts by the undermining of old ideas, and the loss of this one lets a host of new ones out to be tried. We have confidence, judging from the past, that what looks like a complication today is the first step toward a greater understanding and simplification in the future.



The mobile desert laboratory, dwarfed by its research material

CALTECH'S ROVING LABORATORY

by LLOYD TEVIS, JR.

This new mobile laboratory spurs studies of how plants and animals survive under desert conditions

THE EARHART LABORATORY at Caltech is one of the outstanding botanical research centers of the world. By manipulating artificial conditions of weather, its botanists have learned a great deal about growth and reproduction of plants. But although control of environmental factors is essential for solving many biological problems, study of life under entirely natural and uncontrollable conditions is equally important and interesting.

Towards that end, Caltech recently acquired another unique laboratory—one on wheels, especially designed for exploring the severe and demanding habitat of the desert. Using the facilities of this Mobile Desert Laboratory, investigators are experimenting with an intriguing aspect of evolution: the ability of some plants and animals to survive the heat, dryness, violent winds and cloudbursts of arid places.

Because plants were first cultivated in Egypt some ten thousand years ago, we might expect to find the protype of a desert laboratory in the ancient civilizations of the Middle East. But the agriculture of those days was entirely empirical.

A related people, the Nabataeans, who, at the time of Christ, built an empire in the desert without benefit of a Nile, were forced to adopt a more experimental approach. In fact, their agriculture—based on a system of terracing the wadis or canyons—was so ingenious that it is being studied today by archaeologists for possible application in Israel.

Coming to the modern era, we find that, although there are many botanical field stations in humid areas, they are comparatively rare in the desert. This seems strange when one considers that nearly a fifth of the total land area of the world is arid, and that the desert is a particularly favorable habitat for ecological research.

The challenge of the desert

Its extreme conditions impose a challenge that is met by comparatively few species. The outstanding attribute of aridity is accentuated by long droughts or broken briefly by torrential and destructive rains; daily fluctuations in temperature are tremendous, winds and sandstorms violent, sunlight and ultra-violet radiation intense, and the soils generally charged with salts.

Because plants cannot fly away or retreat into burrows, as animals do, they often show striking adaptations to these extremes. The botanist, Daniel Trembley MacDougal, who for many years was director of the famed Desert Laboratory at Tucson, once said:

" . . . Though we may not recognize it as such, the peculiar plant life of the desert is part of the fascination for us. The panorama of wind-swept expanses, blazing sunlight, and shimmering mirages, all bathed in a swirl of heat and color, suggests an elemental and as yet unconquered world. Into this hostile environment, armed forms of vegetation have forced their way, showing by toughened leaves, indurated stems, and stored-up water, the means by which they have gained a foothold in a region so widely different from their ancestral origin in the seas . . . "

When Frederick Coville explored Death Valley in 1891, he was so impressed by the botany of arid places that he conceived a plan for a permanent laboratory somewhere in the Southwest "to ascertain the methods by which plants function under the extraordinary conditions existing in deserts."

His plan was accepted by the newly-formed Carnegie Institution of Washington, and he and MacDougal were asked to select a site for buildings in what was then the Territory of Arizona.

Among the many visitors who came to use the facilities of the Carnegie Institution's Desert Laboratory at Tucson were Eduard Schratz of the Kaiser Wilhelm Institute, who investigated the suction tension of desert perennials; Henrich Walter, who studied the osmotic value of sap; and Dice and Blossom, who compared the coloration of rodents with the environment.

Almost from its inception, the Laboratory also undertook projects that involved travel to distant places. In 1905, the rampaging Colorado created a great inland body of water 300 miles to the west. This fired the imagination of the botanists, who, accordingly, went to the new Salton Sea to begin an investigation, lasting many years, of the movements of plants along the changing shoreline.

A study of the Mohave Desert was initiated in 1915. Much later, Forrest Shreve, then in charge of the Laboratory, undertook a comprehensive survey of the entire Sonoran and Chihuahuan Deserts. This project, which previously had been impractical because of the frequent revolutions that swept Mexico, was designed to carry the study of the Tucson plants to their distributional limits—to determine how they had originated and differentiated under the impact of aridity. But the geographical scope was so ambitious that before long most of the work of the Laboratory was being accomplished far from the home base at Tucson.

So in 1939, after a fire had destroyed one of the buildings, the Desert Laboratory was given up, and its facilities were transferred to the United States Forest Service.

Shreve's recent monograph, "Vegetation of the Sonoran Desert," published after his death, is a fitting and logical culmination to an impressive list of publications that stemmed from the Carnegie Institution's study of the desert: over 400 articles, monographs, and books.

Now that the Tucson Laboratory has long been out of existence, we might look at the deserts of the world, outside of North America, to see what laboratories are in operation today.

Desert laboratories today

There are none in Australia and South America. The Sahara has two small stations with primitive facilities, and there are two in the Kalahari of South Africa. The vast Asiatic deserts, from Suez to the Gobi, are a little more fruitful in this regard. Israel has three observation sites in the Negev and a small laboratory at Beersheba. India is establishing a Desert Research Institute at Jodhpur. And Russia is experimenting with a number of semi-permanent stations, one of which traces the effect of sandstorms on vegetation.

All of these stations or laboratories are small, and none of them is strictly comparable to the one at Tucson. The Tucson Laboratory was devoted to pure science while the others are concerned with economical applications.

In thinking about the need for a center in this country to continue the traditions of the Arizona Laboratory, we notice that in the desert, in particular, the most interesting situations are likely to develop far from headquarters. The Laboratory at Tucson had hardly

Professor of biology Frits Went (right) and lab workers count seedlings that have survived desert temperatures.

come into being when the Salton Sea attracted the staff members to a distant region, where they had to make their studies without the instruments assembled at Arizona.

Again, when Maximov, the Russian plant physiologist, visited the Imperial Valley in 1926, he was amazed to find the creosote bushes alive after a long period without rain. But, as he wrote with much regret, "The absence of a laboratory in the neighborhood prevented my determining the water content of this interesting plant when in a condition of permanent drought." And by the time he got to Arizona, rains had fallen—so he returned to Russia without ever being able to investigate the survival of creosote.

Desert rains, which so profoundly stimulate the flora and fauna, are notoriously local. A single site may be dry for years while cloudbursts are frequent nearby.

In order to overcome difficulties of this sort, which are encountered by conventional field stations, Frits Went of Caltech has long advocated the construction of a laboratory that would be mobile—one which, like the nomadic Tibu of the Libyan Desert, could follow the rains from place to place.

His idea was realized last summer. Through the generosity of Mrs. Austin McManus of Palm Springs—whose father more than 70 years ago pioneered that now glamorous town in the desert—funds were provided for a truck and house-trailer.

The trailer has been modified into a biological laboratory with work tables and instruments, such as microscopes and balances. Since desert conditions require that the investigators be comfortable, the kitchen stove, refrigerator, hot water heater, and shower have all been retained—and for summer operations there is both an air conditioner and an evaporative cooler. The utility department and key to the whole operation is the truck. It carries 500 gallons (or about two tons) of water under pressure, a 4000-watt generator, and an air compressor. Because it is equipped with its own electricity and running water, the truck-trailer unit is independent of a fixed site.

Known as the California Institute of Technology Mobile Desert Laboratory, it is based at the Rancho Senora del Lago in the desert near Palm Springs.

Probably no other area in the world could offer a mobile laboratory such a diversity of arid terrain to explore. The white sands of the valley floor, bounded to the southeast by the Salton Sea and the dunes of the Algodones, are rimmed by bajades, canyons, and mountains culminating in the 10,000-foot peak of San Jacinto. The only opening from the west, the Gorgonio Pass, is a funnel for almost constant, sand-blasting winds. The palm oases of the foothills, with their peculiar insect fauna, are relicts of a moister age; while the Delta of the Colorado has a climate that is one of the driest and hottest on earth; and across the Sierra Juarez is a fog desert where xerophytes are festooned with moisture-loving lichens. Though much of this great land is under invasion by the works of man, large areas have been set aside for permanent protection—Anza and Borrego State Parks, Death Valley, and Joshua Tree National Monument in the Mohave.

At present, the desert is suffering one of the most prolonged droughts of recent times. Animal numbers are at a low; and many shrubs, which once had grown to a fair height, are dead or dying. Under these circumstances we are particularly interested to know how species of animals and plants survive.

An obvious and easy animal to investigate is the black harvester ant of the genus *Veromessor*, whose colonies, although rare, can still be found in the white sand desert. This species depends on seeds for food, yet for the last three years there has not been enough rain to bring up the annual vegetation; and there has hardly been a really good flower year for a decade.

Robbery pays

Our method of study is to mark a number of colonies and then follow their fate from month to month. And we investigate the food that the ants carry to their nests by the simple expedient of robbing the workers. It is as though a giant were to post himself outside a supermarket and, with huge tweezers, tease all persons who came out until they dropped their bundles. In this way, without seriously upsetting the life of the colony, we are able to get a picture of the amount and kind of food that it collects every week of the year.

An interesting supplementary method would be to uncover the underground granaries of non-marked colonies. But our last attempt had to stop at a depth of 12 feet. At that depth, which made further excavation impractical, we had not reached any of the main chambers, and the passageway was still spiralling down at a steep angle. We did find, however, a small store of seeds at 8 feet, and, although it is often said that ants bite off the radicles to prevent germination, these seeds sprouted when given light and moisture.

One reason that the black harvester ant digs such deep nests is that its temperature tolerance is extraordinarily narrow for a desert insect. In summer, although it may be sluggishly active all night, dumping sand and refuse on the middens, it does not forage until sufficiently warmed by the sun—around 6 a.m. Then food is hunted at top speed, for by 8 a.m. the sand is so hot that the workers have to go below, not to reappear again until the cool of evening. If a wind should arise while the ants are foraging, all wheel around and hurry back to the formicary.

The more familiar one becomes with the black harvester ant the more surprised one is that so sensitive a creature succeeds so well in the desert. The one other harvester occupying the white sands, a large red variety of the genus *Pogonomyrmex*, would seem to be better suited. It is aggressive, it inflicts a severe sting, and it forages all day, even on sand that is 150°F. or hotter. Yet its colonies are the least numerous. Should the present drought continue, it will be interesting to see which species can truly survive the extreme aridity—and how and why it is able to do so.

In studying the food of the black harvester ant, we found that the amount and variety collected by a particular colony each day was quite constant for a number of weeks. Then, when seeds apparently became increasingly rare the workers would disappear, and drifting sands would close the abandoned hole. The colony seemingly had failed. But always within a few days a new hole would be opened—fifty feet or so away—and a new territory invaded for food.

Altogether, we found that the ants brought as many as 15 different kinds of seeds to their nests, though two species comprised 90 percent of the total.

One came from a small insignificant plantain of the genus *Plantago;* the other from a small, insignificant comb-bur of the genus *Pectocarya.* Were it not for the fact that more than three years ago these drab little plants had sprouted and seeded in abundance, the ant colonies probably would not be able to keep alive today. Interestingly enough, cheek pouches of kangaroo rats also yielded only these same kinds of seeds—indicating that rodents, too, are depending upon them for survival.

The ants found very few seeds of those plants which are so colorful in wet years. Sand verbena and desert-gold each made up only one percent of the total, and there was no primrose.

It would seem, then, that possibly because of the toll levied by ants and rodents, seeds of some of the desert annuals in this particular area are becoming scarce, and more than one wet season may be needed to replenish the supply.

Artificial rain

In order to get more exact information about numbers of seeds in the sand, we set up an experiment in which a different but comparable area of the desert was sprinkled with artificial rain each month. After each area had received the one wetting, it was given no additional water. Whatever plants came up had to grow without further moisture. We were interested also in determining the kinds of seeds that might germinate at different times of the year, and in following the fate of seedlings.

In spite of the fact that ants had collected some 15 species of seeds in the sand, the only kinds to germinate during the hot summer months—July, August, and September—were a sand-mat of the genus *Euphorbia* and sand verbena of the genus *Abronia.*

As these plants were not supplied with additional water, most of the verbena perished very quickly. But the sand-mat proved itself a true "summer annual." Without apparent water and growing in full sunlight on white sand—which reached a temperature of 140°F. daily, one inch below the surface—most of the plants thrived. They increased their spread (that is, their diameter) at the phenomenal rate of three-quarters of an inch a day until flowering, lived for as long as four months, and produced copious amounts of seed.

It may be that the plants obtain their moisture from dew. Professor Duvdevani of the Hebrew University in Jerusalem has found that certain plants can draw dew-water through their leaves into the roots and even into the soil for storage. But we know almost nothing about the occurrence of dew—if it occurs at all—on our California deserts during summer. Fortunately, this deficiency can be overcome now by using an instrument for measuring dew-fall developed by Profesor Duvdevani, Caltech's Desert Laboratory is equipped with one.

The end of September saw an abrupt change in weather last year. The heat of summer gave way to mild temperatures, and in contrast to results achieved by summer watering, that done in October and November produced thirteen species of "winter annuals"—but no sand-mats.

Besides this striking difference between the vegetation of the hot and cooler months, there was also a difference between October and November. In October, which was relatively mild, one of the kinds of seeds that are so important now to the black harvester ant sprouted four times more abundantly than all other species combined. This was plantain.

But in November, when minimum temperatures fell below freezing, plantain was rare; while a mallow of the genus *Malvastrum*, which previously had been scarce, was abundant.

Obviously, then, the kind of weather following a desert rain goes a long way towards determining the composition of the flora that subsequently arises. And, hence, even in wet years, the annual vegetation of one year may be quite different from that of another.

So far, our watering experiments have not met the conditions required for germination of the second species that is important to the ants, for not a single comb-bur has appeared.

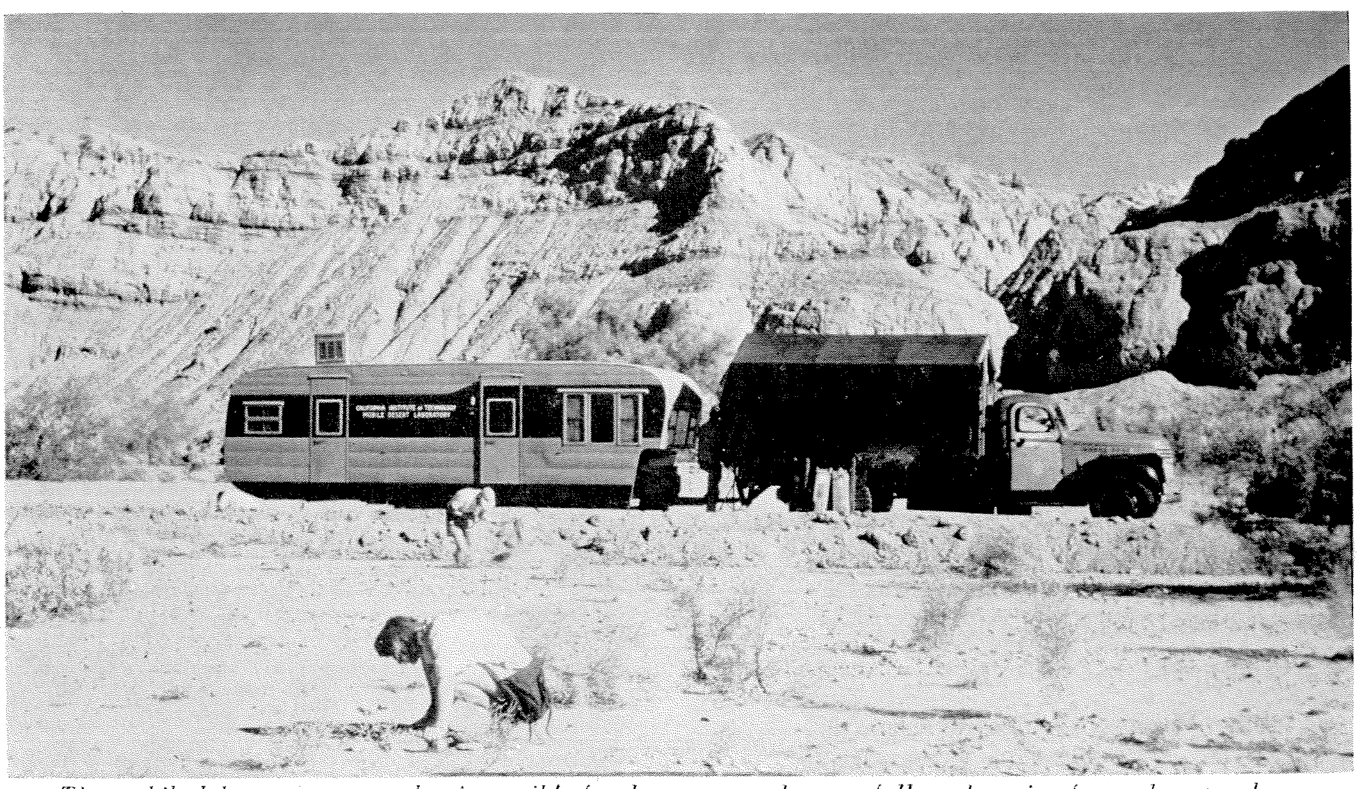
Except for moisture deficiency, the chief cause of mortality during the summer was rabbits, which ate verbena but not sand-mat—the latter being protected by a milky juice that is said to have protein-digesting powers. In October and November, wind was very destructive to seedlings because of the sand-blasting that acompanied it.

Research, such as this on the ants and the annual vegetation of the white sand desert, requires fairly continuous, long-time study of a single area, and might not seem appropriate for a mobile laboratory. But we intend that such studies are to be part of the program in order to provide continuity.

Another idea is that the mobile laboratory should not operate only for the benefit of Caltech. Rather, we would like to see it used as was the Desert Laboratory at Tucson, which attracted workers from all over the world. And, though that laboratory was concerned chiefly with plants, we plan to give equal encouragement to the study of animals.

The relation between animals and plants, as exemplified by harvester ants and seeds, is one of many interlocking factors affecting survival of species. In warm, humid climates, a bewildering array of organisms makes the segregation and evaluation of these factors difficult. But in the desert, where the flora and fauna are limited by aridity, the task is less complex.

That is why Caltech's new research center on wheels is designed particularly to investigate arid regions. The desert itself, with long periods of magnificent weather broken by violent extremes, is an exquisite biological laboratory. There is much to be learned from it, and by studying how its plants and animals survive the climatic extremes, we hope to complement the work that Caltech's Earhart Laboratory is doing with controlled weather.



