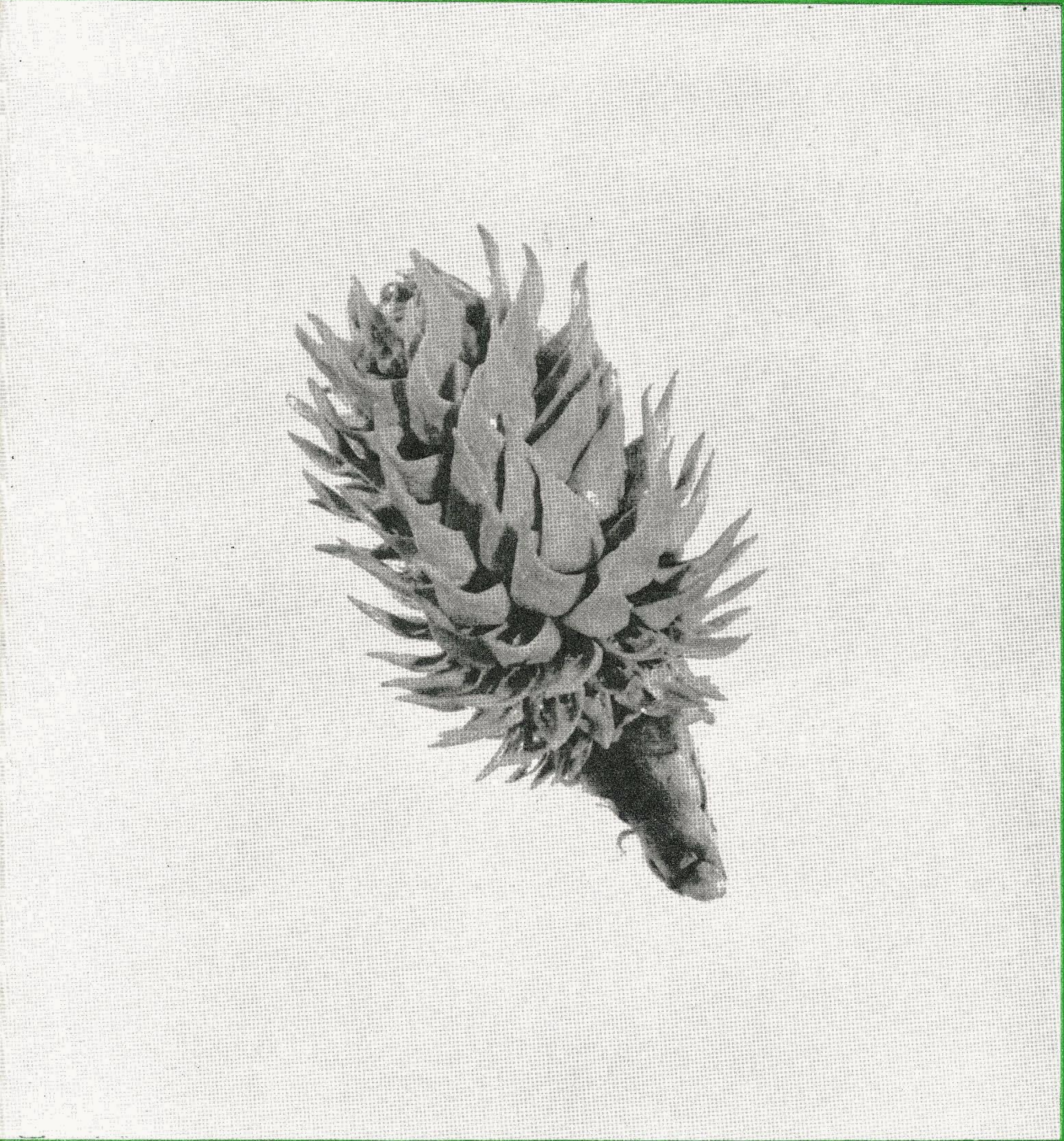
ENGINEERING | AND | SCIENCE

OCTOBER/1957

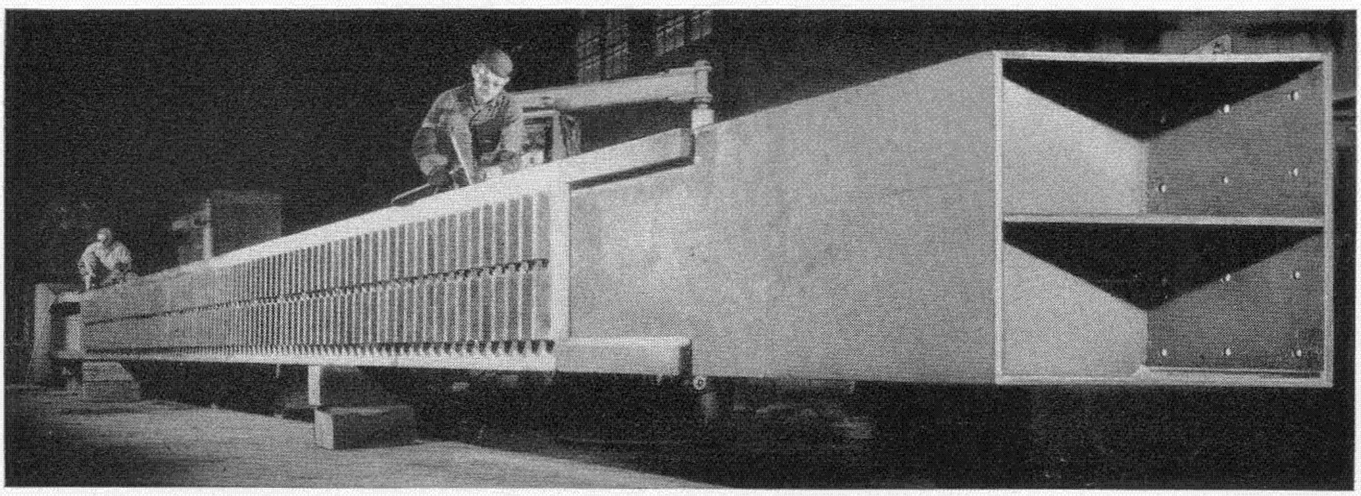


Pine Tree Project . . . page 28

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Only STEEL can do so many jobs so well

Steelaire Home. The entire structural frame of this house is made from tough, cold-formed steel, so it is unaffected by rot, fungus, and termites. Even more important is the fact that the steel frame resists warping and sagging. It's one of a line of *Steelaire* homes and is made by the U. S. Steel Homes Division of United States Steel.