The mobile laboratory now makes it possible for desert researchers to follow the rains from place to place.

A CALTECH QUIZ

by GEORGE W. BEADLE

1.

2.

You think you know the Caltech campus? Then try to identify these pictures, taken by George W. Beadle, chairman of the Division of the Biological Sciences.

You should be able to answer three questions about each picture: (1) What is it? (2) Where is it on the campus? (3) Which way was the camera pointing?

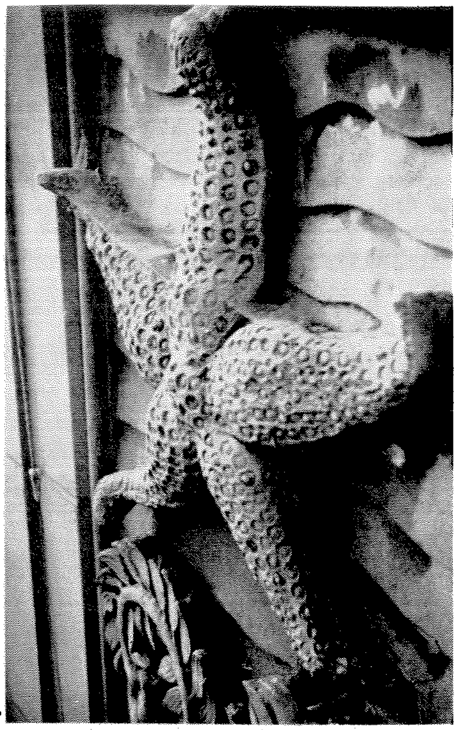
Give yourself 1 point for each picture. If you get 7, you are highly observant. If you get 13, you are cheating.

Answers on page 38.

3.


4.


5.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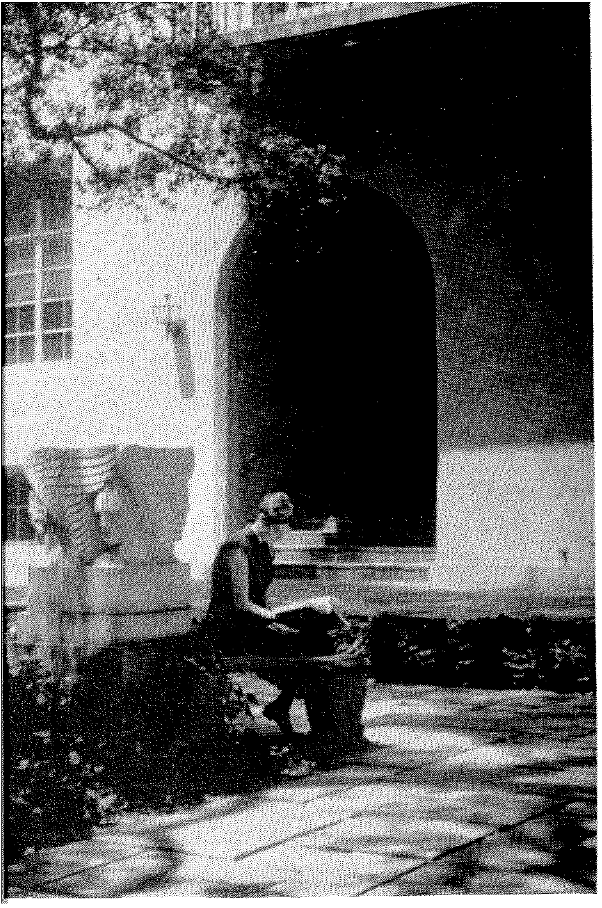

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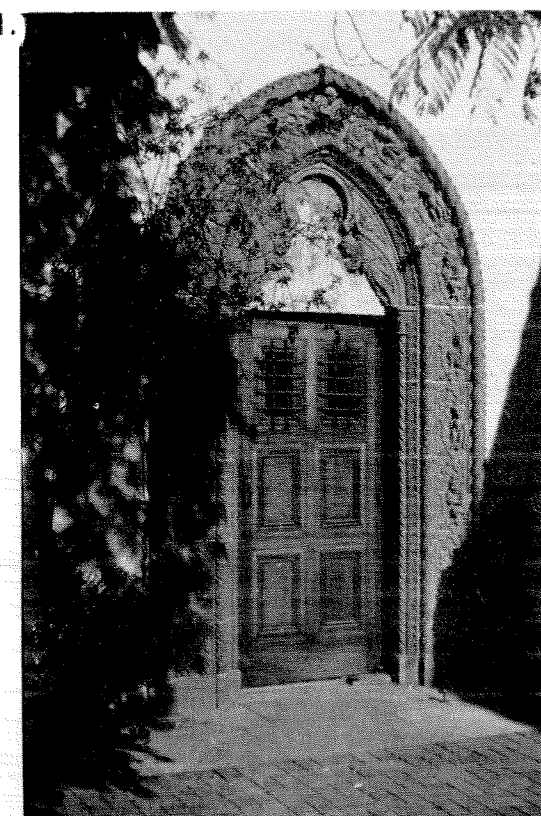

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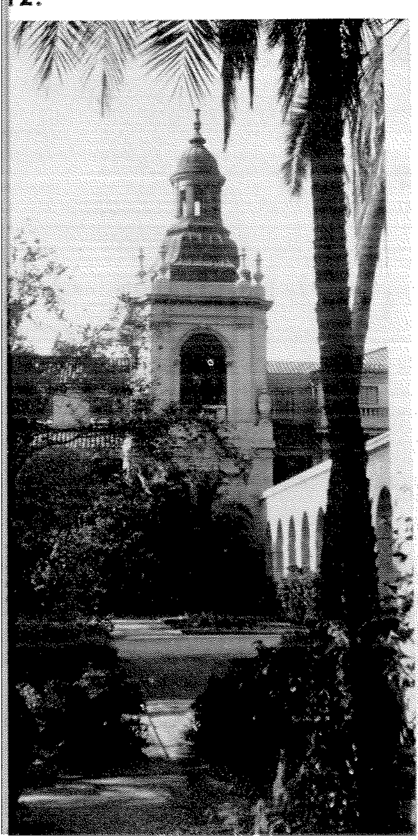

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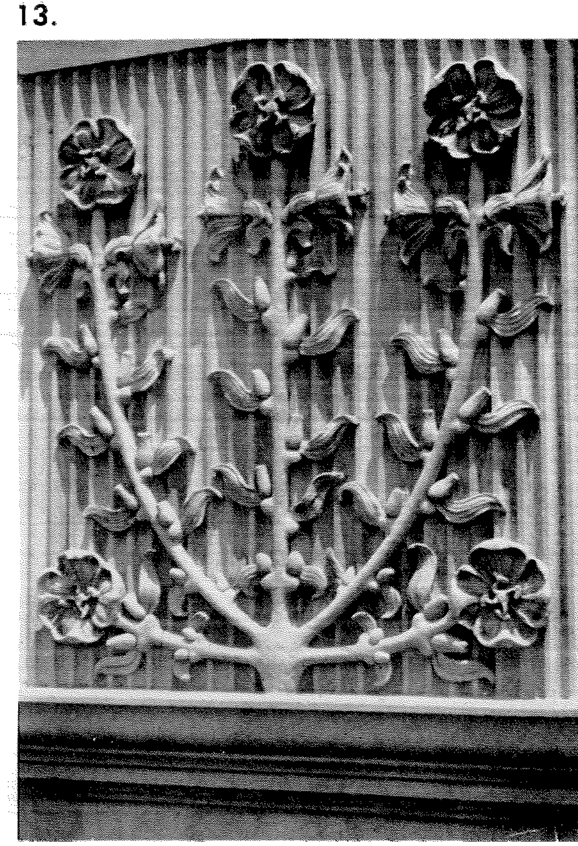


SCIENTIFIC PROSPECTING

Recent Caltech discoveries may point the way to a new method of locating hidden mineral deposits

A NEW METHOD of prospecting for hidden mineral deposits may result from discoveries made recently by three Caltech scientists—geologist A. E. J. Engel, and geochemists Samuel Epstein and Robert N. Clayton. Studying clues left by nature 250 million years ago, they have found that the location of underground ore is indicated by variations in oxygen isotope ratios in surrounding rock.

It has long been known that some of the greatest base metal deposits in the world were formed when hot fluids, carrying ores with them, forced their way into carbonate rock formations such as limestone and dolomite. The intruding fluids permeated outward, heating the rock for a considerable distance and causing certain chemical changes in it. The affected areas, on which pioneer research was conducted in 1920 by Caltech geologist D. F. Hewett, are known as alteration halos. They are commonly 10 to 20 times larger than the ore deposits they surround, occasionally 1,000 times larger.

Caltech's current study began with a two-fold purpose: (1) to learn more about the physical-chemical properties of the replacement deposits and surrounding halos, and thus more about the formation of the earth's crust, and (2) to see if there was some systematic variation in the chemical make-up of the halos that would point to their hubs of ore. Such a clue would be welcome, for most surface ores are already located and being worked, and the discovery of underground ores is today too often a matter of luck.

A program of field work, supported by the U. S. Geological Survey, was begun in July, 1954, by Dr. Engel. As an experimental model he chose the Leadville limestone, a sedimentary formation in central Colorado that contains some of the country's richest silver, lead, and zinc deposits. A part of this formation near the towns of Gilman and Minturn was best for his purpose because it offered the greatest number of known factors: its lead and zinc deposits were well defined; they were surrounded by an alteration halo some 200 square miles in area; and the geology of the land was well understood.

Dr. Engel first collected rock specimens containing calcite, dolomite, and quartz from the unaltered area around the outside of the halo. He then collected from within the halo, moving in narrowing circles toward its center and finally taking samples from drill cores where the concentration of ores was heaviest.

The next step was to analyze the specimens from the unaltered beds outside the halo to see if they showed any systematic variations in texture, chemical composition, or oxygen isotope composition. They showed no variation in texture or chemical composition, and their oxygen isotope composition was uniform and consistent.

Dr. Engel then analyzed the specimens from the alteration halo. Again he found no variations in their texture or their chemical composition, regardless of their proximity to the central ore deposit.

Analysis for the isotopic composition of these, as well as the first, specimens was made in Caltech's geochemistry laboratories by Drs. Epstein and Clayton, who were already engaged in a research program to determine the variations of oxygen isotope ratios in nature and the effect of geological processes on these variations. The instrument they used for analysis was a special mass spectrometer initially developed at the University of Chicago by Dr. H. C. Urey and a group including Dr. Epstein and Charles R. McKinney, now at Caltech. The spectrometer's precision was such that it could measure, in two million units of ordinary oxygen, the addition or deletion of one unit of O^{18}.

What the mass spectrometer showed was that the ratio of O^{18} to O^{16} in each sample from the alteration halo varied directly with its distance from the ore deposit. Put another way, the oxygen isotope composition of the halo samples depended upon the extent to which they had been permeated and heated at the time of the original ore intrusion.

The analysis of oxygen isotope ratios in the Leadville limestone was the equivalent of having a geochemical thermometer capable of taking temperatures that existed there millions of years ago. According to Dr. Robert P. Sharp, chairman of Caltech's geology division, it should be a valuable tool for investigating the origins of the earth's crust. As for its practical application, that will have to be tested by further experiments in other areas.

"It is quite possible," Dr. Sharp says, "that this variation in oxygen isotope ratios will become extremely important as a means of locating 'hot' spots of rock alteration that may be associated with ore deposits. It could prove to be the basis for one of the most significant contributions to ore prospecting in fifty years."

Small, informal discussion groups were the heart of the conference.

STUDENT-FACULTY CONFERENCE

AT CAMP HESS KRAMER, a few miles north of Malibu, some sixty persons were engaged in a Caltech student-faculty conference. Some of the participants had wandered down to the Coast Highway—to the lone market or to the beach. In the main hall of the camp scattered groups were playing games or singing around the piano.

One undergraduate wandered away from the piano, passed the ping-pong experts on the porch and started back toward the cabins. The youth shuffled along the path and then suddenly paused to look up at clear, bright stars and breathe deeply of cool, fresh air.

It was a good thing to get away from the noise and hilarity for a while and try to organize his thoughts. A myriad of new ideas had come his way today, and if he was going to contribute intelligently to tomorrow's discussions, he would have to straighten out all of these new thoughts and make them fit with his old ones. He could already see that some of the old ones had to be discarded.

His elders had frequently emphasized that his point of view would change. Several different faculty members had said that the late adolescent years tended to breed discouragement, implying that values changed as a person became older.

But he was being urged to base his present actions on some future, hypothetical values. It struck him as nonsense: if a person had different values at different ages, which values are *right*?

He was distracted from this difficult train of thought by the approach of a second youth. After exchanging comments on the tranquility of the evening, they drifted into a discussion of the techniques of the conference. The small, informal discussion groups which were the heart of the conference were proving excellent for bringing forth difficult and touchy problems, and faculty and students had seemed to easily reach a plane of mutual understanding.

"If we can just get across to them," said the first youth, "—if we can just make them realize that we really are dissatisfied, and if we can get them to respect our opinions, then I'll be satisfied, even if the thing doesn't come out with any real improvements at all."

His companion nodded agreement, but soon moved down the path, leaving the philosopher alone with his thoughts. He wondered whether the ideas that seemed good at first would hold up later. Someone had suggested that the ME15 computing period be used in other courses. Computing period was described as a problem-working session in which both the instructor and one's classmates were present to keep one on the right track. The idea still seemed good and he believed that he could imagine it being favorably applied to his junior year physics courses.

He remembered a long discussion about proposed coordination between mathematics and physics in the first two years. Thinking back over his own underclass years, it became apparent that this was not really a major problem, and he was amazed at the time that had been spent on it.

A student view

of the weekend conference held by the

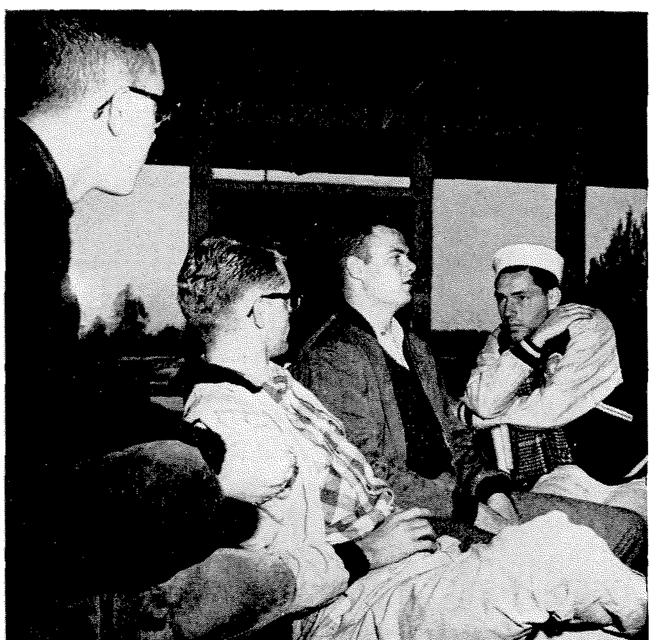
Caltech YMCA, January 18-20

His own group had worried about the dulling effect of "cook book" laboratory routines, and he gloried in the immense significance of this until he remembered that it was partly his own idea, and he was prejudiced.

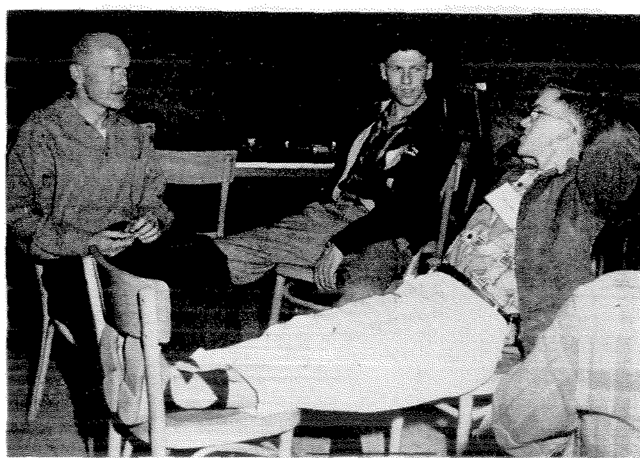
Then it came to him that this was all useless. We are only dealing with surface problems, he thought. Too much time is being spent on topics like academic freedom, which do not matter to a majority of the students. Why don't we try to get to the heart of the problem? What causes bad student morale anyway?

He revolved the problem in his mind, and it began to seem closely related to the general school atmosphere. Many students seemed to feel that Tech had a bad effect on their personality development, and that they did not have an opportunity to express themselves. Are attitudes too narrow? he wondered. Are activities too limited in scope, in effort, in results? Are the faults not in the school officials or in the curriculum, but in the students themselves?

But how could he say that the Admissions Committee was doing a poor job of selecting "the man whose intellectual power is combined with the spark of leadership and human understanding"; how could he say that Techmen tend to be weak-willed and narrow-minded



Student tries to sell pet theory to fellow students



Student tries to sell pet theory to faculty

without damaging his school, his friends, and himself?

Overwhelmed by his own thoughts, he walked purposefully back to the lodge to seek a friend. Together they headed down the road to the beach, and their conversation took a lighter, easier turn.

The market at the bottom of the road doubled as a lunch counter, and a large group of students was delightfully engaged in guessing the age of an intriguing waitress. Students and faculty shuttled in and out, laughing and talking together in a manner that amazed the good-natured proprietor.

These activities were undisturbed by the entrance of the new pair, who joined in for a while and then bought some liquid refreshments to take down to the beach.

A small fire sparkled on the beach, and the newcomers found a noisy, jolly group, boisterously singing college songs, both old and new. They located a place to sit in the cool sand, opened the bag of potato chips, took a few swallows of bubbling liquid, and relaxed. Deeper thoughts were willingly put aside while they joined the warm camaraderie.

It was sometime later that the youth withdrew from the group and wandered down along the sand. In a sudden flash of brightness, he realized that everyone present probably had his own pat explanation for the world's problems, and there was no reason to suppose that his own was any more useful than the others. He saw that the conference would not bring any immediate, far-reaching answers, but he saw, too, that his weekend would give him enough impetus to get through one or two more weeks of school.