World's Biggest Crowd. On power shovels, a "crowd" is the arm which moves the dipper and dipper-stick forward and back. It coordinates closely with the lift motion of the dipper, and is a key part in the operation of the shovel which must withstand extremes of stress at any temperature. This is a picture of the biggest crowd ever built, now installed on the biggest power shovel in the world. It's made from USS "T-1" Steel, the remarkable new constructional alloy steel developed by United States Steel. An exceptionally strong and tough steel, it is noted for its welding characteristics. *"USS" and "T-1" are registered trademarks.*

Slap That Bermudavarius! The Talbot Brothers of Bermuda, famous for their colorful calypso music, recently retired their homemade packing-case "bass viol," and proudly premiered in its place the world's first Stainless Steel bass viol (or dog house or Bermudavarius, as it's customarily referred to). An exact replica in USS Stainless Steel of their original homemade design, it was built for them under U. S. Steel's supervision by a well-known manufacturer of Stainless Steel sinks who commented that the fabricating job wasn't difficult—but certainly was *different.*

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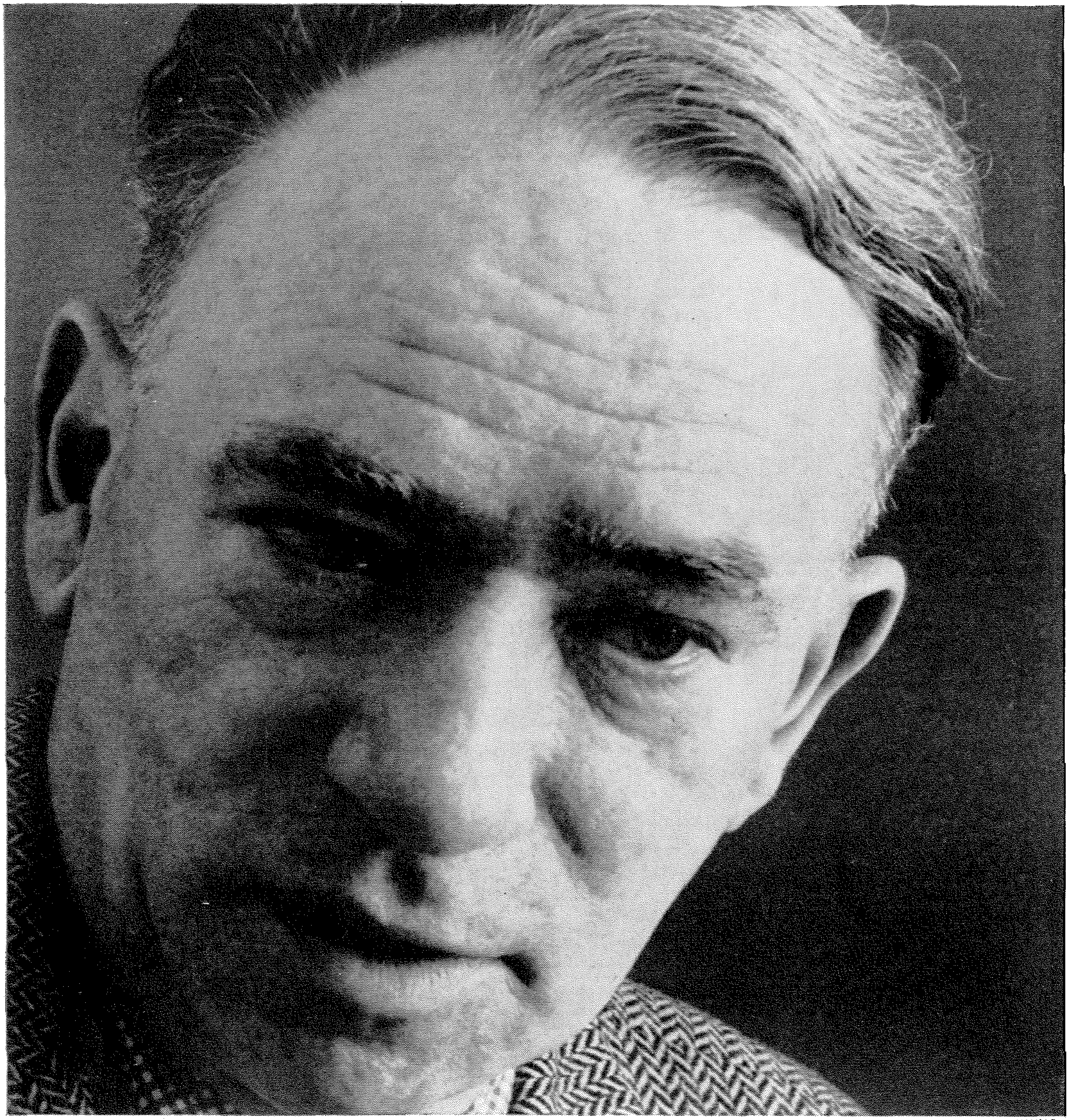
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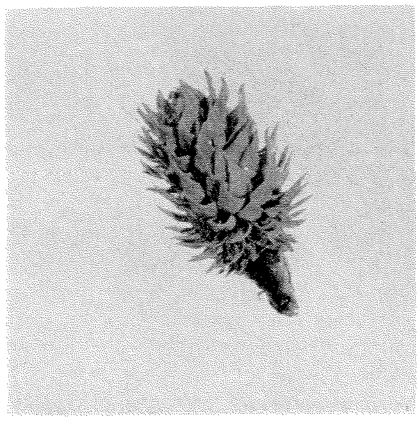
ENGINEERING AND SCIENCE

OCTOBER, 1957 VOLUME XXI NUMBER 1

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

IN THIS ISSUE



ON OUR COVER this month—a very special pine cone, produced in Caltech's Earhart Plant Research Laboratory. Usually it takes the Southern pine tree from 10 to 15 years to produce cones. On page 28 you'll find out how Caltech and U.S. Forest Service researchers brought the time down to 2 years—and what this could mean to the future of forestry.

The pine cone on the cover is now preserved in lucite and will be presented this month to the U.S. Forest Service, to mark the beginning of a new era in scientific forestry.

SIMON RAMO's article on page 17, "A New Technique of Education," will give you a rough idea of what our educational system will be like —or *could* be like—in a few more years. The article has been adapted from a talk given last spring before the annual convention of the California Business Education Association.