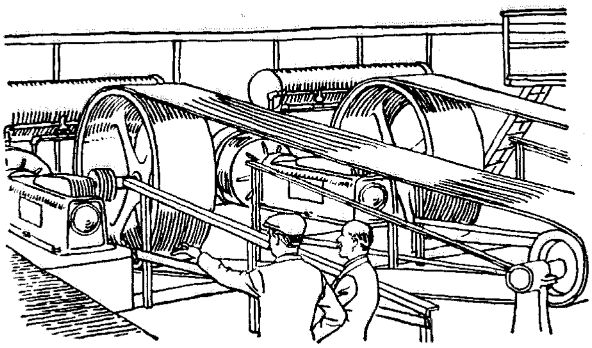
And then he would go home to see his girl, and that should give him enough push to last two more weeks, and by that time the pressure of finals should get him through the term.

And somehow he would finish the remaining year, and when it was all over, the soothing haze of forgetfulness would pass over everything, and he would be glad he had seen it through.

Inspired, he hurried over to speak with his friend. "Let's hit the sack, huh?"

—*Bob Walsh '58*

ONLY 35 YEARS AGO...



oil field compressors featured long belt drives like this...

IN THOSE DAYS, a compressor was one thing and a gas engine was another. When you hooked them together with a long belt you used up most of a large building. The "no-man's-land" between the units was useless — uninhabitable because of the dangerous flying belts.

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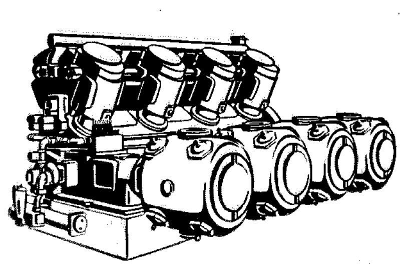

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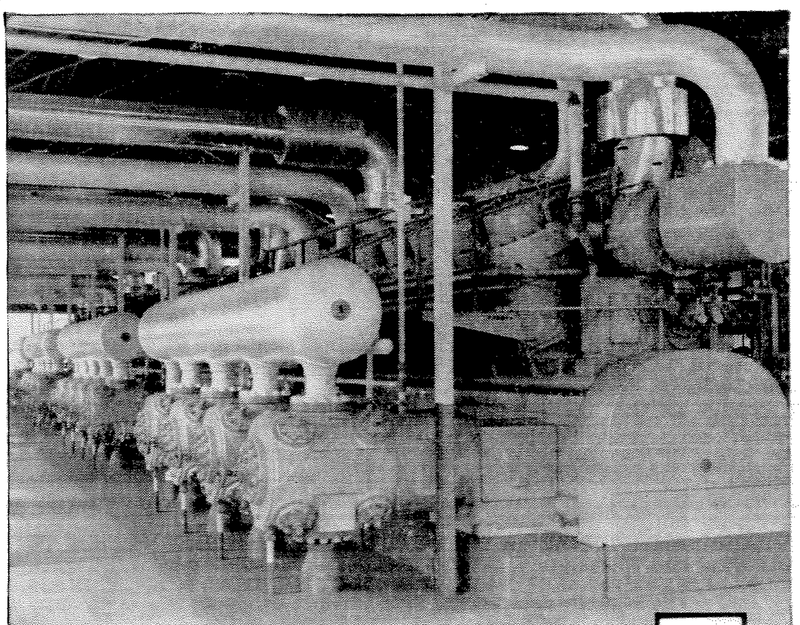

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Left to right: Dan Palmer, Texas A&M, '54; Ted Webb, Caltech, '55; Bob Stancil, Georgia Tech, '54; Chuck Herndon, Illinois, '50.

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THE MONTH AT CALTECH

Leaders of America

J. Robert Oppenheimer, nuclear physicist and chairman of the Princeton Institute for Advanced Study, will come to the Caltech campus on February 28, as the first visitor in this year's Leaders of America program. He will be here until March 5, meeting informally with students and faculty during his stay.

The Leaders of America program, sponsored by the Caltech YMCA, was set up last year to bring outstanding men to the campus to meet with students over a five-day to one-week period. Last year's visitors included Paul G. Hoffman, board chairman of the Studebaker Packard Corporation; Supreme Court Justice William O. Douglas; and Dr. Ralph Bunche, Under Secretary General of the United Nations.

Gifts and Grants

Albert B. Ruddock, chairman of the Caltech Board of Trustees, reports that the Institute received $2,758,900 in gifts and grants during the six months ending December 31, 1956. Of the total amount, $1,039,000 was for endowment, $1,596,500 was for current operations, and $123,400 for plant and building purposes. All told, there were 130 donors, including corporations, foundations, individuals, and government agencies.

Major gifts added to the principal of the endowment fund were $525,000 from the Ford Foundation for faculty salary increases, and $500,000 from the Rockefeller Foundation for research in chemical biology. Major additions to plant and building funds were $75,000 from the Kresge Foundation, for expansion of the Seismological Laboratory, and $28,000 from the Carl F. Braun Estate for chemical biology laboratory facilities.

Of the gifts for current operations, more than $250,000 came to the Institute as "unrestricted money," to be used at the discretion of the administration and trustees. The largest bloc of such funds, $184,135, was given by Caltech's Industrial Associates. Including the Industrial Associates, 59 business corporations gave the Institute a total of $526,000 in the half-year period.

Geophysics Award

Dr. Beno Gutenberg, professor of geophysics and director of Caltech's Seismological laboratory, was recently awarded the Emil Wiechert Medal of the German Geophysical Association, in appreciation of his accomplishments in seismology and in the investigation of the earth's structure.

This is the second award of the medal, which was established in 1955, for outstanding accomplishment in geophysics. Dr. Gutenberg's contributions to geophysics include investigations of the structure of the earth and its core, seismic waves, the structural differences between continents and ocean bottoms, and the magnitude of earthquake shocks.

Trustees

Earle M. Jorgensen, Los Angeles industrialist, was elected a member of the Caltech Board of Trustees last month. At the same time, Shannon Crandall, Jr. of Pasadena was named vice president of the board.

Mr. Jorgensen is president and general manager of the Earle M. Jorgensen Company, one of the leading steel distributors of the country, and board chairman of the Baker Steel and Tube Company. He is also a director of the Citizens National Trust and Savings Bank of Los Angeles and of the Northrop Aircraft Company.

Active in civic affairs, Mr. Jorgensen is a director of the Los Angeles Chamber of Commerce, the Los

CONTINUED ON PAGE 36

Careers Grow—Through Science

FROM THE ELEMENTS OF NATURE—a limitless frontier—scientists develop new products and processes that benefit everyone. To the college graduate, these new things mean career opportunities that did not exist before.

The scientists of Union Carbide have introduced an average of one new product per month for over 25 years. They are now introducing them at the rate of two a month.

Today, more than one-third of the work of the people of Union Carbide all over the country is in providing products and processes that did not exist in commercial quantities 15 years ago.

Nearly 3,000 scientists, in 23 Union Carbide laboratories, devote full time to research.

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No blue sky...just to back up our belief that you and Collins

We're going to build a proposition which we believe deserves your most serious consideration, if you are a mechanical or electrical engineer. This proposition is built on pure and simple fact—no high flown promises or broad generalities. Our proposition: you and Collins should get together. We present these facts to support it.

FACT NUMBER 1:
Collins Radio Company's sales have increased 10 fold in each of three successive seven year periods. 1933 sales were \$100,000; 1940 sales, \$1,000,000; 1947 sales, \$10,000,000; 1954 sales, \$100,000,000, and 1956 sales, \$126,000,000. (Note graph.) This company *has grown, and is growing* at a phenomenal rate. Total employment is 9,000 of which 24% are research and development personnel.
You grow when the company you work for grows.

FACT NUMBER 2:
As shown in the graph at right, the employment of research and development personnel has increased steadily despite fluctuation in sales. Notice that even during periods of national sales regression Collins continued to strengthen its engineering staff.
Collins has based its growth on the solid foundation of stability in the engineering department.

FACT NUMBER 3:
At Collins, the ratio of engineers to total employees is extremely high, far higher than the average among established companies engaged in both development and production. First and foremost, Collins is an engineering company.
Engineering is king at Collins—never takes a back seat to production expediency.

FACT NUMBER 4:
Collins' reputation for quality of product is universally recognized. It has led to Collins' phenomenal sales record. At Collins there is no compromise when quality is at stake.
If you're the man we want, you'll get real satisfaction out of this quality-consciousness.

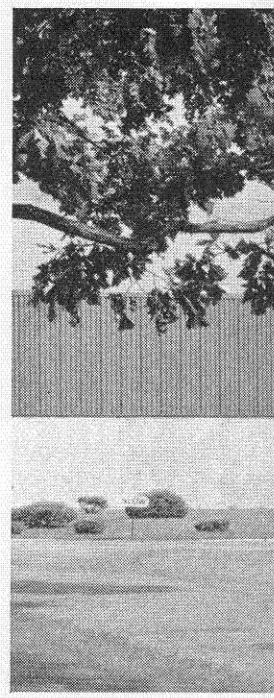
FACT NUMBER 5:
Electronics is Collins' only interest. In no way is it subsidiary to the manufacture of industrial or consumer products. Collins builds electronic equipment, not airplanes or vacuum cleaners. Every research, development and production facility is devoted to progress in electronics.
If electronics is your interest, you'll like the climate at Collins.

FACT NUMBER 6:
There is a limitless variety of fields and types of work for the Collins engineer. Recent Collins work in air and ground communication, and aviation electronics include developments in transhorizon "scatter" propagation; single sideband; microwave and multiplex systems; aircraft proximity warning indicator; aviation navigation, communication and flight control; broadcast; and amateur equipment.

There is big opportunity for your special talents.

Right now we are prepared to offer you a technical or supervisory assignment in one of many interesting fields. And the sky *is* the limit as far as responsibility and salary are concerned.

You will work in one of Collins' new research and development laboratories located at Cedar Rapids, Iowa; Dallas, Texas; and Burbank, California. Offices and subsidiary companies are located in New York; Washington, D. C.; Miami; Knoxville; Seattle; Hickman Mills, Missouri; Toronto, Canada; London, England; and South America. All your moving expenses are paid. Company benefits are tops in the industry.



We repeat—if you are a mechanical or electrical engineer, you and Collins should get together. Take the first step now, for more information, write:

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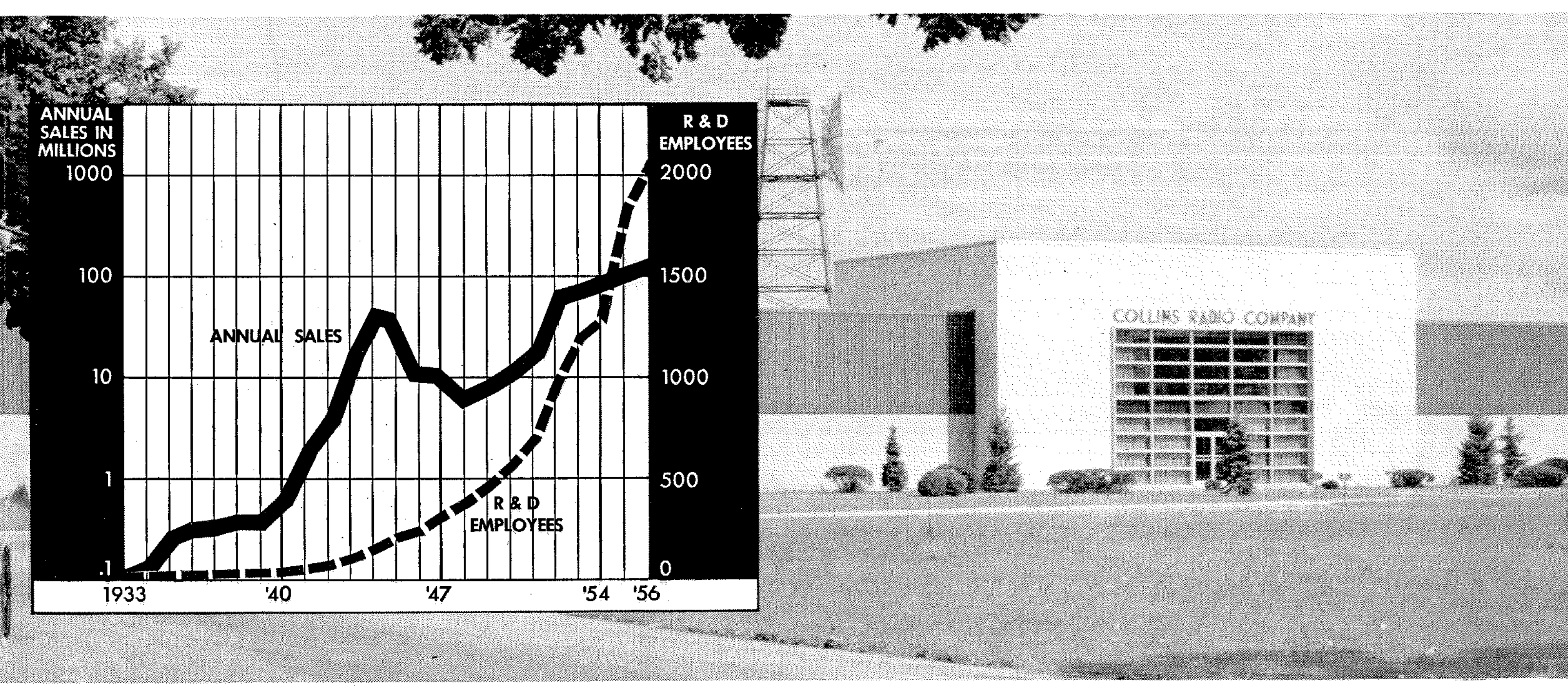
Collins Radio Co.	Collins Radio Co.	Collins Radio Co.
Cedar Rapids,	2700 W. Olive Ave.	1930 Hi-Line Drive
Iowa	Burbank, California	Dallas, Texas

black and white facts should get together



This graph shows the relationship between sales and employment of engineering personnel at Collins. Notice the steady increase in research and development employment despite sales fluctuations.

Collins new research laboratory building at Cedar Rapids, Iowa. Air-conditioned, shielded against radio waves, completely equipped.

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Angeles Area Building Funds, Inc. and the National Conference of Christians and Jews. He is currently vice chairman and a member of the executive committee of the Los Angeles Chapter of the American National Red Cross.

In the educational field, Mr. Jorgensen serves as a director of the California Institute Associates, as a trustee of Occidental College, and as a director of the Flintridge School for Boys. He is a life member of the Pomona College Associates and a member of the Claremont Men's College Affiliates.

A native of San Francisco, Mr. Jorgensen served in the Tank Corps in World War I, his commanding officer being Lt. Col. Dwight D. Eisenhower.

Mr. Crandall is president of the California Hardware Company of Los Angeles, with which he has been associated since his graduation from Stanford University in 1924. He is also a director of the Pacific Mutual Life Insurance Company, and of the Security First National Bank of Los Angeles.

He has been a member of the Caltech Board of Trustees since January, 1955, and was president of the California Institute Associates from January, 1954, to January, 1956.

Also prominent in community affairs, Mr. Crandall is president of the Children's Hospital Society and vice president of the Barlow Sanitarium. He is a director of the Community Chest, the University Religious Conference and the Los Angeles Area Building Funds, Inc. He is chairman of the Board of the American Library of Information.

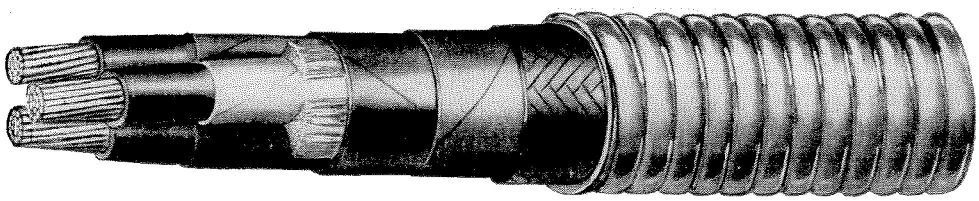
A commander in the U. S. Navy during World War II, Mr. Crandall served as director of procurement for the Aviation Supply Office in Philadelphia.

Franklin Award

Dr. Arnold O. Beckman, a member of the Caltech Board of Trustees and president of the Los Angeles Chamber of Commerce, was presented the 1957 Benjamin Franklin Award last month by the southern California printing industry, "for exemplifying the spirit of Franklin as a scientist, educator, industrialist and community leader."

Dr. Beckman received his PhD from Caltech in 1928, taught chemistry here until 1940, when he went into business for himself, manufacturing scientific instruments. He is now president of Beckman Instruments, Inc., its scientific division in Berkeley, and a subsidiary, the Helipot Corp. He is also president of Arnold O. Beckman, Inc.

CRESCENT INTERLOCKED ARMOR POWER CABLE



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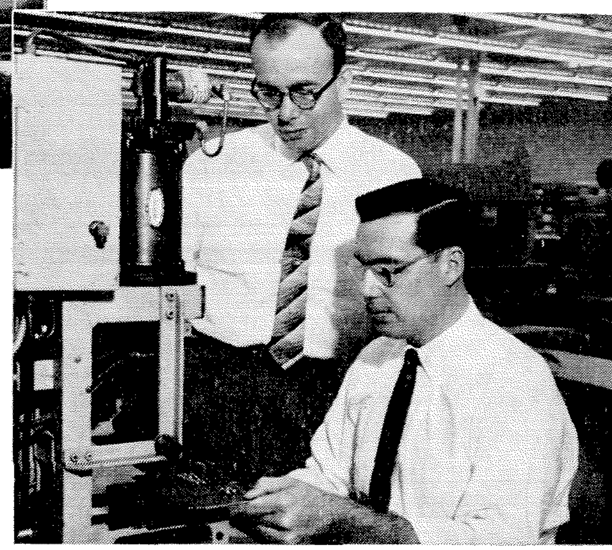
OVER 70 YEARS EXPERIENCE

Meet Bill Hancock

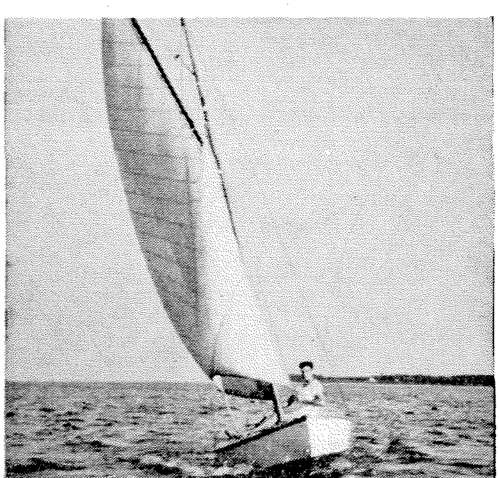
Western Electric development engineer

Bill Hancock is a graduate of Pennsylvania State University where he majored in industrial engineering. Bill joined Western Electric as a planning engineer in November, 1951, at the Kearny Works in New Jersey. Later, he was assigned to the new Merrimack Valley Works in North Andover, Massachusetts, as a development engineer. Here Bill is shown leaving his attractive New England home for his office while his wife, Barbara, and their daughter, Blair, watch.