Dr. Ramo, executive vice president of The Ramo-Wooldridge Corporation in Los Angeles, got his BS at Caltech in 1933, and his PhD in 1936. He is now a research associate in electrical engineering here.

PICTURE CREDITS

Cover	Graphic Arts, Caltech
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p. 30	ASCIT Photos Wes Hershey

CONTENTS

STAFF

Publisher........Richard C. Armstrong '28
Editor and Business Manager........Edward Hutchings, Jr.
Editorial Assistant........Gerda Chambers
Student News........Robert T. Walsh '58
Student Photographers........Dennis L. Paul '59
William R. Schmus '60

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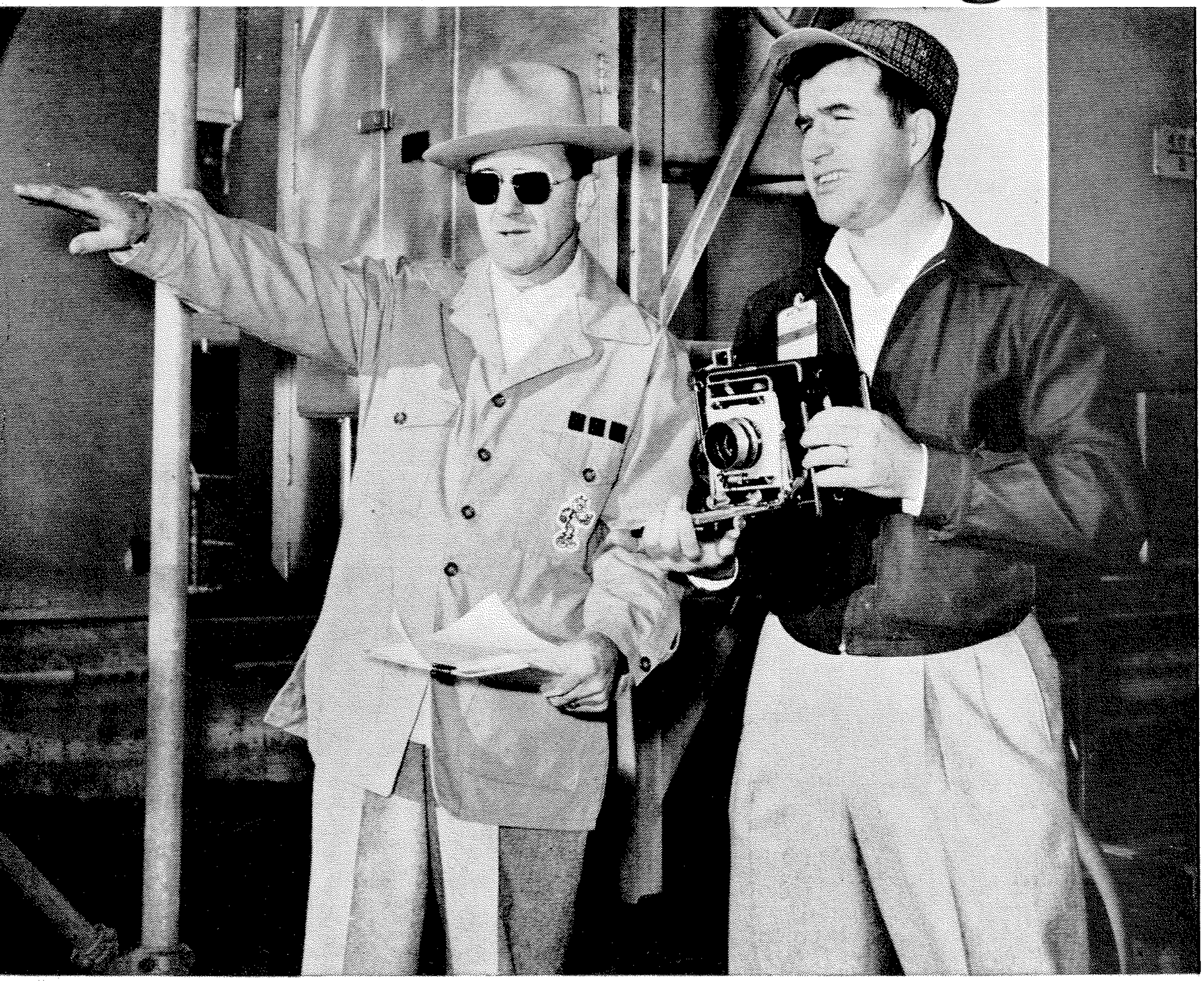
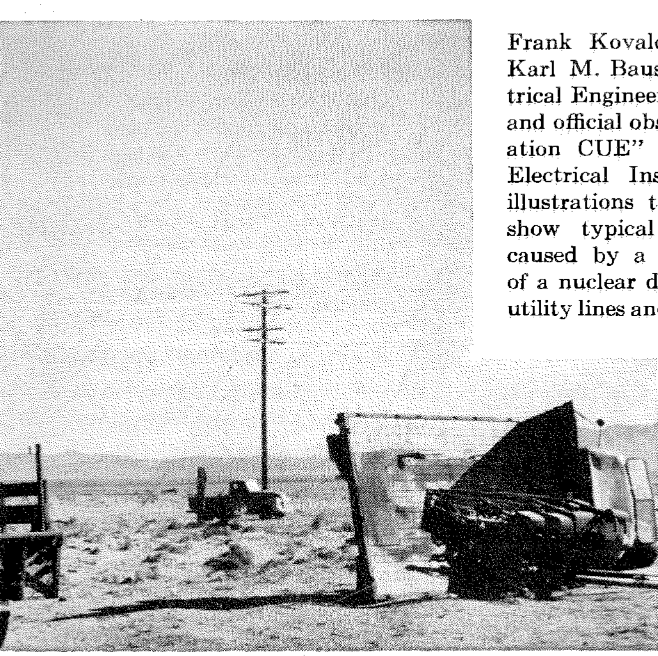
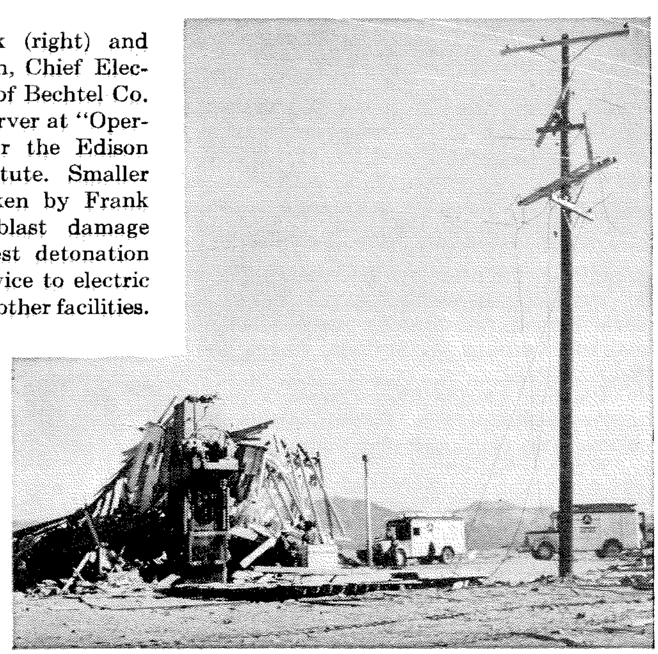
..an editor on the go