Bill's present assignment at Western Electric: the development of methods and machinery for assembling one of today's most promising electronic developments—electronic "packages" involving printed wiring. At a product review conference Bill (standing) discusses his ideas on printed wiring assemblies with fellow engineers.



Bill and his supervisor, John Souter, test a machine they developed to insert components of different shapes and sizes into printed wiring boards. The small electronic packages prepared by this machine are being used in a new transistorized carrier system for rural telephone lines.



Sailing off the north shore of Massachusetts is one of Bill's favorite sports. He also enjoys the golf courses and ski runs within an easy drive from where he lives and works.

Engineers: Western Electric offers you a wide variety of interesting, *creative* opportunities. It makes no difference what your field of specialization is. You can fit—now—into our operation as the manufacturing and supply unit of the Bell System ... or into our defense job. A free booklet—"Your Opportunity at Western Electric"—outlines company operations and specific job opportunities in detail. Send for it. Write to: College Relations Department, Room 1030, Western Electric Company, 195 Broadway, New York 7, N. Y.

Western Electric

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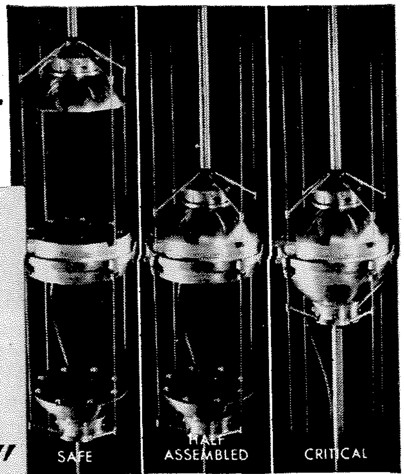

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OF THE UNIVERSITY OF CALIFORNIA
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Answers to

A CALTECH QUIZ

(page 24)

1. This character decorates one of the pillars at the front entrance to Throop Hall; camera pointing east.

2. You are in Dabney Garden, behind the Humanities building, facing west.

3. This decoration (it's a plane) is beside the main (north) entrance of the Guggenheim Aeronautical Laboratory.

4. You are looking north, coming on to the campus from California Street. The High Voltage Lab is on the right.

5. You are looking northeast from the arch between the Synchrotron and the Central Shop. That's the side wall of the Synchrotron building in the background.

6. This decoration is on the north wall of the library annex of Kerckhoff (so close to the top of the building that Dr. Beadle had to photograph it by hanging from the roof on a rappel rope).

7. You are looking north, between East Bridge and the High Voltage Laboratory.

8. This is the Blacker House courtyard; camera pointing northwest.

9. The courtyard in front of the Astrophysics building. You are facing southwest, and the doorway is the east entrance to Mudd.

10. You are in the alley on the east side of Throop, facing south.

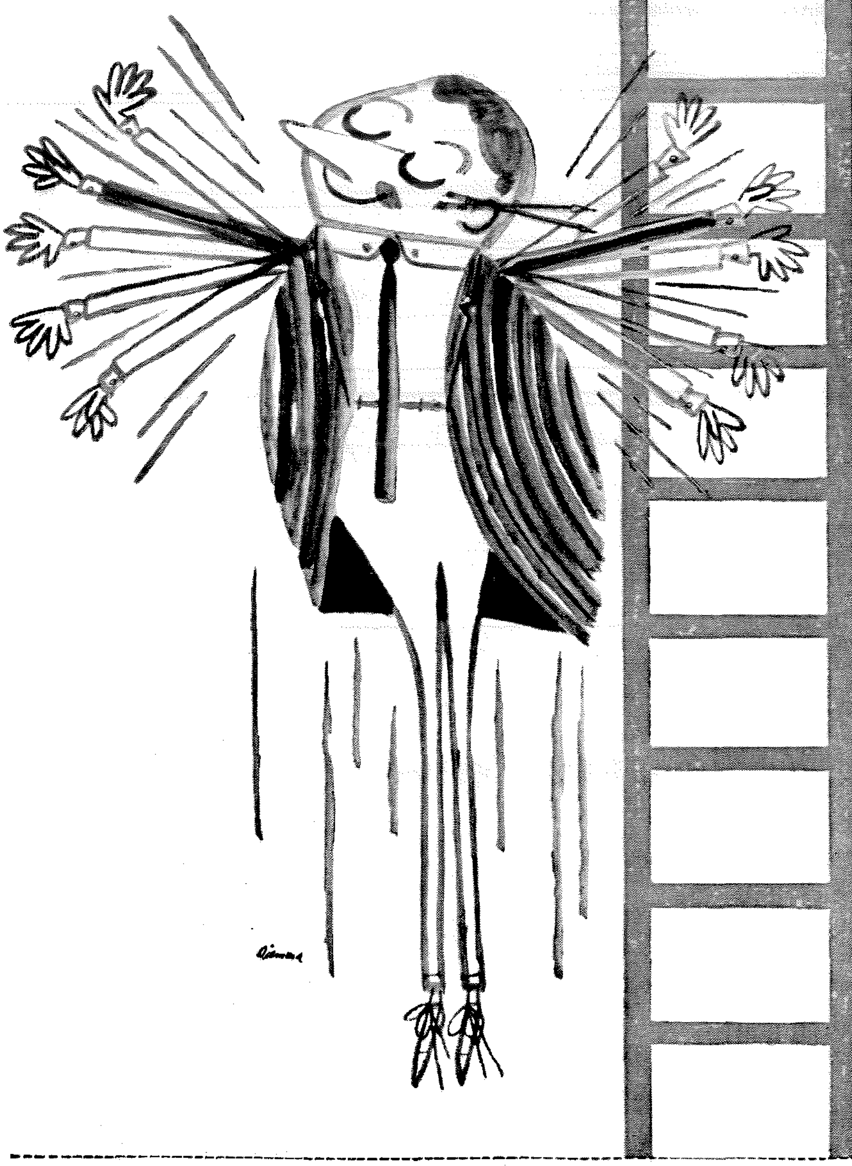
11. Ricketts House courtyard, looking north and a little to the east.

12. Just testing. This is the Pasadena City Hall. Off-campus.

13. This decoration is on the south side of Kerckhoff; it's a conventionalized evening primrose (oenothera to geneticists, who have used it to study mutations).

How to make the most
of your engineering career
ONE OF A SERIES

go where an engineer can rise to the top



In many companies, an engineer rises, but soon encounters a low ceiling. Promotions tend to go to non-engineering executives. And engineers (surveys show) find it difficult to make their ideas understood—or appreciated.

So select a company in which you'll be working with, and for, engineers—where an engineer is given an opportunity to advance when positions ahead open up.

Another point: choose a company that's growing, preferably in an *industry* that's growing and expanding too.

Boeing, you'll discover, fills the bill on all counts. Engineers at Boeing hold jobs right to the top. They talk your language. They appreciate the vital contributions engineers make. And they reward *engineers.* Boeing is growing fast, and today employs 400% more engineers than 10 years ago. Besides, Boeing operates in the dynamic, fast-growing field of aviation.

At Boeing you'll enjoy assignments that lead to an excitement-filled future. A future with a *future:* in supersonic flight, jet-powered civil and military aircraft, gas turbine engines, guided missiles. At Boeing, engineers and scientists of *all* types, and advanced mathematicians, are probing the very frontiers of knowledge. They invite you to join them. You'll find high salaries, career stability, retirement programs, and company-financed opportunities for graduate study. And you'll live in wide-awake, young-spirited communities.

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Vacuum melting has opened up new horizons for development of alloys. Here, a Pratt & Whitney Aircraft metallurgist is shown as he supervises preparation of an experimental high-strength nickel-base alloy, melted and cast under high vacuum.

Induction melted heat of high-temperature alloy being poured in P & W A's experimental foundry. Molten metal is strained into large water tank, forming metal shot which is remelted and cast into test specimens and experimental parts. Development and *evaluation of improved high-temperature alloys for advanced jet engines is one of the challenges facing metallurgists at P & W A.*

at Pratt & Whitney Aircraft in the field of Materials Engineering

The development of more advanced, far more powerful aircraft engines depends to a high degree on the development of new and improved materials and methods of processing them. Such materials and methods, of course, are particularly important in the nuclear field.

At Pratt & Whitney Aircraft, the physical, metallurgical, chemical and mechanical properties of each new material are studied in minute detail, compared with properties of known materials, then carefully analyzed and evaluated according to their potential usefulness in aircraft engine application.

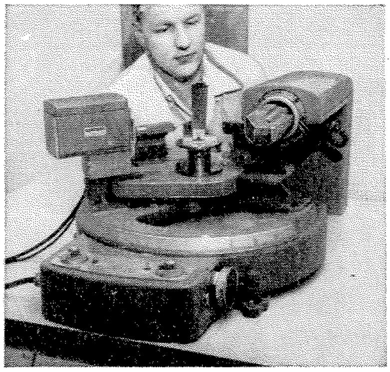
The nuclear physics of reactor materials as well as penetration and effects of radiation on matter are important aspects of the nuclear reactor program now under way at P & W A. Stress analysis by strain gage and X-ray diffraction is another notable phase of investigation.

In the metallurgical field, materials work involves studies of corrosion resistance, high-temperature mechanical and physical properties of metals and alloys, and fabrication techniques.

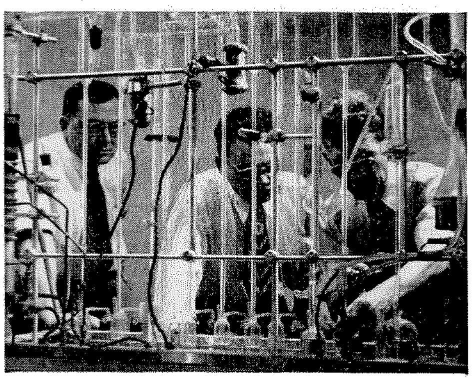
Mechanical-testing work delves into design and supervision of test equipment to evaluate fatigue, wear, and elevated-temperature strength of materials. It also involves determination of the influence of part design on these properties.

In the field of chemistry, investigations are made of fuels, high-temperature lubricants, elastomeric compounds, electro-chemical and organic coatings. Inorganic substances, too, must be prepared and their properties determined.

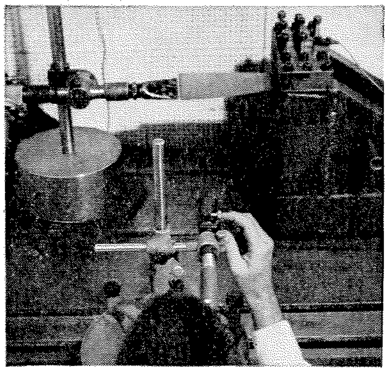
While materials engineering assignments, themselves, involve different types of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of mechanical design, aerodynamics, combustion and instrumentation — spells out a gratifying future for many of today's engineering students.



Engineer measures residual stress in a compressor blade non-destructively, using X-ray diffraction. Stress analysis plays important part in developing advanced aircraft engine designs.



The important effects of gases on the properties of metals have been increasingly recognized. Pratt & Whitney chemists are shown setting up apparatus to determine gas content of materials such as titanium alloys.



P & W A engineer uses air jet to vibrate compressor blade at its natural frequency, measuring amplitude with a cathetometer. Similar fatigue tests use electromagnetic excitation.

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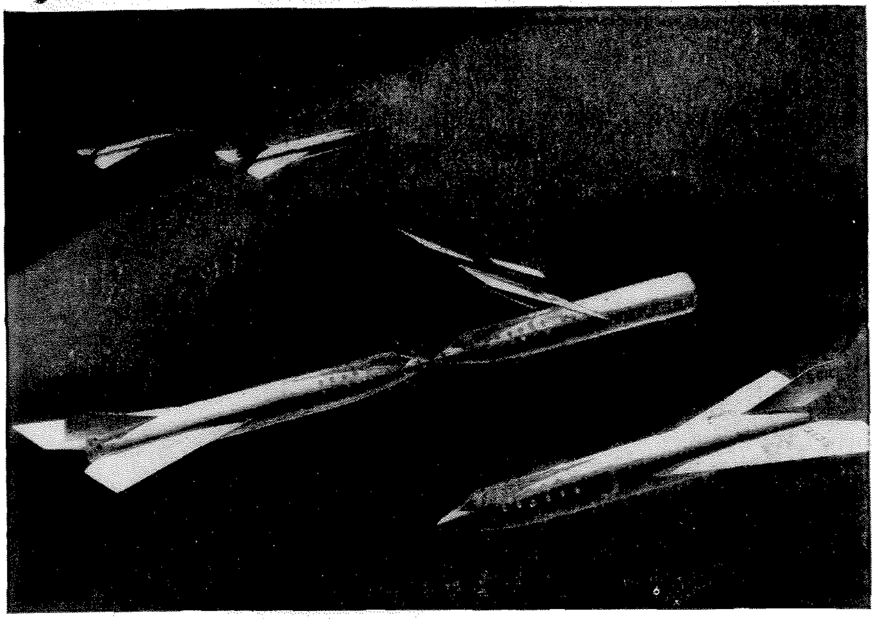


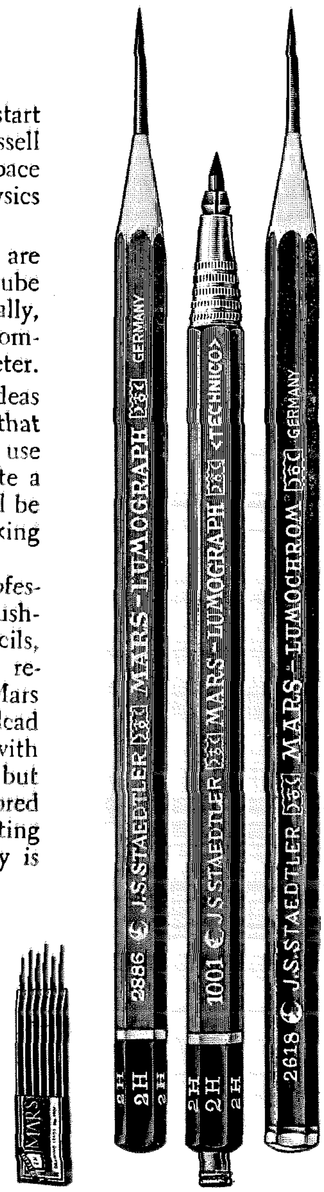
birth of a satellite

Most new ideas, like this inhabited satellite, start out as drawings on a sheet of paper. Here artist Russell Lehmann shows the first step in building the space station proposed by Darrell C. Romick, aerophysics engineer at Goodyear Aircraft.

Two ferry ships, one stripped of rocket units, are joined end to end. As others are added, this long tube forms temporary living quarters for crews. Eventually, outer shell will be built around core, making completed station 3,000 feet long, 1,500 feet in diameter.

No one can be sure which of today's bright ideas will become reality tomorrow. But it is certain that in the future, as today, it will be important to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars — from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored drafting pencil, 24 colors.

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PERSONALS

1920

James R. Black, general traffic manager of the Pacific Telephone and Telegraph Company in southern California, died on December 20, after a long illness. He was 58 years old. A native Pasadenan, Jim had been with the telephone company since 1920, and had held such positions as traffic chief, district traffic superintendent, and division traffic manager before being named general traffic manager in 1941. He was president of the Caltech Alumni Association in 1934-35. Jim is survived by his wife, Georgenia; two sons, James and Stuart; and four grandchildren.

E. Victor Housell, senior engineer in the plant department of the Pacific Telephone and Telegraph Company in Los Angeles, completed 35 years of service with the company last month. *Mark A. Sawyer* also chalks up 35 years with Pacific Telephone this month; he's a protection engineer in the engineering department.

1921

Alfred J. Stamm, subject matter specialist in chemistry at the U. S. Forest Products Laboratory in Madison, Wisconsin, has just returned from a trip around the world with his wife, two daughters and a son. Al took a leave of absence to accept a senior Fulbright research award at the Australian Forest Products Laboratory in Melbourne.

Edward D. Seaver is now vice president and chief engineer of Summerbell Roof Structures in Los Angeles.

1926

Jen-Chieh Huang is vice president of the Taiwan Sugar Corporation in Taipei, Taiwan, China.

1928

Richard G. Folsom, MS '29, PhD '32, is director of the engineering research institute of the University of Michigan in Ann Arbor. He was formerly chairman of the department of mechanical engineering at UC in Berkeley.

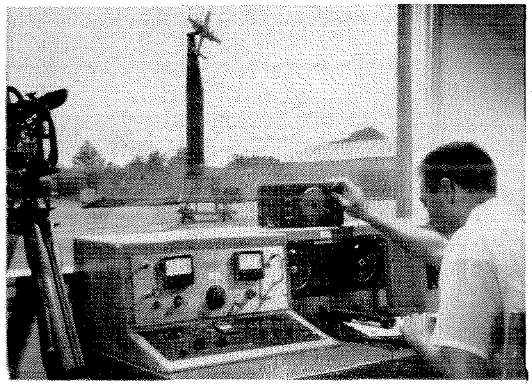
Ralph Waldo Cutler, MS '29, has gone into business for himself as a consulting structural and mechanical engineer in South Pasadena. He was formerly a partner in the Vernon Construction Company.