Frank Kovalcik (right) and Karl M. Bausch, Chief Electrical Engineer of Bechtel Co. and official observer at "Operation CUE" for the Edison Electrical Institute. Smaller illustrations taken by Frank show typical blast damage caused by a test detonation of a nuclear device to electric utility lines and other facilities.



LETTERS

Bellflower, California

Sir:

I believe you will be interested in some of the material developed as a result of the 25th reunion of the class of '32 last spring—particularly this summary of returns to a questionnaire mailed to all members of the class in March, 1957. Replies were received from 66 men—exactly 70 percent of the class of '32.

Howard Finney, Class Secretary

(1) Weight gained since '32? 23.1 lbs (total: 2,171 lbs.)
(2) How much hair lost? 22%
(3) How many wives acquired? 127 total
(3.1% never married)
(84.6% married once)
(12.3% married twice)
(4) How many children? 192 total
(5) How many grandchildren? 17 8/9 (10 grandfathers)
(6) Of how many organizations are you now, or have been, a member?

Professional	289
Civic	68
Fraternal	45
Social	69
Religious	56
Charitable	54
Educational	68
Recreational	62

(7) How many offices held?

In organizations listed in (6)	275
Political	7
Other	6

(8) How many years of Military Service?

Active duty (18.6%)	102 yrs.
Inactive (Reserve, National Guard, etc.) 18.6%	154 yrs.

(9) Did you own an automobile while an undergraduate?

Yes	64%
No	35.4%

(10) How many automobiles have you owned since leaving college? 7.33
(11) How many automobiles do you now own? 1.77
(12) Do you own your own home?

Yes	89.2%
No	11.8%

(13) Do you have a swimming pool?

Yes	9.2%
No	91.8%

(14) How many different companies have you worked for since graduation? (Count self-employed and present employer) 4.9
(15) How closely does your present position match your major field as an undergraduate?

Same field	38.5%
Closely related field	33.8%
Remotely related field	15.4%
Unrelated field	12.3%

(16) What was your approximate gross annual income in the first year after leaving school?
Mode-$1,000 Avg. $1,308 $1,090
(17) Present gross annual income?
Mode-$12,000 Avg.-$22,620 $15,000
(18) What was your political conviction upon graduation?

Republican	64.0%
Democrat	25.0%
Other	9.4%
None	1.6%

(19) What is your political conviction now?

Republican	90.7%
Democrat	6.2%
Other	——
None	3.1%

(20) Publications—Books 11 total
Papers 70 total
Articles 132 total
(21) Patents 23 total
(22) Honors—1 Nobel Prize winner
2 Fulbright Fellowships
1 Fulbright Lectureship
1 Guggenheim Fellowship
1 Visiting Professorship
2 Foreign Exchange Fellowships

Warren, Michigan

Sir:

I have managed to round up a bevy of talent (see page 10) which originated at the California Institute of Technology and is now with General Motors Styling.

Since your magazine has indicated interest in automotive affairs, I thought it might be interesting for you to show to your readers that, if

CONTINUED ON PAGE TEN

they are not satisfied with their automobiles, the Caltech educational method is partly to blame.

Peter Kyropoulos
Executive in Charge of Technical Development
General Motors Styling

Standing, left to right: Peter Kyropoulos, MS '38, PhD '48; H. I. White, ID '48, chief designer, Frigidaire studio; C. C. Whittlesey, ID '48, executive in charge of fabrication, program planning and service. Kneeling: Roy Stake, BS '57, jr. engineer; Robert F. McLean, BS '43, executive in charge of research, product planning and analysis; and R. P. Brinkman, ID '48, staff engineer, product and exhibit design studios. A model of the Firebird, which was tested in the wind tunnel at Caltech, is in the foreground, and in the background is the Olds F-88, an experimental car.

Washington, D.C.

Sir:

There are one or two points that I thought you would want me to note in regard to the IGY articles in *Engineering and Science* for June, 1957. The introduction to the articles contains an expression or two and an omission which may leave the reader with an erroneous impression about the IGY program.

. . . In terms of the responsibility of our Technical Panels, the verb "controlled" appears strong to us. The Academy, through its IGY Committee and its subject-matter panels, *plans* and *directs* the IGY program from an over-all scientific and program point of view.

There is also the reference to the fact that the Technical Panels are under the administration of the National Science Foundation. The Technical Panels report to the Academy's U.S. National Committee for the International Geophysical Year and not at all to the National Science Foundation.

And here occurs the matter of an omission: neither in this introductory section nor in the lead paragraphs identifying the authors are there any references to the Academy and its Committee.

Knowing the complexity of the IGY program, it is understandable that the organization of the program can not be known everywhere, but the facts are these. The IGY, both nationally and internationally, is a civilian, non-Government scientific program.

The pattern almost everywhere is similar to that in the United States. Here the National Academy of Sciences is responsible for the planning and direction—as well as seeing to the execution—of our efforts. In this program the National Science Foundation has had a very important role, and the Academy and the Foundation have worked jointly and most closely together.

Government support has been obtained for the effort by the National Science Foundation; in particular, Congressional appropriations of $39 million have been secured through the Foundation.

The Academy has also obtained the cooperation of many institutions and agencies so that the total effort, from a scientific point of view, is much greater than the effort made possible by the special appropriations.

Arnold W. Frutkin, Director
Office of Information
U.S. National Committee, IGY
National Academy of Sciences

A Vought Vignette
ONE OF A SERIES

The propulsion engineer who was allergic to switches

During the Vought Crusader's N.A.A. record-breaking flight across the continent, fuel management was a vital factor. But it wasn't the constant worry it might have been. Fred Alvis had seen to that, beginning four years ago.