1929

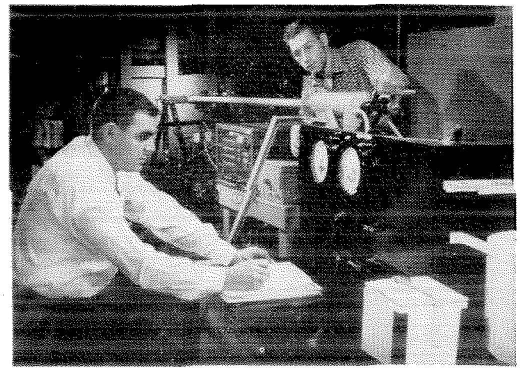
Ernest B. Hugg, MS '30, was recently appointed assistant director of the Physical Plant department (formerly known as Buildings and Grounds) at Caltech.

1931

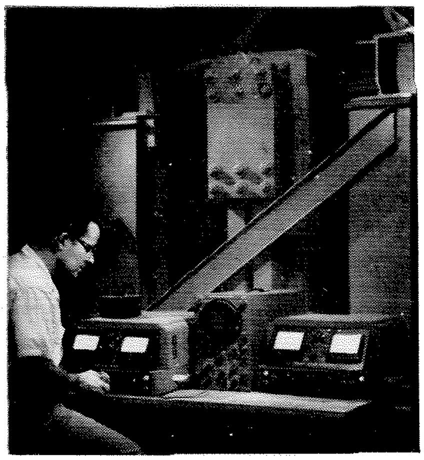
George F. Wislicenus, MS, PhD '34, is now director of the ordnance research lab at Pennsylvania State University in Uni-



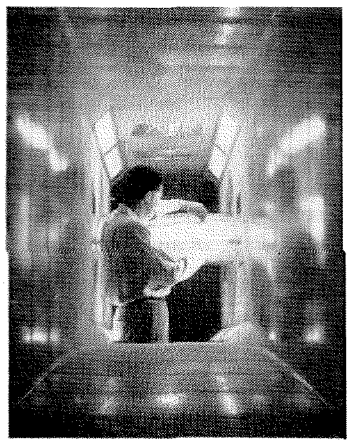
Electronics Research Engineer Irving Alne records radiation antenna pattern on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space. Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.



Mechanical Research Engineer W. M. Watkins (left) directs Research Mechanic Earl Rollo in operating Lockheed's new Hailstone Gun during a test on the effect of hailstones on new types of plastic radome "skin." The gun, which was designed by Watkins and Mechanisms Group Engineer G. W. Louthan, fires up to five hailstones spaced 25 feet apart at speeds ranging from 270 to 500 mph. The hailstones, which are made in the gun, can be varied in size from ⅜″ in diameter.



Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.



C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Master's Degree Work-Study Program

The program enables graduates in Engineering, Mathematics and Physics to attain a Master's Degree at the University of California at Los Angeles or University of Southern California while gaining important practical experience on the engineering staff of Lockheed Aircraft Corporation in Burbank, California.

Additional information may be obtained from your Placement Officer or Dean of the Engineering School or by writing E. W. Des Lauriers, Employment Manager and Chairman of the Master's Degree Work-Study Program.

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes—and better careers.

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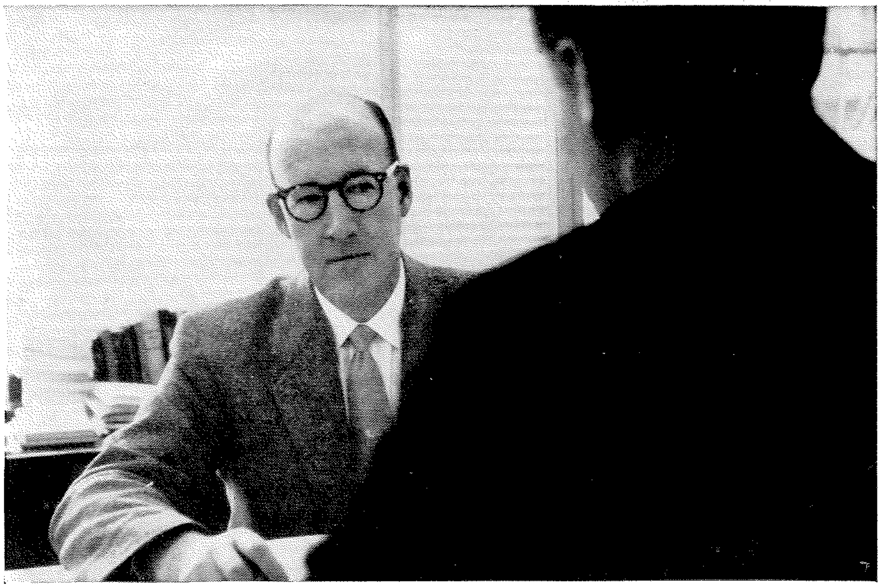
CAREERS WITH BECHTEL



KIRBY SCHLEGEL, *Supervising Engineer, Refinery Division*

STRUCTURAL ENGINEERING

One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.

QUESTION: *Mr. Schlegel, your group is a service group, isn't it? In other words, you do structural work on all jobs handled by the Refinery Division?*

SCHLEGEL: That's right. Our group is composed of about half graduate engineers and half non-technical draftsmen.

QUESTION: *What the young structural engineer considering a job likes to know first of all is how he would start out—what his duties would include.*

SCHLEGEL: Well, drawings are what might be called the "end product" of our department. New graduate engineers are almost invariably put on the drawing board.

They must learn to put their ideas on paper, and the only way they can learn is by doing such work.

QUESTION: *This is really the beginning of design work?*

SCHLEGEL: Yes. It is the way the man begins learning how to become a practicing engineer—something no college can teach him.

QUESTION: *You said you employ a number of non-technical draftsmen.*

SCHLEGEL: That's right. There is a great amount of routine and detail they can handle, thereby freeing the engineer for creative design effort.

QUESTION: *How long a period will the new engineer spend making drawings?*

SCHLEGEL: Ordinarily about a year—sometimes more, sometimes less, depending on his aptitude and how he applies himself.

QUESTION: *When he does advance, what will he be doing?*

SCHLEGEL: He moves on to simple design work, then progresses to heavier design assignments. Group supervision follows.

QUESTION: *Do job applicants sometimes hesitate about starting on the drawing board?*

SCHLEGEL: Not very often. Most of them realize that a degree and theory are just tools. They must learn how to use these tools in practical engineering work. In other words, the only way a man can translate his knowledge into something practical is on the drawing board where he can exercise his creativity and bring his ideas into being.

Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering —Mechanical...Electrical...Structural ...Chemical...Hydraulic.

Write for new brochures showing the wide variety of projects Bechtel builds throughout the world.

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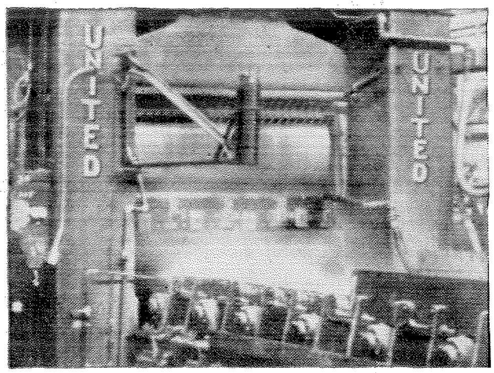
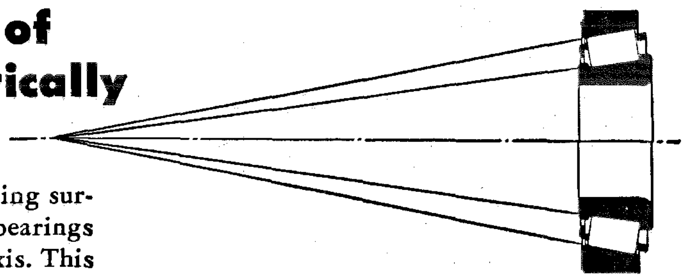
Another page for **YOUR BEARING NOTEBOOK**

How to break records rolling plate



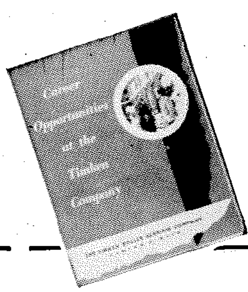
High steel plate production calls for high rolling mill speeds. And this means friction must be reduced to the minimum, so that roll acceleration will be easy. Low friction minimizes skidding and scuffing between rolls to maintain gauge. Engineers who designed this huge, continuous plate mill met the problems by specifying Timken tapered roller bearings for the work rolls and back-up rolls. Result: The mill has set new production records. Since their installation, Timken bearings have rolled over 9 million tons of steel.

True rolling motion of TIMKEN® bearings practically eliminates friction



All lines drawn coincident with the working surfaces of the rollers and races of Timken bearings meet at a common point on the bearing axis. This means Timken bearings are designed according to geometrical law to have *true rolling motion.* And they're manufactured with microscopic accuracy to live up to their design. Result: Timken bearings virtually eliminate friction, give longer bearing life, keep equipment rolling smoothly.

Want to learn more about bearings or job opportunities?



Many 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 "Career Opportunities at the Timken Company". The Timken Roller Bearing Company, Canton 6, Ohio.

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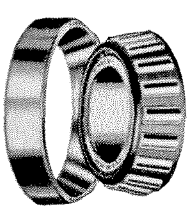
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

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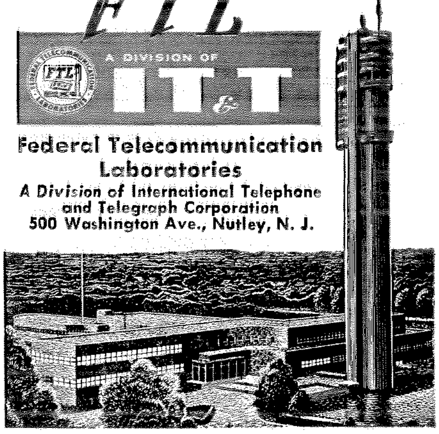


East Coast Laboratory and Microwave Tower

versity Park. He's also serving as secretary of the American Society of Mechanical Engineers.

1932

Joseph Sheffet, MS '33, has been elected 1957 vice president of the Structural Engineers Association of Southern California. He has his own business as a structural engineer in Pasadena.

1933

Jack Sparling was installed as a director of the Structural Engineers Association of Southern California at their January 2 meeting in Los Angeles. Jack is vice president and chief engineer of Quinton Engineers, Ltd., in Los Angeles.

1935

Rear Admiral James S. Russell, MS, writes from Washington, D.C., that he will be completing his second year as chief of the Navy's Bureau of Aeronautics in March. "Although one gets appointed and sworn in for four years," says Jim, "a relief during the third year is usual. I am enjoying this excursion into big business with its engineering, administration, and high finance, but 'tis a pleasant day when a seaman can return to the sea."

Jesse E. Hobson, PhD, has been named vice president of the United Fruit Company of Boston and New York. He had been director of the Stanford Research Institute in Menlo Park, California, for eight years prior to his resignation early in 1956. The Hobsons will now make their home in Boston.

1936

Chauncey W. Watt, Jr., came back to California last June to work as a product engineering supervisor at Consolidated Electrodynamics Corporation in Pasadena. For the past 14 years Chan has been in Massachusetts, working for MIT in the digital computer lab and the Lincoln Labs. He married a Boston girl and they have a 10-year-old daughter, Kathie.

1937

James W. Daily, MS, PhD '45, professor of hydraulics at MIT, is now a senior member of the American Society of Mechanical Engineers.

Noel R. Park is working as a geophysicist for the Standard Oil Company in Midland, Texas.

1938

Roger H. Cowie reports that he is "working for the Shell Oil Company in New Orleans as a marine geologist, supervising exploration geological work in the Gulf of Mexico, off the Louisiana coast. I now have five children—all little demons: George, 14, was born in Wewoka, Oklahoma; Alison, 12, was born in (of all places) Pasadena, California; John and Victoria, 8, were born at Waynesville, Missouri; and Steve, 2, arrived in Houston, Texas."

Gardner P. Wilson recently joined the ElectroData Division of the Burroughs Corporation in Pasadena as manager of the western engineering branch, which works on the development and design of large electronic computers. The Wilsons live in Pasadena and have two daughters, 12 and 10.

1939

Arthur J. Stosick, PhD, formerly division chief of the rockets and material division of Caltech Jet Propulsion Laboratory, is now assistant to the director of the new Union Carbide Research Institute which will be located near Tarrytown, New York. Facilities for the new Institute, which will be devoted to basic research, should be completed by the spring of 1958.

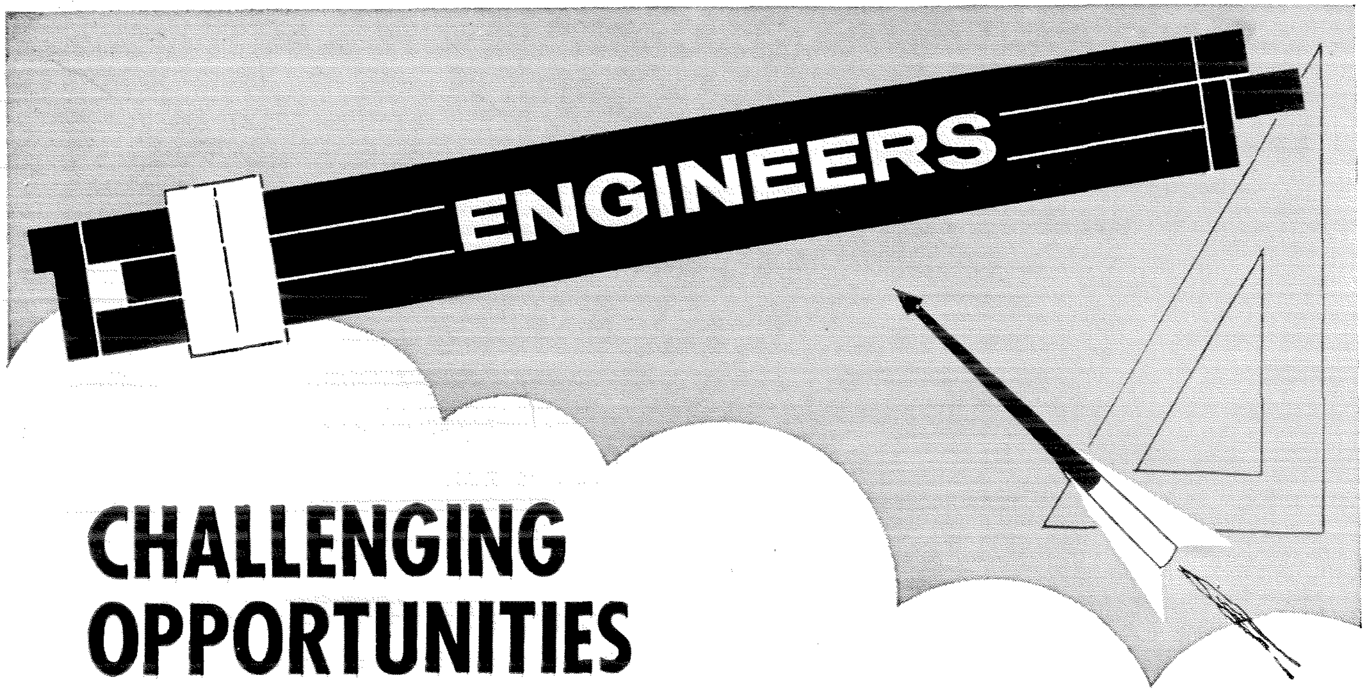
1941

Jerry A. Jones is now manager of the chemical and metallurgical research laboratory of the Lockheed Aircraft Corporation's Georgia division in Marietta. Except for two years of duty in the Navy, Jerry has been with Lockheed since 1951. The Jones' have three children and are living in Atlanta, Georgia.

Joseph W. Trindle, MS '49, ("PhD frustrated by Smythe"), has been a North African missionary for the past six years. He writes: "During our very recent sick leave to the States, I wasn't unaware of the temptation to get one of the engineering jobs which were so plentifully advertised. ('Just think! If you get a decent job, you can send out *four* missionaries,' was the way one member of my family put it to me), but both my wife and I are very happy to be back in Morocco.

"When our freighter put in to Casablanca, we were greeted by the Port Engineer, who had known me during the war. He and his wife gave us the keys to the city for two days. We heard from them that Radio Cairo is continuing to inflame the Moors against the French, despite the insistence of the new Sultan that the French are welcome citizens of the new Morocco. There are ten to fifteen thousand Moorish troops closing in on the southern city of Agadir who have defied the authority of their Sultan, and are looting the countryside to obtain their sustenance. Europeans are having to evacuate.

"There is also a general slowdown strike whereby factories are being forced to shut. To cite an example, a Simmons Mattress factory in Casablanca, which formerly made over eighty mattresses a day, is now producing seventeen. The



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manager pleads with the workers, showing how the factory will be forced to close and they will be jobless; but they prefer to listen to Cairo. And so Morocco, with every resource for a lively industrial life, is returning to the poverty it knew before the French came.

"These are some of the conditions which make us happy to be back, believe it or not; for such human dilemmas can never be solved by human resources, however great; whereas the gospel of Christ is always the very power of God and alone can save. Our work will not be without its danger, for the Koran specifies that apostates from Islam should die; and in their zeal to kill our converts, it is quite understandable how fanatics would seek to kill us also."

1943

Charles P. Strickland, Jr., has been named industrial sales manager of the southwest district for the York Corporation, a subsidiary of the Borg-Warner Corporation. With headquarters in Houston, Texas, he will be responsible for the sale of York industrial air conditioning and refrigeration products in Louisiana, Texas, and parts of Alabama, Mississippi and New Mexico. The Stricklands have a new daughter, Charlene, who is just four months old. Their other children are Anita, 10, and Frederick, 1½.

Capt. William E. Sweeney, MS, AeE, director of electronics in the Navy's Bureau of Aeronautics, writes that since they combined the departments of Armament, Aircraft Navigation and Electronics last August, he now has a new title—director of Avionics. Bill got a second MS—this one in business administration—from George Washington University in Washington, D.C., last June.

1944

George G. Shor, Jr., MS '48, will be back in La Jolla in February. He writes: "During the last year, I've moved around. In the summer, I led a two-ship oceanographic and geophysical trip to the Aleutians and the Hawaiian Islands; I expect to go on another next summer. Immediately after this, I attended the International Geological Congress at Mexico City, along with other Caltech staff members and alumni. Among those who had come the farthest was *Joe Alexander*, MS '50, who is with the British Colonial Geological survey at Batu Gajah, Malaya. He reported that he had his PhD from the University of London, and, since leaving Caltech, he has acquired a wife, teenage stepdaughter, and an infant son, and is finding field work at Malaya a good deal safer than it was when he was there in 1948.