When the Crusader project was formed, Fred was just a few years out of Alabama Poly. His was still a new face. Mighty new, Fred would have agreed when he was tapped to develop the functional design of the Crusader fuel system.

Navy specs told Fred his system should be reliable and very lightweight. Pilots, too, gave him a special request. In the ready room near the flight line they described the constant in-flight attention required by complex fuel systems. "Can you fix it so we can forget fuel for a minute?" they asked the young designer. "Can you cut down on those switches?"

Fred went all-out for simplicity, plunging into a three-month whirl of schematics. He was encouraged by close design group assistance in studies and layouts. Soon he was making procurement selections and writing functional reports. Then, with the fuel system mockup, Fred unveiled what he'd done.

It was a showpiece of simplicity. Absent was the usual complex CG control system. Fred had bypassed the problem entirely by canny choosing of fuel cell locations and fuel line sizings. Absent, too, was an emergency system — together with the need for it! There was a unique air transfer system for moving fuel from the Crusader wing tank to the main sump, plus some freshly conceived lesser features.

As mockup and flight tests proved, Fred's ideas more than met weight and reliability requirements. And, as pilots were shown, all simplification features led directly to the cockpit. There Fred had won his war against switches.

Only one had survived.

At Vought, the invitation to find a fresh approach is extended to every engineer. Here, in groups that coordinate for mutual progress, and in test facilities that can evaluate the most advanced proposals, ideas receive the attention they deserve.

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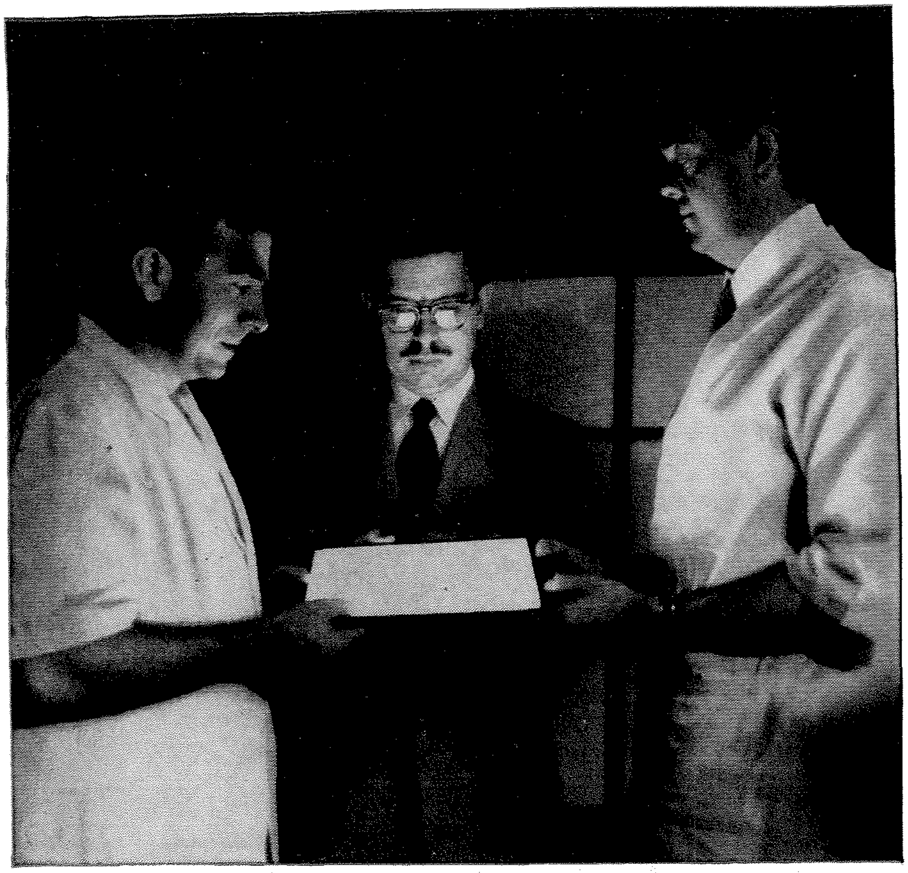


"Glowing wafer" of light (electroluminescence) sheds illumination on the faces of three Westinghouse scientists who helped to develop it. Left to right: Dr. Willi Lehmann (University of Brunswick, Germany); Dr. Henry F. Ivey (University of Georgia, Massachusetts Institute of Technology); and R. W. Wollentin (Rutgers University).

The Light With no Third Dimension

A new source of light is nearing practicality. Called electroluminescence, it comes from a flat surface. By the twist of a knob, you can change the brightness, or even the color, of a room.

Since electric lighting first became practical, only three basically different light sources have achieved widespread use—incandescent, fluorescent, and gas-discharge lamps. Now a fourth basic type—electroluminescence—is nearing practicality. With fewer theoretical limitations than any of its predecessors, it promises to revolutionize lighting and become a practical light source of the future.

In an incandescent lamp, light comes from a single point. In a fluorescent lamp (form of gas-discharge), light comes from a straight line. In electroluminescence, light comes from an area or flat surface. Electroluminescence is light emission from phosphor powders embedded in an insulator, excited by an a-c field.

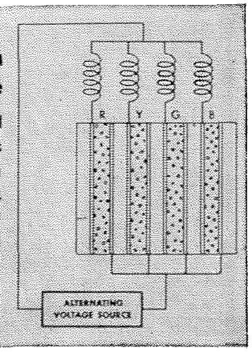
Westinghouse engineers gave the first practical demonstration of this new light source. They lighted an entire room with flat electroluminescent panels on the ceiling and three walls. These panels were one-foot-square flat glass plates about as thick as a window pane and coated with a plastic containing the phosphor. They were topped off by an aluminum conducting coating. Hooked up to a source of power, these plates had a brightness of 100 foot lamberts in their present stage of development.

Since some phosphors have more than one emission band, the color and brightness of electroluminescent lighting can be changed by varying the frequency. It is possible to control the color of a room, and brightness too, simply by twisting a knob. Besides supplying ordinary light, this new light source has other fascinating possibilities. Just one is "picture framing" television. An electroluminescent cell might replace the conventional cathode-ray tube in such a set.