"In October I came to Woods Hole Oceanographic Institution for a four-month exchange visit, bringing my wife and children—Sandy, 5, and Lyn, 1½—with me. New England weather has confirmed in all of us a great love for California. We came east a family of four—and will return a family of five, including a small Yankee named Donald Williston Shor, who arrived on December 15.

"All this traveling is for the Scripps Institution of Oceanography at La Jolla."

1946

Andrew Berrien Campbell, engineering supervisor of the Hillman-Kelly Company in Los Angeles, will be married to Miss Verenice Mills of San Francisco, on St. Valentine's Day, in San Gabriel, California.

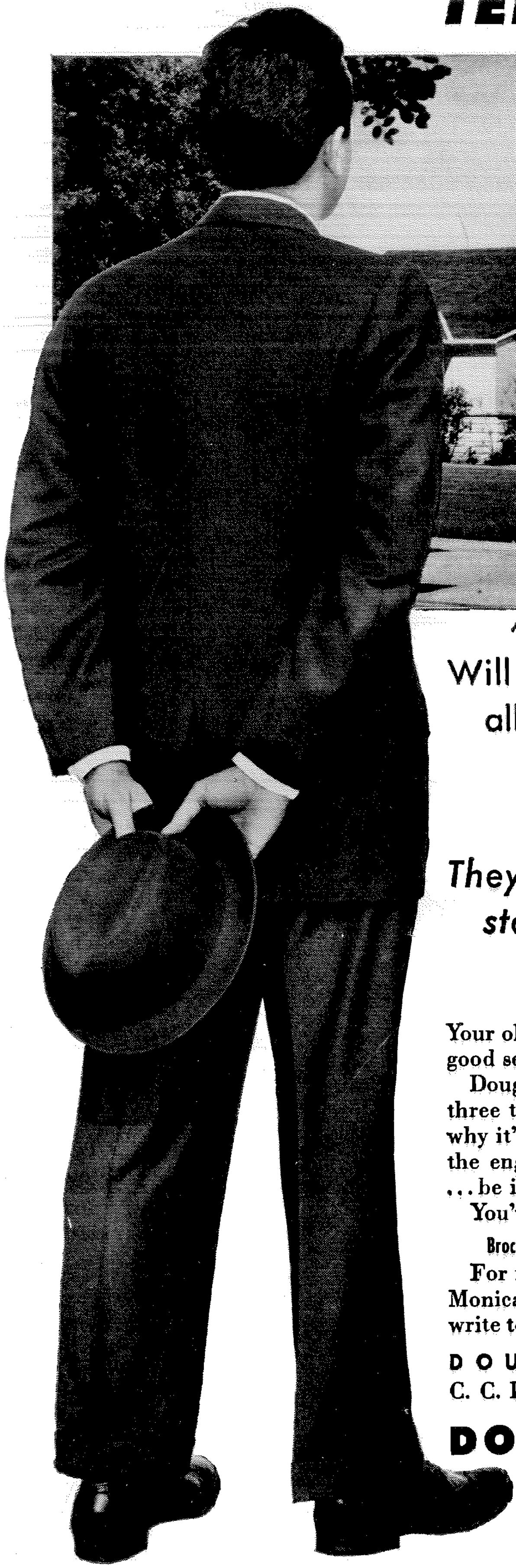
Comdr. Robert J. Trauger, U.S.N., MS, is now a student at the Industrial College of the Armed Forces at Fort McNair in Washington, D.C. Previously he headed the Patrol Plane Design Branch in the Navy's Bureau of Aeronautics in Washington. He's hoping his next tour of duty will be in California.

Richard A. Fayram, MS, senior research engineer at Aerojet-General Nucleonics in San Ramon, California, died of heart complications following a case of chicken pox, on Christmas morning, at his home in Orinda, California. He had been a consultant to the radiation laboratory at the University of California at Berkeley and was associated with the Aerojet-General Nucleonics project as a senior staff member for the past year. Dick had worked in the atomic energy field since 1947, when he was a member of the NEPA division of the Fairchild Engine and Airplane Company in Oak Ridge, Tennessee. In 1955 he received a Fulbright Fellowship which took him to Oslo, Norway, where he studied the application of nuclear energy to ship propulsion. He is survived by his widow, Jeannette, and three children—David, Margaret and Richard, Jr.

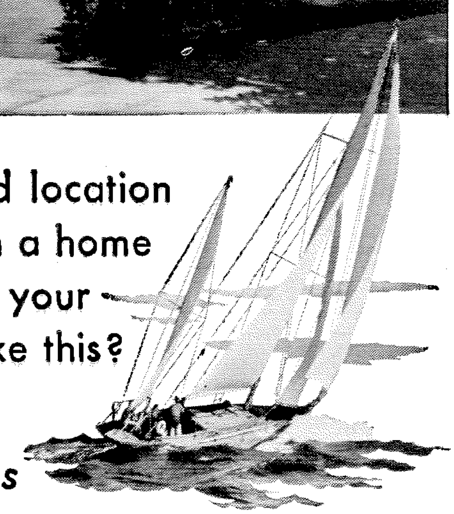
Richard H. De Lano, MS '46, secretary of the Systems Laboratories Corporation in Sherman Oaks, California, has been appointed as director of the company's systems integration division. For the past ten years, his major experience has been in electronics and radar, one of his major projects being the development of the Falcon air-to-air guided missile when he was senior staff physicist at the Hughes Aircraft Corporation.

John Richter is now field engineer for the Portland Cement Association in the Los Angeles metropolitan area. He was formerly a sales engineer for the Davidson

ENGINEERS... LOOK TEN YEARS AHEAD!



A Douglas engineer lives here



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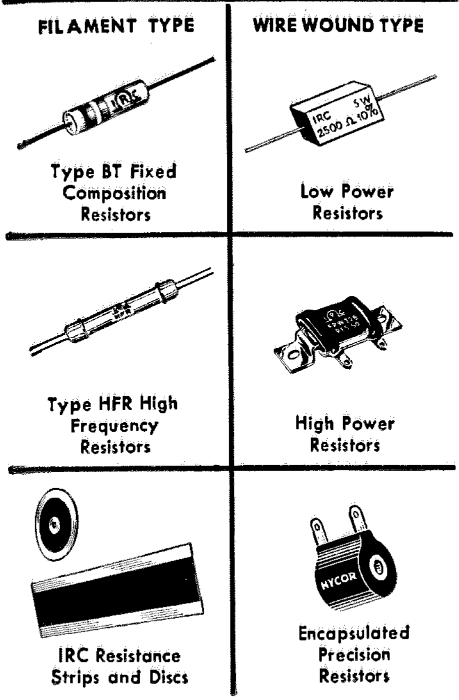

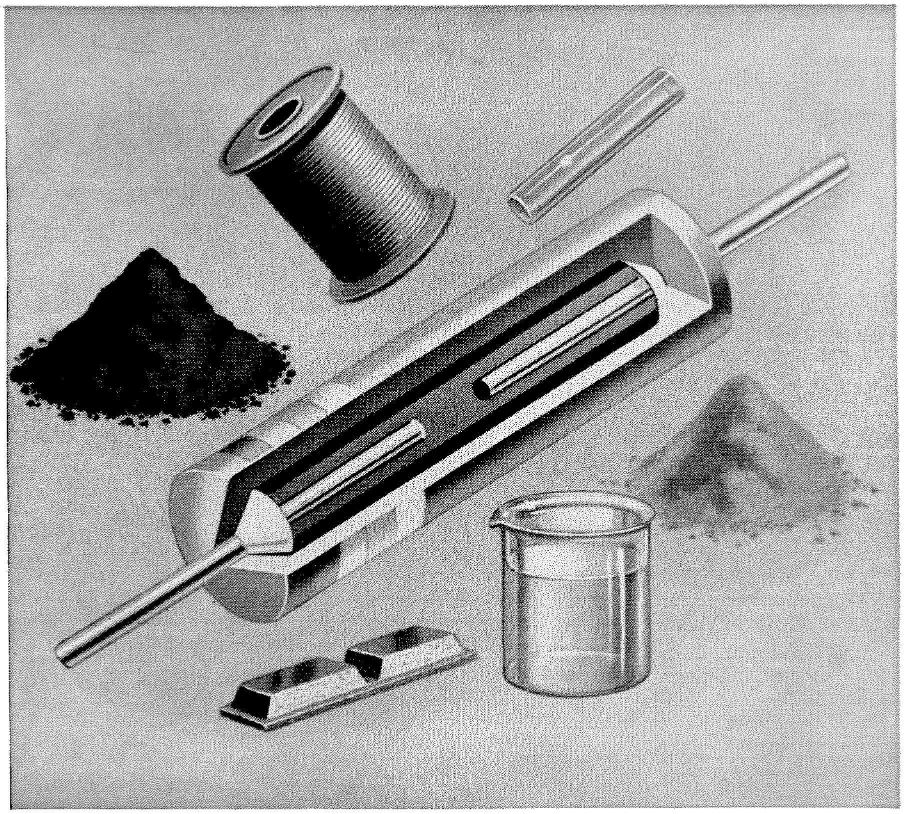

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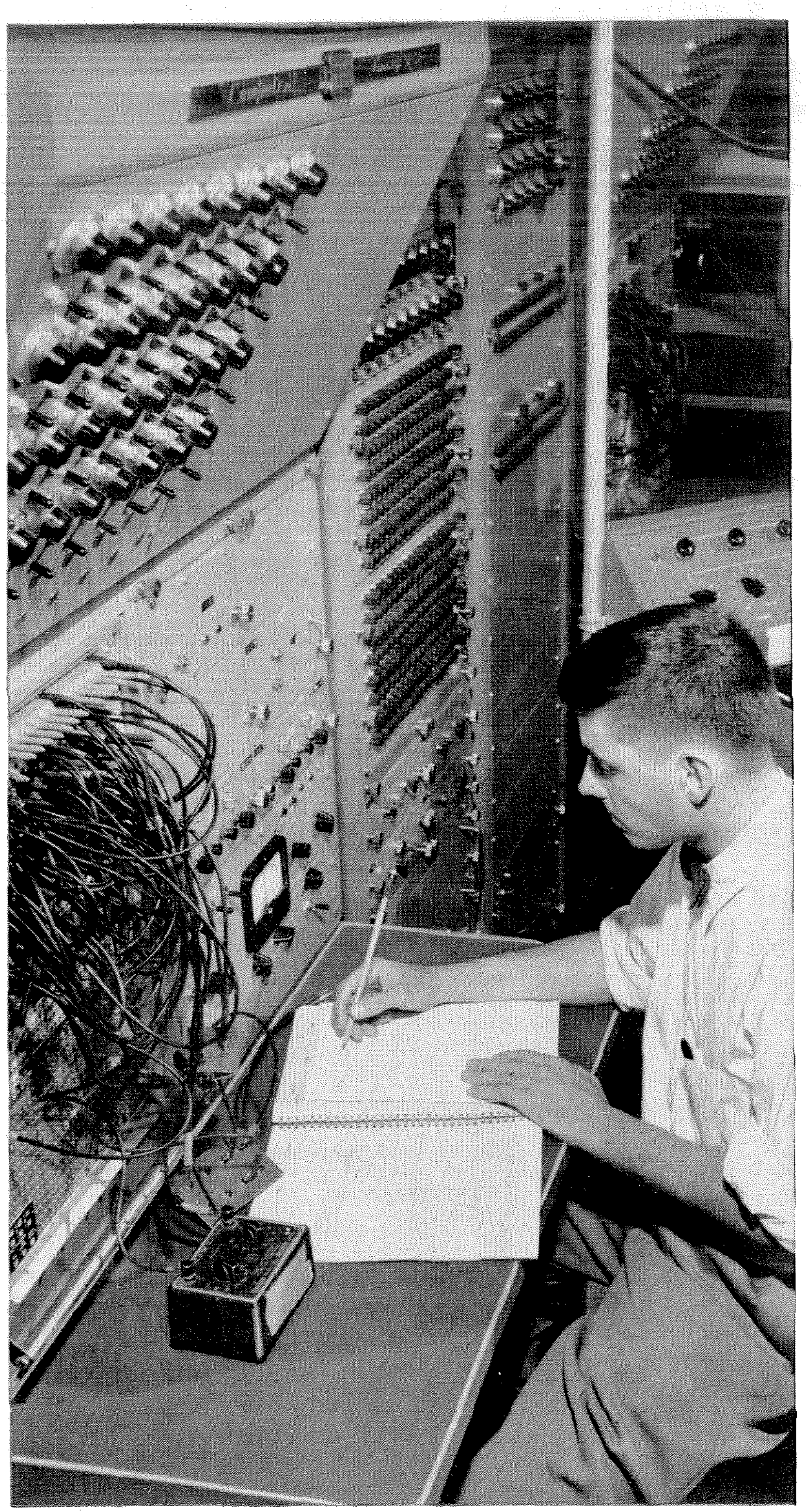

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And working with men rated tops in their fields you'll *earn* while you *learn* and start right in on specific assignments in the field of your choice. You will be given important work from the beginning for there is no ceiling on ideas in fields like guided missiles, inertial navigation, advanced radars, microwave technology and many more where Sperry is blueprinting the future *now*.

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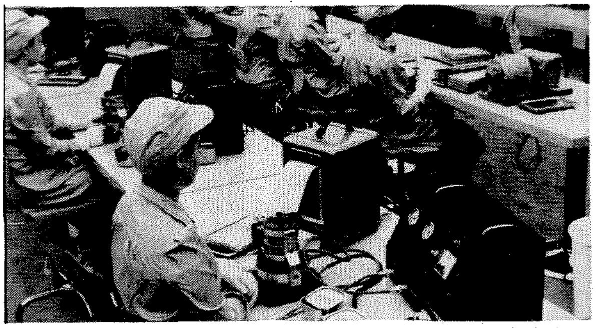

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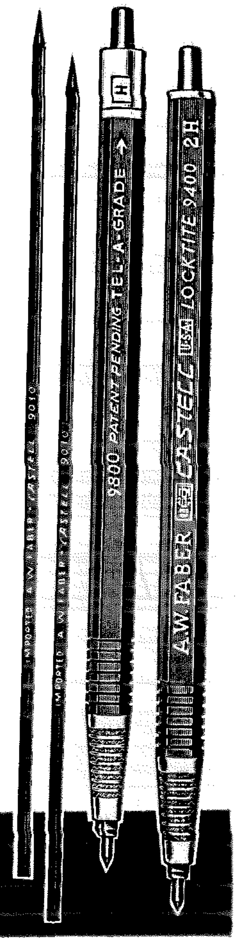

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Brick Company in Los Angeles. The Richters have two sons and live in La Canada.

Morton M. Astrahan, MS, is manager of advanced engineering in the IBM research laboratory in San Jose, California. He's been with the company since 1949.

1948

Hamed Kamal Eldin, MS, is public relations manager for the Near East division of Esso Standard, Inc. His office is in Maadi, Cairo, Egypt.

George Roe writes from Hawaii that he "just got back from a two-year trip around the world. I worked for a few months in Australia—and married an Australian girl. We're settling down in Honolulu for good. I've just returned to a job as engineer and estimator for a large general contractor here."

Charles Susskind reports that he now has a third child, Amanda Frances, born on New Year's Day. The other two children are Pamela, 4, and Peter, 2. Charles is now assistant professor of electrical engineering at the University of California in Berkeley and he is also active as an engineering consultant. In his spare time, he is a journalist and broadcaster for KPFA-FM on cultural topics, notably music.

1949

Carl W. Helstrom, MS, PhD '51, research mathematician for the Westinghouse Research Laboratories in Pittsburgh, Pennsylvania, was married in New York City last October to Miss Barbro Dahlbom of Bollnäs, Sweden.

Charles H. Arrington, Jr., PhD, has been appointed laboratory director for the Du Pont Company's chemical department in Wilmington, Delaware. He's been with Du Pont since 1949.

1950

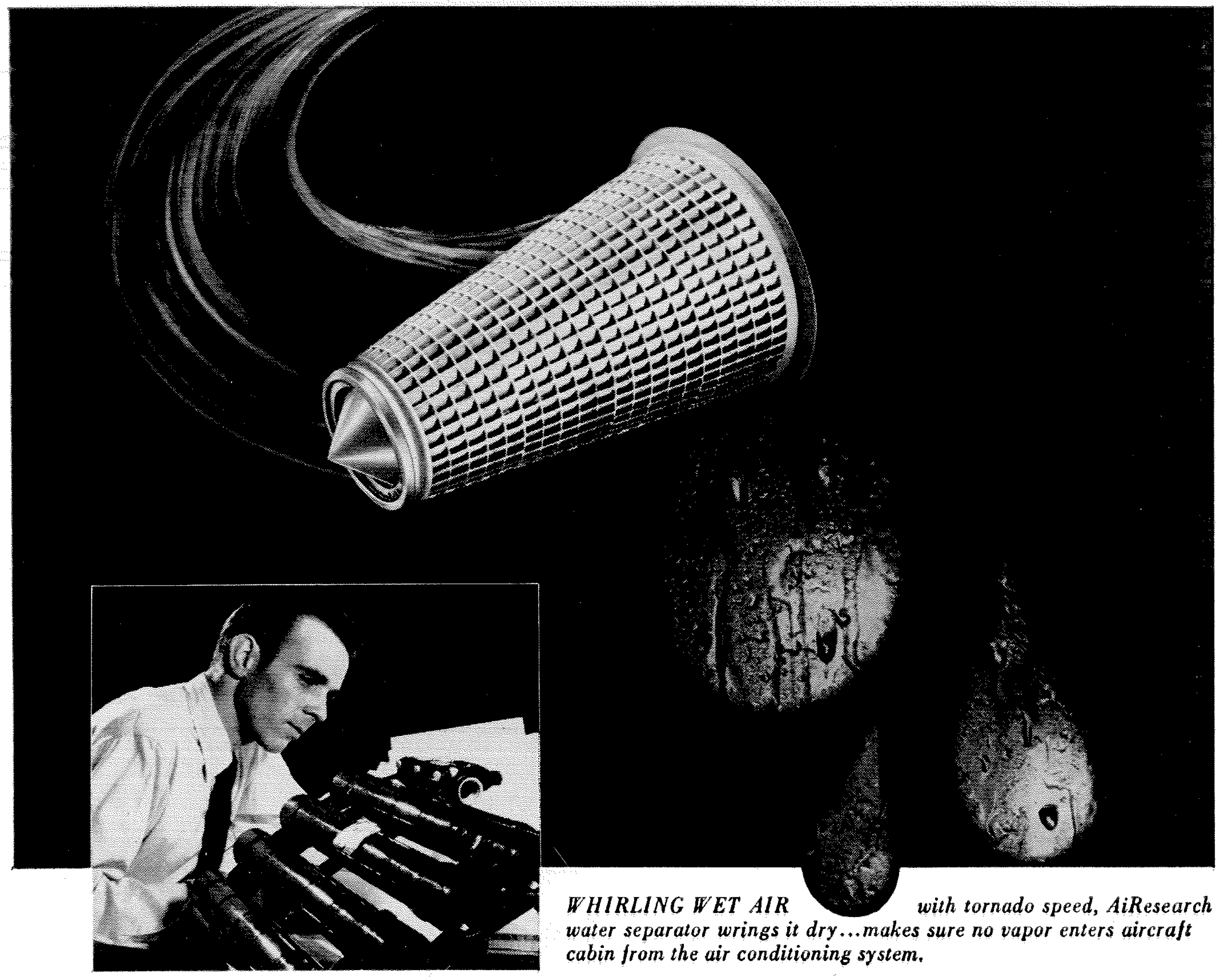
Cdr. Jack L. Shoenhair, MS, writes from the Naval Air Station at Pensacola, Florida, that he is now Assistant Overhaul and Repair Officer there, and has been selected for Captain. He also reports a new addition to the family—Kathy—which makes a total of four.