Westinghouse engineers, under the supervision of E. G. F. Arnott (Princeton '28), developed electroluminescent lighting under the name of "Rayescent" lighting. Westinghouse approached the problem, not as a commercial venture, but as a pure research project. Much work remains to be done in this field. It is typical of the pioneering developments undertaken by Westinghouse.

Changing Colors in Electroluminescence

Multicolored panel of one type is made by stacking red (R), yellow (Y), green (G), and blue (B) phosphors. Inductors are used to tune each layer.



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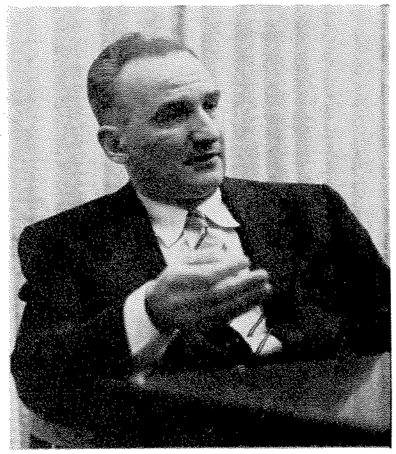


A NEW TECHNIQUE OF EDUCATION

by SIMON RAMO

A noted scientist proposes some radical changes in our educational system to bring it in line with our increasingly technical world

WE ARE IN RAPID transition today to a new world which threatens to be dominated by technological advance. In that new world, (1) man will have learned so much about nature's store of energy and its release that he will have the ability to virtually destroy civilization; (2) production, communications, and transportation will all be "automatic"—these operations of man's material world will have become so vast and complex that they will have to proceed with a minimum of participation by man, his muscles, brains, and senses; and (3) man will conquer space.

There seems little question that these three factors will have dominant effects in the coming decades. The effects are already being felt. (There is even a serious note in the facetious thought that any man who has the courage to stand up and claim that the replacement of man's brains will not have a very important effect on society takes the risk of having his brains among the first to be replaced.)

By hindsight, what is happening would appear to have been entirely predictable centuries ago. We might consider all of man's history until now arbitrarily broken up into two periods, the second of which is now in transition to the new and third one.

In the first period, which might be called the "pre-science" era, man was not consciously employing science to alter his society. Of course he was aware of the world about him, and he sought to adapt himself to nature's laws. But when he objectively began to develop organized ways of thought and experimentation to further his knowledge of nature, then he entered the era of the "discovery of science and its utilization." One step in this second period is the so-called industrial revolution.

In this second era, now coming to an end, man learned to communicate and navigate, to create and harness sources of power well beyond his own muscles, all with the natural result of increased production and fast transportation. In such an era, man would be expected to learn gradually more and more about matter and energy, so as to make possible the release of larger and larger amounts, to the eventual point where he could quickly destroy civilization. He would be expected to so increase and speed up production, transportation, and communications as to tie the entire globe together in an enormous network of automatic machinery, cables, and moving vehicles. In time he would have such potentialities in the control and generation of energy, and in communications and transportation, as to make possible intercontinental ballistic missiles, space satellites, and rockets to the

"A New Technique of Education" has been adapted from a talk given before the California Business Education Association by Simon Ramo, research associate in electrical engineering at Caltech, and executive vice president of The Ramo-Wooldridge Corporation.

moon. So, finally, he would spread out from the surface of the earth to all the space surrounding it.

And the transition is happening just this way to the new technical age. What makes the present period singular is that now, for the first time, a sharp coincidence between the needs and the state of the art exists. The requirements for the new society, the pressure, and the strength of resources to bring it about, now match a sufficiently deep understanding of the laws of nature to make these big steps practical.

Considering the needs

Consider first the needs. As one example, note that we are already at the point in air transportation where we badly need a major entry of automatic techniques in the over-all system for airline navigation and traffic control. Today we are alarmed about occasional accidents. But it will hardly take very much increase in the number of cities originating plane flights, or in the amount of air freight to be handled, or in the spectrum of speeds from the very low-speed helicopters to the high-speed jets, or in the demand for reliable operations in all-weather conditions, before we approach near-chaos at the airports and intolerable dangers in the air lanes.

Similarly, the military situation demands the extension, and often the replacement, of man's brains and senses by automatic gadgetry. The guided missile is taking over in many areas from manned airplanes. Getting up into the skies swiftly in response to detection of enemy bombardment vehicles, finding the location and the expected future path of such enemy vehicles, making the decisions as to what path should be chosen to effect an interception—these functions, to be accomplished with tremendous rapidity for fast vehicles in all weather, and involving a great deal of mathematical complexity in the decisions, are well beyond the pilot's eyes, ears, and brain.

Business and industry — whether it be department stores, insurance companies, banks, railroads, or ordinary factories—have become so large and complex that the sound containment of their operations from an organization standpoint becomes more and more impossible without the use of automatic techniques.

Now the status of science is such that, without a single new discovery—without even one more new law being discovered by an Einstein concerning the nature of the universe or the secrets of the nucleus—we can set out to design mechanical and electronic systems that will take over, and do better, many of the things we now do with our brains and senses.

The coming crisis in education

This rapid and potentially dislocating scientific advance can be expected to heighten and worsen the coming crisis in education. Already, the increasingly technical world uses more scientists and engineers, yet the very industrial development that is part of the growing technical society takes the engineers and scientists away from the university and high school facilities, and the fast world in which we live makes the long study of science seem unattractive to the youngsters. The technical society is complex, rapid, and increasingly dangerous. We can blow up the whole world, yet such a premium is put on the use of our human and physical resources for everything but education that it seems that the new technical society is going to be accompanied by a weakened ability to keep pace education-wise.

Now, if the world were in transition to something different on a very, very slow scale, we could argue that these factors would take care of themselves. Supply and demand would then presumably set to work to make the teaching profession pay off better. Further, the new technical society would be expected to cease to develop rapidly if there were not enough engineers and scientists to make possible that development. So the pace would have to adjust itself to one that would allow all the factors to settle into their respective permanent relative magnitudes.

Looking ahead

But we are moving much too rapidly for that, and our technical growth is paralleled by social maladjustments still left over from previous eras. The adjustments, instead of being slow and stabilizing, could be chaotic. Obviously, something new is needed. Education should be at the head of the list for priority attention. Our hope for attaining any kind of stability in the highly technical world ahead must rest on the ability to look ahead, understand the world and adjust to it. We must reject such solutions as that we do indeed blow ourselves up; and we cannot accept something approaching a robot-controlled world that consists largely of ignorant and uneducated masses who are slaves to a few individuals who push all the buttons on the machines.