1952

Harry E. Williams, MS, is attending the University of Manchester in England on a Fulbright Scholarship. He was formerly a development engineer at Caltech's Jet Propulsion Lab.

Peter Verdier, listed as one of our "Lost Alumni" in the December *E & S*, has been located at the chemistry department of Harvard University, where he is studying for his PhD.

To the engineer with a bent for research...



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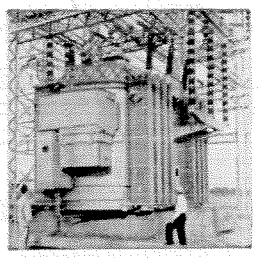
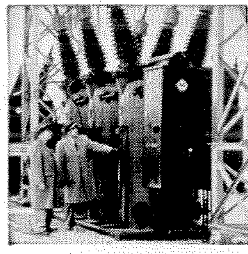
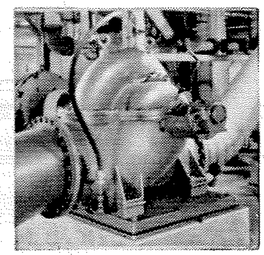

Transformers of all Types


Circuit Breakers

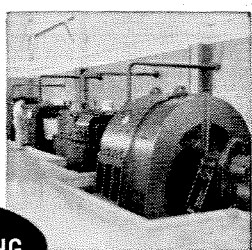
CONSTRUCTION

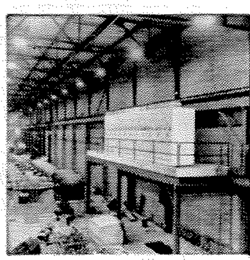

Road Building Equipment


Pumps, Blowers


Cement-Making Equipment

MANUFACTURING


Motors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Changes in By-Laws

THE BOARD OF DIRECTORS of the Alumni Association, California Institute of Technology, amended the By-Laws of the Association at its regular meeting, held on January 15, 1957. The purpose of the amendments was to clarify certain portions which have in the past led to confusion. These amendments were passed by the unanimous vote of all Directors.

—*Donald S. Clark*
Secretary

Article III
Board of Directors

SECTION 3.01 Constituency of Board
The affairs of the Association shall be managed by a Board of Directors, consisting of nine (9) members of the Association, of whom the President of the Association shall be a member ex-officio, four (4) Directors shall be senior directors serving the second year of their two-year term, and four (4) Directors shall be junior directors serving the first year of their two-year term. The President of the Association shall serve as the chairman of the Board with voting power.

SECTION 3.02 Powers of the Board (change section number only—from Section 3.07)

SECTION 3.03 Regular Meetings
Regular meetings of the Board of Directors shall be held at any place within the State of California which has been designated from time to time by resolution of the Board, or by written consent of all members of the Board. In the absence of such designation, regular meetings shall be held at the principal office of the Association. The Board of Directors is hereby granted full power and authority to change the principal office from one location to another in the County of Los Angeles, California.

SECTION 3.04 Special Meetings
Special meetings of the Board of Directors for any purpose or purposes shall be called at any time by the President or if he is absent or unable or refuses to act, by the Vice-President, or by any two Directors.
Written notice of the time and place of special meetings shall be delivered personally to the Directors or sent to each Director by mail or other form of written communication, charges prepaid, addressed to him at his address as it is shown upon the records of the Association, or if it is not so shown on such records or is not readily ascertainable at the place in which the meetings of the Directors are regularly held. In case such notice is mailed or telegraphed, it shall be deposited in the United States mail or delivered to the telegraph company in the place in which the principal office of the Association is located, at least two days prior to the time of the holding of the meeting. Such mailing, telegraphing, or delivery as above provided shall be due, legal, and personal notice that such special meeting shall be held at any place within the State of California which has been designated from time to time by resolution of the Board or by written consent of all members of the Board. In the absence of such designation, special meetings shall be held only at the principal office of the Association.

SECTION 3.05 Waiver of Notice (change section number only—from Section 3.12)

SECTION 3.06 Notice of Adjournment
Notice of the time and place of holding an adjourned meeting of the Board of Directors shall be given to absent Directors.

SECTION 3.07 Quorum (change section number only—from Section 3.13)

SECTION 3.08 Removal from Board of Directors
The Board of Directors may remove any member of the Board from his position. Such removal shall be made for good cause shown at a regular or special meeting of the Board of Directors duly called and held. All members of the Board shall be given special notice of such proposed action at least ten (10) days prior to the meeting.

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Johnson established the automatic temperature control industry when we developed the room thermostat over 70 years ago. Johnson is the *only* nationwide organization devoted exclusively to planning, manufacturing and installing automatic temperature and air conditioning control systems. As the industry's specialists, with 100 fully staffed branch offices, we've done the control systems for most of the nation's better buildings—skyscrapers, schools, industrial plants, hotels, hospitals and other large buildings. The work is diversified, exacting, with plenty of challenge for your engineering ability.

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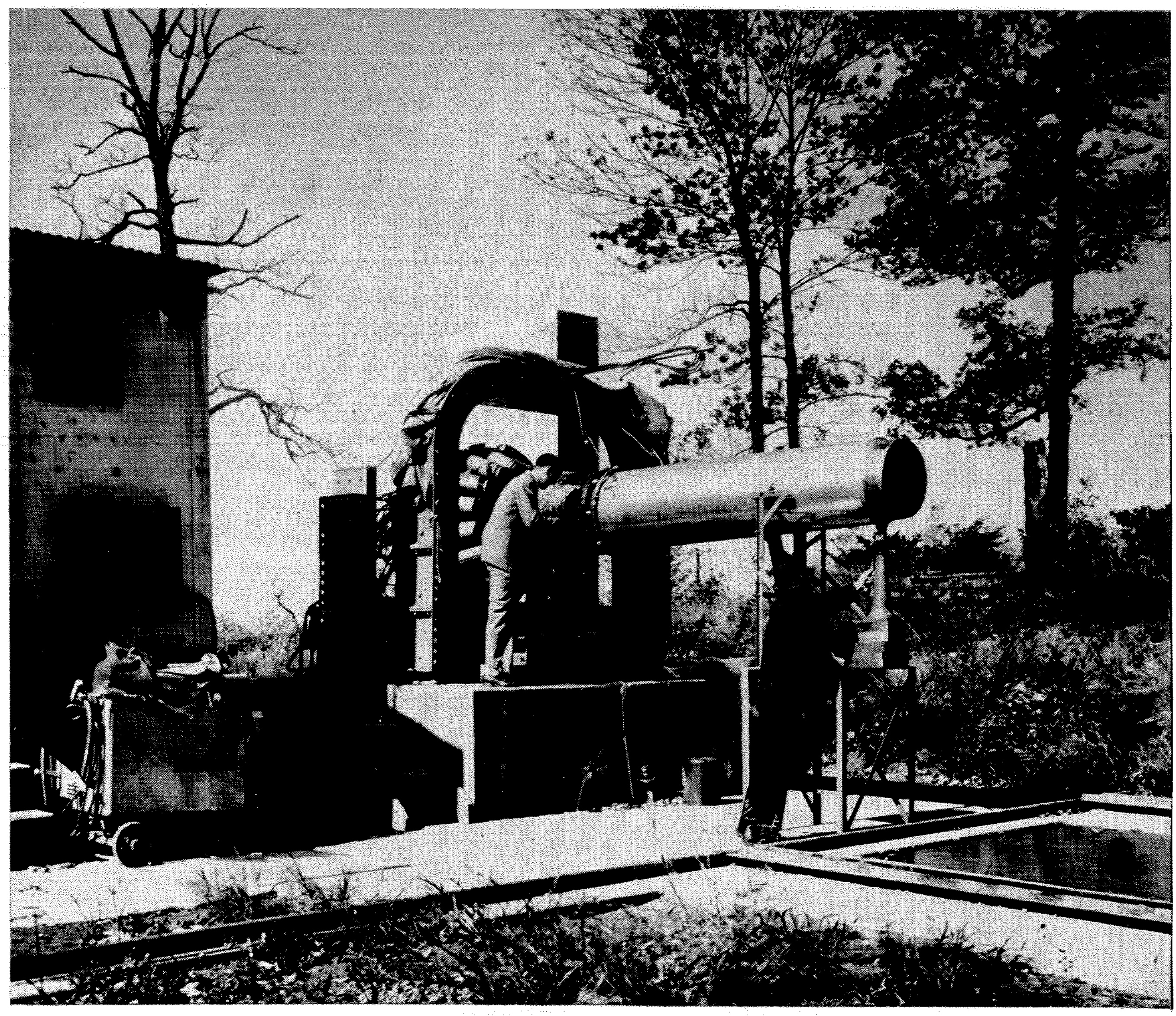

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Watch for announcement of personal interviews on your campus by representatives of Convair San Diego.

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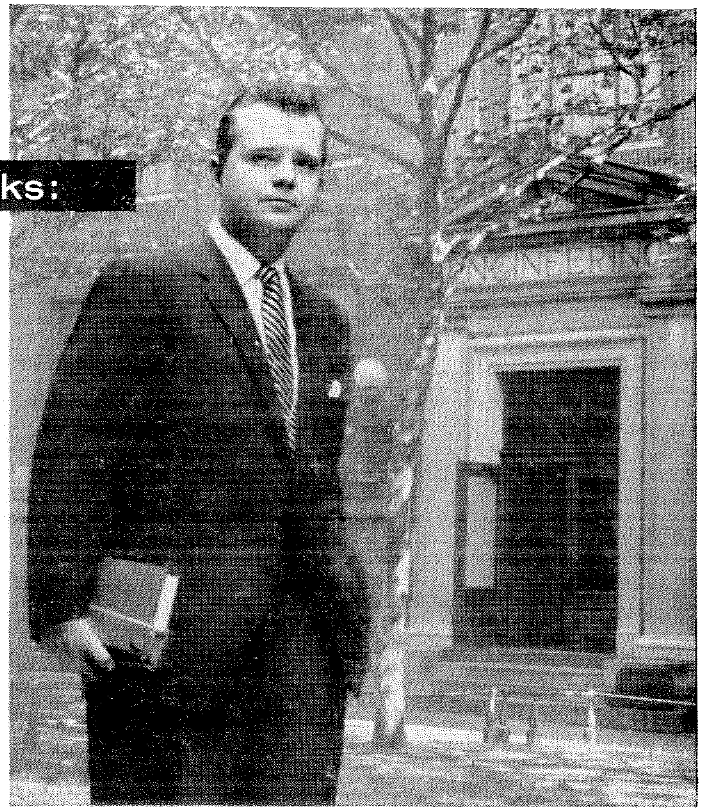
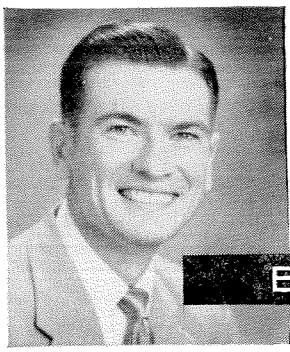
Walter Paulson asks:

Does Du Pont have summer jobs for students?



Walter A. Paulson, honor student at Pratt Institute, Brooklyn, and member of the honorary engineering fraternity, Tau Beta Pi, expects to receive his B.S. in Chemical Engineering in June 1957. He is interested in the professional advantages that a student may derive from technical experience obtained during summer work.



Bob Carter answers:

Robert G. Carter received his M.S. in industrial engineering from Ohio State in 1951 and joined Du Pont soon afterward. After varied plant experience, he recently undertook an interesting new assignment in the Polychemicals Department at Du Pont's Sabine River Works, Orange, Texas. The major function of his current work is to coordinate cost information as an aid in maintaining cost control.

You bet we do, Walt! They're part of a regular Technical Training Program which Du Pont has had for years.

Ordinarily we try to assign summer employees to work which ties in with their fields of training in college and with their long-range interests. Informal or formal instruction on Company matters is usually provided.

We're definitely in favor of these summer contacts, for they provide students with practical technical experience and make them more valuable to industry when they graduate. And it gives us a chance to become better acquainted, too, with some of the men we'll be considering for permanent employment, later. It's a program of mutual benefit.

In addition to the Formal Technical Training Program, we frequently have a number of vacation replacement jobs and other temporary positions which are available to college students.

Last summer we hired a total of 720 students from 171 different colleges and universities. Most of these were juniors, or were graduate students about one year away from permanent employment.

You can see our program is a fairly substantial one, Walt.

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Article IV

Officers of the Association

SECTION 4.01 Officers

The officers of the Association shall be a President, Vice-President, Secretary, and Treasurer.

SETION 4.02 President

The powers and duties of the President are:

(a) To preside at all meeting, regular and special, of the members and of the Board of Directors;

(b) To call special meetings of the Board of Directors to be held at the office of the Association, or such other place as may be fixed by the Board of Directors, at such time as he shall deem proper;

(c) To affix the signature of the Association to all papers and instruments in writing that may require the same, when authorized so to do by the Board of Directors; to affix the signature of the Association to all certificates of membership that may require the same; and to supervise and control, subject to the direction of the Board, all officers, agents, and employees of the Association;

(d) To give, or cause to be given, notice of all meetings of members and of the Board of Directors required by the By-Laws to be given;

(e) To prepare and present the annual report as provided in Section 2.08 of these By-Laws.

All powers and duties hereby or by law conferred or imposed upon the President may be exercised and performed by him either within the State of California or elsewhere.

SECTION 4.03 Vice-President (change section number only—from Section 4.06)

SECTION 4.04 Secretary

The powers and duties of the secretary are:

(a) To keep full and complete records of the proceedings of the Board of Directors and of the meetings of members;

(b) To keep the corporate seal of the Association and to affix the same to all of the instruments that may require it;

(c) To give, or cause to be given, notice of all meetings of th members and of the Board of Directors required by the By-Laws to be given;

(d) To keep and maintain the membership book provided for in Section 2.05 of these By-Laws;

(e) To sign membership certificates and other instruments when authorized to do so by the Board of Directors;

(f) Generally to do and perform all such duties as pertain to his office and as may be required by the Board of Directors.

SECTION 4.05 Treasurer

The powers and duties of the Treasurer are:

(a) To receive and provide for the custody of all moneys belonging to or paid into the Association.

(b) To deposit in the name of the Association all funds in his custody in such banks or other places of deposit as the Board of Directors may from time to time designate;

(c) To sign all checks, making sure the disbursements are made only in accordance with authorizations of the Board of Directors. All checks shall be countersigned by the President or the Vice-President or the Secretary;

(d) To supervise and control the keeping of the accounts and books of the Association;

(e) To prepare and present to the Board of Directors an annual budget;

(f) To prepare and submit to the Board of Directors and to the annual meeting of the members a preliminary report of the financial transactions and affairs of the Association;

(g) To prepare a final audited financial report for the preceding fiscal year to be published in the first issue of the Association publication following the close of the books for the fiscal year.

SECTION 4.06 COMPENSATION

The Officers and Directors shall serve without compensation except the Secretary and Treasurer, who, at the discretion of the Board, may receive compensation, the conditions and amount of which shall be set by the Board of Directors.

SECTION 4.07 Removal from Office

The Board of Directors may remove any officer from his position. Such removal shall be made for good cause shown at a regular or special meeting of the Board of Directors duly called and held. The person to be considered for removal shall be given special notice of such proposed action at least ten (10) days prior to the meeting.

Article V

Nomination, Election, and Terms of Office

SECTION 5.01 Nomination

Not later than December fifteenth, the President shall appoint a committee consisting of three (3) members of the Association who may be Directors; the President shall be ex-officio member of this committee. The duty of this committee shall be to propose a member for nomination for each of the four (4) Directors to be elected with at least one (1) alternate for each. The President shall present the names of these members to the Board of Directors in January for discussion. The Board of Directors also shall discuss possible candidates for the office of President, Vice-President, Secretary, and Treasurer at the January meeting.

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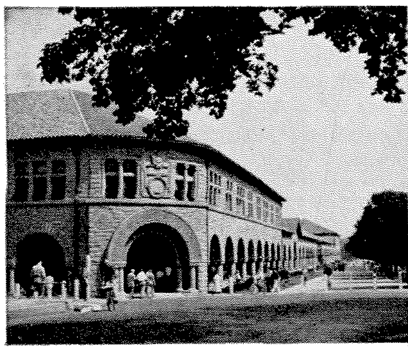

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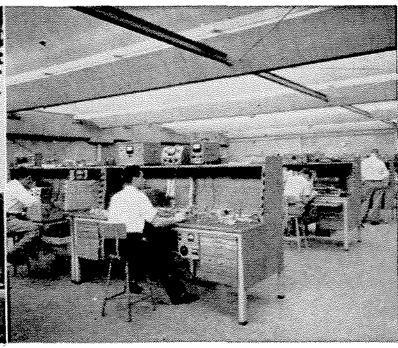

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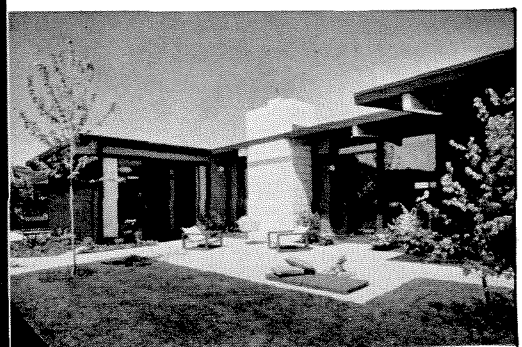

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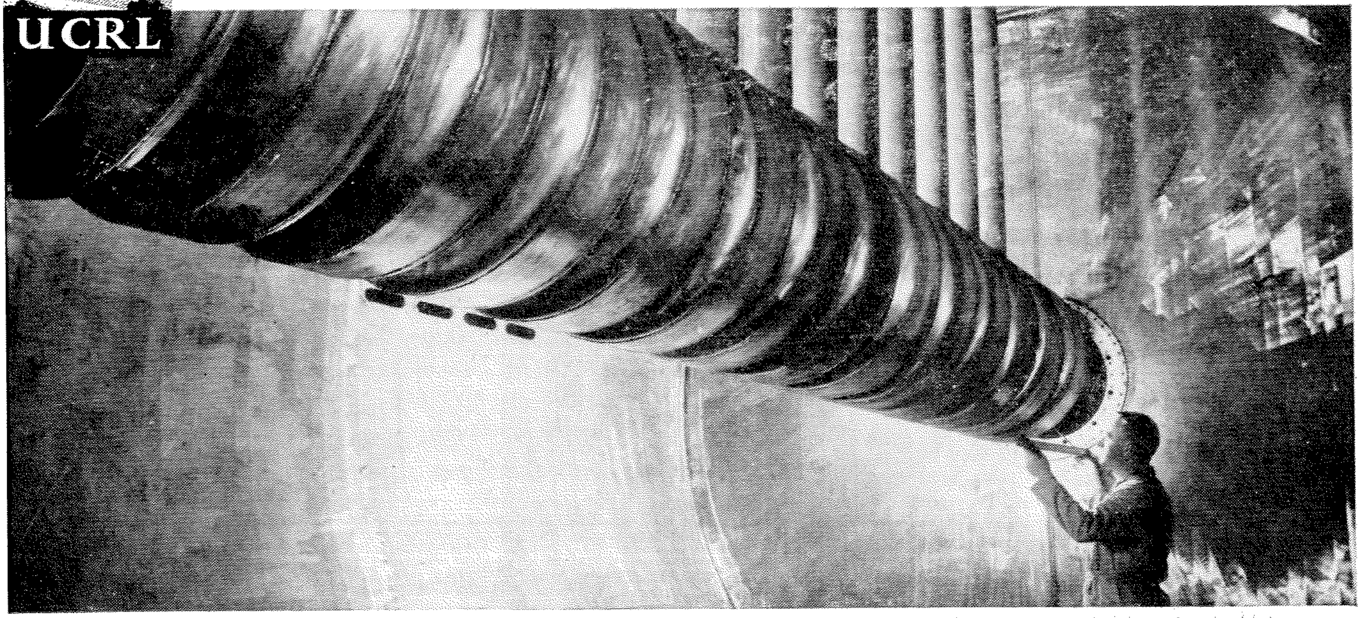

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Not later than March first, the Board of Directors shall meet as a nominating committee without the presence of the Secretary and the Treasurer. The President acting as the chairman of the committee shall report the actions to the Secretary of the Association for inclusion in the official minute book. The Board of Directors shall make one (1) nomination for each office and for each directorship, to be as follows:

President—shall have served on the Board of Directors within the past five (5) years.

Vice-President—shall be a junior member of the Board of Directors at the time of his nomination and shall serve his second years as a senior member of the Board as well as Vice-President.

Secretary

Treasurer

Four (4 Directors—to serve for two (2) years.

The Secretary shall cause to be published in a publication of the Association, or in a special notice sent to each member not later than April first, an announcement of such nominations. Additional nominations may be made for the four (4) Directors by petition signed by at least twenty-five (25) members in good standing provided that the petition is received by the Secretary not later than April fifteenth.

SECTION 5.02 Election

In the event that no nominations other than those made by the Board of Directors are made before April fifteenth, nominations shall be closed and the Secretary at the next succeeding meeting of the Board of Directors shall cast the unanimous vote of all members for the election of the candidates so nominated and notify those elected of their election.

If the Secretary receives additional nominations on or before April fifteenth, he shall prepare a ballot with all the *nominations made as in Section 5.01 hereof which, not later* than May first, he shall send to each regular member of the Association together with instructions for voting. In order to be counted, ballots must be received by the Secretary by 6 o'clock P.M. May fifteenth. The Secretary shall determine from his records if the voter is entitled to vote. At least ten (10) days prior to the annual meeting of the Association, the Directors shall meet and receive from the Secretary those ballots which are valid. The Directors at that time shall canvass the vote, and notify those elected of their election. The four (4) nominees to directorships receiving the largest number of votes shall be elected. In the event of a tie, the Board of Directors shall elect.

If a nominee dies during the period between his nomination and election, a substitute nominee shall not be named. If nomination shall have been made only by the Board of Directors, the Board shall make appointment as provided in Section 5.06 hereof. If nominations shall have been made by the Board of Directors and by the members, the four (4) living nominees receiving the largest number of votes shall be elected Directors.

The results of the election shall be announced at the annual meeting of the Association next succeeding the election, and the results shall be published in the publication of the Association.

SECTION 5.03 Qualification

Each member of the Board of Directors shall be a regular member of the Association.

SECTION 5.04 *Eligibility for Immediate Re-election*

No officer or director may serve more than one (1) term consecutively in the same office except the Secretary or the Treasurer each of whom may succeed himself.

SECTION 5.05 Term of Offices

The term of each officer and director shall begin at the close of the annual meeting following the election. The President, Vice-President, Secretary, and Treasurer shall serve until the close of the first succeeding annual meeting and until their successors are chosen and qualified. The four (4) Directors shall serve until the close of the second succeeding annual meeting, and until their successors are chosen and qualified.

SECTION 5.06 Vacancies

If a vacancy in any office or directorship occurs for any reason, the remaining members of the Board shall elect a qualified person to fill the vacancy for the unexpired portion of the term, or to serve until his successor is duly elected and qualified. Such appointments shall not be made of any person who has been a Director within the twelve months last preceding the appointment. In the event that more than two vacancies occur on the Board of Directors, said Board *shall have no authority to transact other business until said* vacancies have been filled.

ARTICLE VI CHAPTERS (change Article number only—from Article V)

ARTICLE VII ALUMNI FUND (change Article number only—from Article VI)

ARTICLE VIII ALUMNI MAGAZINE (change Article number only—from Article VII)

ARTICLE IX LIABILITIES (change Article number only—from Article VIII)

ARTICLE X FISCAL YEAR (change Article number only—from Article IX)

ARTICLE XI OFFICE (change Article number only—from Article X)

ARTICLE XII AMENDMENTS (change Article number only—from Article XI)

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CALTECH CALENDAR

ALUMNI EVENTS

April 6	Alumni Seminar
June 5	Annual Meeting
June 29	Annual Picnic

ATHLETIC SCHEDULE

Varsity Basketball

February 19
Pasadena College at Pasadena College

February 23
Pomona-Claremont at Caltech

Varsity Tennis

February 21
E. LAJC at Caltech

February 23
Occidental at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 P.M.

February 22
Floods!
—by Dr. Norman Brooks

March 1
The Birth and Death of Stars
—by Dr. Jesse Greenstein

March 8
X-ray Diffraction and Structure of Molecules
—by Dr. R. E. Marsh

March 15
Nuclear Physics in Photographs
—by Dr. Vincent Z. Peterson

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William F. Nash, Jr. '38

SECRETARY
Donald S. Clark '29

VICE-PRESIDENT
Willis R. Donahue, Jr., '34

TREASURER
George B. Holmes '38

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John R. Fee '51
Edward P. Fleischer '43
Chester W. Lindsay '35
John E. Osborn '39
Richard H. Jahns '35
Richard W. Stenzel '21

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Secretary-Treasurer — Frank F. Scheck '48
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Vice-President — Wayne MacRostie '42
State Water Project Authority, Sacramento

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State Division of Highways, Design Department,
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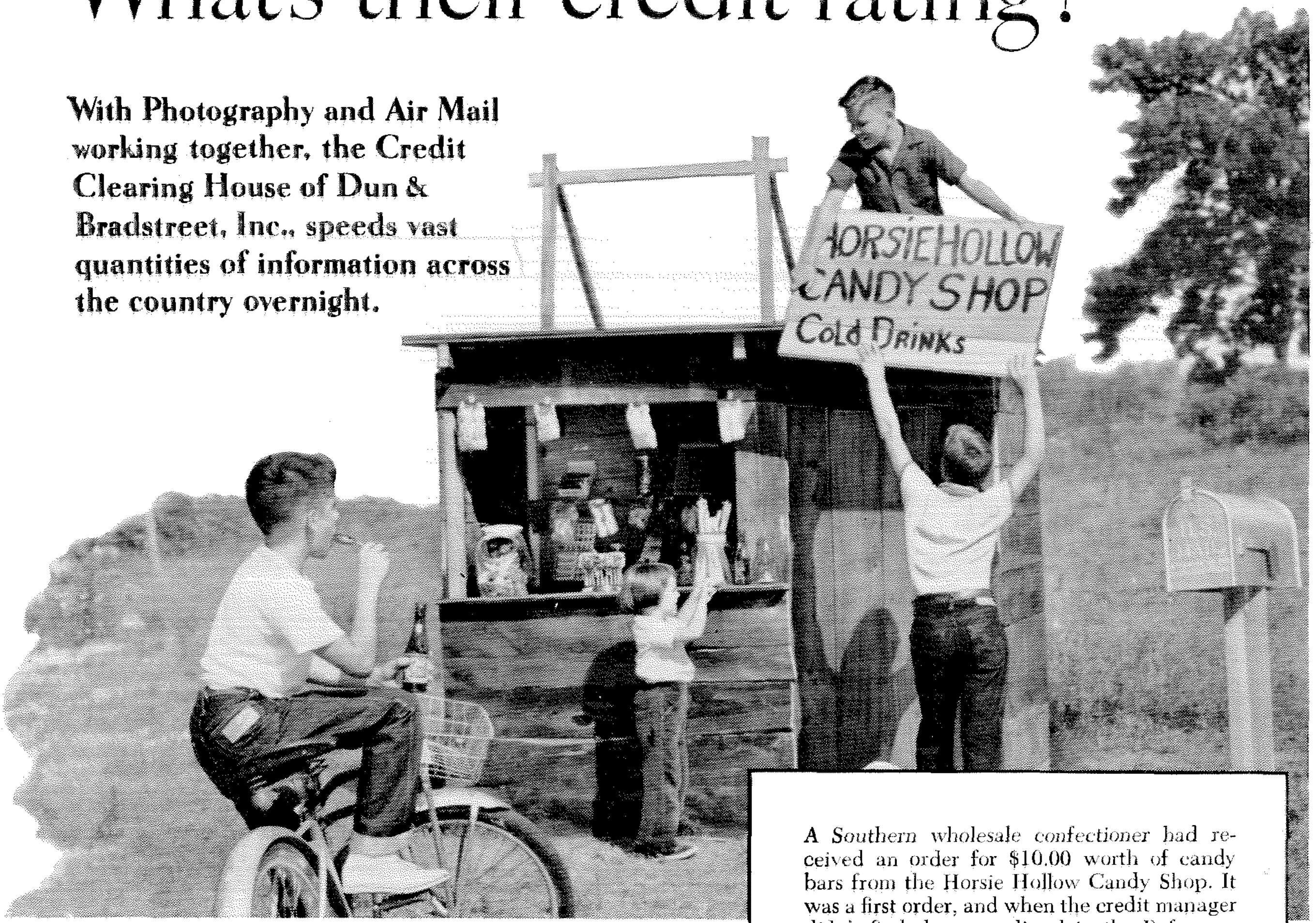


Even if Dun & Bradstreet reporters photographed every business they investigate, it would not be among the biggest uses of photography this famous credit organization employs.

One most important way makes last-minute credit information in the apparel trades available thoughout the country overnight. Current data and analysts' opinions on more than 150,000 apparel retailers are microfilmed, transferred to micro-cards and flown daily to Credit Clearing offices.

It's another example of photography and Recordak microfilming saving time and money. They are working for railroads, banks, oil companies and countless other businesses and industries both large and small.

Behind the many photographic products becoming increasingly valuable today and those being planned for tomorrow lie intriguing and challenging opportunities at Kodak in research, development, design and production.

If you are interested in these opportunities in science and engineering—whether you are a recent graduate or a qualified returning serviceman, write to the Business and Technical Personnel Department.

Eastman Kodak Company, Rochester 4, N. Y.

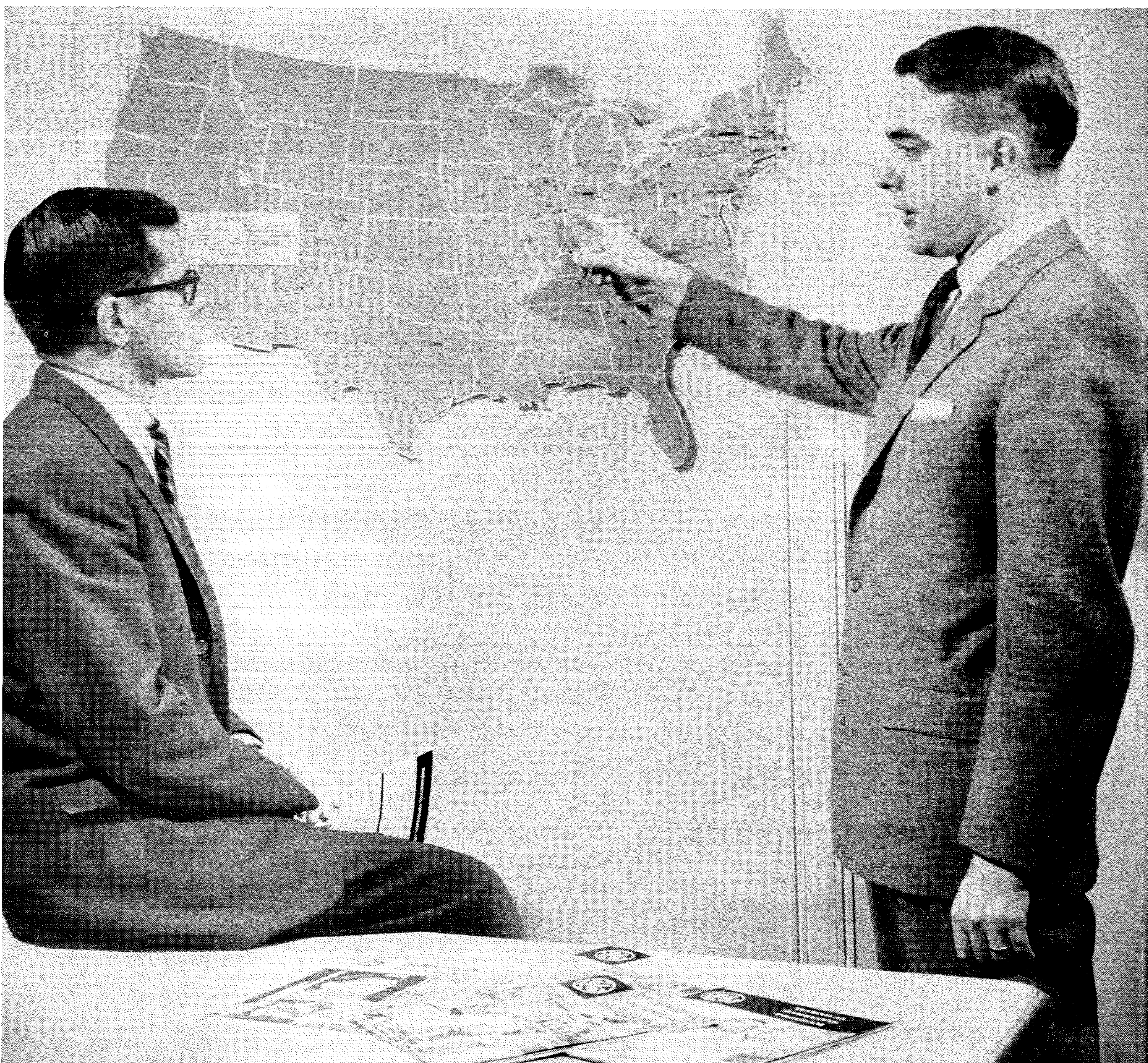
A Southern wholesale confectioner had received an order for $10.00 worth of candy bars from the Horsie Hollow Candy Shop. It was a first order, and when the credit manager didn't find the name listed in the Reference Book, he phoned the Dun & Bradstreet office for a report on the venture.

The reporter assigned to the case located the concern on a dirt road, and he took a snapshot of the premises and its busy proprietors which inspired this illustration. He interviewed the owners and wrote a report which was forwarded to the wholesaler.

It informed him that the enterprise was operated as a partnership by two neighbors who were both "eleven years of age and unmarried"—also that "although the owners are men of limited means, they have a high standing in their community." The financial statement indicated assets of $13.25 in merchandise and cash, with a valuation of $35.00 for the building consisting of a remodeled turkey coop.

The partners were reported as experienced with a five-year record of selling lemonade and cookies with their home pantries as the principal sources of supply. There was no indebtedness as their mothers' terms were strictly C.O.D. The wholesaler took a more liberal attitude and shipped on regular terms. The bill was paid in ten days, and the wholesaler opened an account in his ledger for the "Horsie Hollow Candy Shop."

Kodak
TRADE-MARK



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