A new technique of education

I should like to propose that these very technological advances, about which we normally speak when we talk about the new technical society, must include advances in the field of education, and it is part of the obligation of those of us who are engaged in the engineering side of modern science somehow to apply ourselves to help the process of education. What is needed is a technique of education which is in keeping with the world ahead.

Picture this new technical society—in which the entire airline system, from reservations to blind landing and take-off, is done almost automatically, with the pilot going along only for the ride; in which money is used only in the country communities, and when we buy something in a store we simply put our thumbs up against a little window, our fingerpints are automatically scanned against our balance, and the proper change is made in the respective accounts of the customer and the store—and ask: what will a high school look like at that time?

We have a choice here of two ways to discuss this. We could take it in very gradual steps, starting with the popular suggestion of greater use of television as a teaching aid, or we can allow our imaginations to open up. Let us accept the risk of poor accuracy in prediction and even the risk of exaggeration in order to make a point. We shall describe a technically feasible, even though in some other ways perhaps unacceptable, "modern" high school of the future. But in doing this, please remember that I am neither predicting nor recommending the school I am about to describe, but only using it as a vehicle for making some points later.

School days

First of all, we will get the student registered. I won't burden you with the details here; when the registration is complete and the course of study suitable for that individual has been determined, the student receives a specially stamped small plate about the size of a "charga-plate", which identifies both him and his program. (If this proves too burdensome for the student, who will be required to have the plate with him most of the time, then we may spend a little more money on the installation and go directly to the fingerprint system.)

When this plate is introduced at any time into an appropriate large data and analysis machine near the principal's office, and if the right levers are pulled by its operator, the entire record and progress of this student will immediately be made available. As a matter of fact, after completing his registration, the student introduces his plate into one machine on the way out, which quickly prints out some tailored information so that he knows where he should go at various times of the day and anything else that is expected of him.

A typical school day will consist of a number of sessions, some of which are spent, as now, in rooms with other students and a teacher, and some of which are spent with a machine. Sometimes a human operator is present with the machine, and sometimes not.

A fundamental limitation

One thing needs to be said at the outset. Any attempt to extend the teaching staff with any kind of mechanical aids would appear to have at least one very fundamental limitation. It would seem that, unless a highly intelligent, trained, and authoritative teacher is available, there is no equivalent way of adapting the material to be presented to the individual student's need, or to judge the understanding and reception of the material and adjust it to the student during the presentation, to discover his questions, weaknesses and misunderstandings, nip them in the bud, and otherwise provide the feedback and interaction between teacher and student that is so essential in transferring knowledge from one person to another.

It is for this apparent reason that, although we can use motion pictures and television to replace a lecturer and can, in theory at least, be more efficient in the use of one skilled teacher's time, enabling him to reach a larger audience, we can only use such techniques for a limited fraction of the total school day. However, you will see in the systems that I propose that, in principle at least, modern technology can go a long way toward removing this apparently fundamental limitation. The whole objective of everything that I will describe is to raise the teacher to a higher level in his contribution to the teaching process, and remove from his duties that kind of effort which does not use the teacher's skill to the fullest.

Let us follow a student who is including in his schedule a course in trigonometry. He will spend a few hours a week on this study in automated classrooms. In the case of trigonometry, only a small part of his time need be spent with a human teacher. Some of his classroom exercises will involve presentation of basic concepts in trigonometry in the company of other students in short lectures, delivered by a special sound motion picture, which uses some human actors who enunciate or narrate the principles to the accompaniment of various and sundry fixed and animated geometrical diagrams.

Push-button classes

However, this classroom has some special equipment. Each chair includes a special set of push buttons and, of course, that constant slot into which the student places his identification plate. The plate automatically records his presence at that class, and it connects his push buttons with the master records machine.

If the class is large, our student is much less likely to sleep or look out of the window than in a normal lecture by a human teacher, because, throughout the motion picture that presents some phase of the fundamentals of trigonometry he is called upon to respond by pushing various keys. He is asked questions about the material just presented, usually in the form of alternatives. Sometimes he is told that the concept will be repeated and the question re-asked, this time for the record. He may even be asked whether in his opinion he understood what was being presented.

Special handling

In other words, he is in constant touch with the "teacher"; but something else equally important needs now to be added. His progress and score are used by the electronic master scheduling device to prepare for the special handling of that student in the other portions of the trigonometry course.

At certain other periods during the week, this student continues his trigonometry instruction in a different kind of environment. This time he is seated in front of a special machine, again with a special animated film and a keyboard, but he is now alone and he knows that *this* machine is much more interested in his individual requirements. It is already set up in consideration of his special needs. It is ready to go fast if he is fast, slow if he is slow. It will considerately repeat what he has missed before and will gloss over what he has proven he knows well. This machine continues the presentation of some principles and asks for answers to determine understandings. Based upon the student's immediate answer, it may repeat or go on to the next principle.

With some hints and assistance by the lecturer in the movie, and with appropriate pauses (not accompanied by a commercial), the student is allowed a period for undisturbed contemplated thought before registering his answer.

The machine's job

This machine is prepared to take a single principle and go over it time after time if necessary, altering the presentation perhaps with additional detail, perhaps trying another and still another way of looking at it, hoping to succeed in obtaining from the student answers that will indicate that the principle is reasonably well understood before it goes on to the next one.

Before the student receives the material from this machine, it will have rapidly selected from its file the appropriate films for presentation. These films are already set up with a number of alternatives at each step, and with such inner workings that the machine is prepared to repeat, advance, or substitute material determined by the student's performance.

You will see from this one example that we are placing the machine and the subject matter in contact with the student, and vice versa, in a feed-back relationship. Of course, we do not cover all possibilities; we do not even cover every possibility that a human teacher dealing with that one pupil could observe. But we handle a great many of the more common ones; we will strive for a very efficient and dynamically interesting presentation of a large amount of the material; we will do a very efficient job of examination of some of the student's understanding.

The teacher's role

A brilliant student could romp through trigonometry in a very small fraction of the course time. A dull student would have to spend more time with the machines. The machines can be so set up that, if a student fails to make progress at the required rate, he can be automatically dropped from the course. Of course, before that happens, or before the brilliant student is allowed to complete the course, a special session with that student by a skilled teacher is indicated. But the teacher will be aided by having before him the complete records of what could be weeks of intensive machine operations.

This will make easier a personal study of that student's understanding and his way of thinking about the subject. The teacher will even be able to judge in what way the operation is inadequate and needs to be supplemented, both to take care of that particular student and to improve the automatic techniques. Some students will learn better than others with these machines. Ultimately, with the proper cooperation between experts in education, expert teachers, experts in trigonometry, and experts in engineering these automatic systems, we can evolve that high level of match between the human teacher and the machine that we seek in that improved high school.

The memorizing machine

We can further illustrate these concepts by other special cases. Let us take the memorizing machine, for example. It is important in many studies to do a certain amount of memorizing of facts and data. As a scientist, I know that a facility in study of an advanced subject oftentimes requires that background information be instantly available to the mind. But what a drudgery it is to memorize the weights of all of the chemical elements! In fact, about the best way to do this kind of memorizing is to get help from another individual, who sits with the facts spread out before him, and before whom the memorizer attempts to recite.

The memorizing machine could remove much of this drudgery and make it interesting and efficient. For instance, for the series of chemical elements, the machine could go through the list while the student punches out the corresponding atomic weights on a cash-register type of keyboard. When he misses one, not only does the red light go on (and the sign say "TILT"!), but the machine remembers that he has missed it. As it continues to chase through the list, it will throw in some of those questions that the student has already answered correctly, just to be sure, and to give him the repetitive exercise, but it will more often come back to those where he had trouble previously.

A few minutes a day spent with memorizing machines, each of which is equipped with thousands of records to cover the important information to be memorized about various subjects, will probably accomplish more for the student than much more time spent in other ways.

Of course, it should be clear that this type of dynamic teaching and studying requires such a concentrated effort that it could not be used as the exclusive and total diet of the student, even if it had no limitations whatsoever. However, before we discuss these limitations, and before we try to make certain that we understand the fundamental difference that this kind of technical development could make in educational processes, let us take one or two other examples.

Machines in the laboratory

It is clear that the use of machines in which the student and the presentation are in responsive communication should be helpful in the presentation of theoretical concepts in science and mathematics, in the learning of basic principles, and in the acquisition of information in most other fields as well. But what about such things as chemistry laboratory, English composition, and the teaching of languages?

Let us take the chemistry laboratory first—and remember that we are speaking here not of the principles of chemistry in the theoretical sense, which would be handled much as in the case of trigonometry, but rather of the physical handling of matter in the laboratory and the acquisition of appreciation of the scientific method of observation and deliberation. I think much can be done here.

Teaching on film

Picture, first, the student seated again before a special viewing screen and certain apparatus. The chemistry professor in the movie has the equivalent apparatus in front of him. He turns some valves and allows some fluid to go into a container. He adds to this another different fluid. He observes the characteristics of the combination, he refers to the theory, he describes what is happening and why it happens. He then asks the student to turn the valves in front of him to let so much red fluid into the glass below, and so much blue fluid into the same glass. He tells the student that, if he has indeed poured the right amount in and observed every other requirement as described, he can expect certain results.

To show the possibilities, imagine that the instructor suggests that the liquid should be pink and asks the student to push button A if he has obtained this result, and button B if he has not. Now let us suppose that the student pushes button A. The moment he does this, the film immediately switches to one in which the professor points an admonishing finger at the student and says, "Oh, oh, oh—now look at that liquid! That isn't pink. You were simply led by suggestion to expect the result. You didn't use your own powers of observation. Clearly, if you look honestly at that liquid, it is, if anything, slightly on the yellow side. You must learn the first principle of science. That is to be honest—not to expect a result, but to seek to observe what result you do indeed have and report it accurately."

Teaching English

On the other hand, if the student refuses to push button A and pushes button B instead, a different film will congratulate him on being objective and having the necessary characteristics for the scientific approach. It is quite possible for experts in chemistry and education, I believe, to create a large number of laboratory setups that can easily be kept full and ready by operators, so that the student can conduct his laboratory experiments without detailed supervision, and with great efficiency and good records.

Teaching English and composition is difficult, as is instilling into one an appreciation of good literature. But even here we certainly can add to the exposure of the student to good literature and, by probing the student's understanding and response, we can alter the speed and nature of the presentation. We can improve his knowledge of the tools of good expression so that we leave only the more creative aspects (which must rest at least partially, presumably, on these tools, and on the knowledge of the characteristics of good literature) to his personal contacts with the skilled teacher.

Teaching foreign languages

Similarly, in the teaching of languages, vocabulary improvement, grammar, and understanding the spoken language could be advanced by these feedback machines. Even the ability of the student to speak the language could be enhanced by machine. He could respond orally to the animated film in front of him, repeat the foreign words spoken to him by an expert into the microphone, play back the results immediately and repeat the whole process. This, you see, goes a substantial step beyond the use of records, which I understand is quite common in the courses now available commercially for learning foreign languages the "easy way."

Let us see what physical and human resources this high school would have. To begin with, the physical plant would include a large amount of apparatus that does not now exist, but that can be designed and constructed with today's art.

There would be administrators and clerks who would handle all of the administrative processes, but who would not be at all concerned with, and not be trained in, education. There would be a group of highly skilled teachers. The more conventional type of teaching would still be a substantial part of the total operation. For the new, automated material, these teachers would work closely with the experts on the subjects, and with the education engineers who design all of the electronic equipment that is basic to the process.

A new industry

To back this up, of course, one would have a very substantial new industry in the United States concerned with the creating of these educational machines and the motion pictures and memory data used by the machines. In general, the industrial organizations concerned with the creation of machines that make possible the teaching of mathematics would have to employ experts in education, experts in mathematics, and experts in engineering. And this industrial team would have to be in good contact with the skilled teachers who make up the high school staff, in order that they might be able to improve their machines, create the proper material, and learn the shortcomings of all of their designs—either of the machine or of the material.

In addition, the high school teaching staff would include education analysts, probably specializing in the various subjects. These individuals would go through the records of the individual students. They would be constantly seeking to discover the special problems that need special attention, by the direct contact of teacher and pupil.

We notice a number of very significant points here. The high school becomes partially transformed into a center run by administrators and clerks, with a minimum of the routine assigned to the teaching staff. The teaching staff is elevated to a role that uses the highest intelligence and skills. A smaller number of teachers make possible the education of a larger number of pupils. The creation of educational material moves partially out into industry, which goes into the education business in partnership with the educators.

A new profession

There is probably a new profession known as "teaching engineer," that kind of engineering which is concerned with the educational process and with the design of the machines, as well as the design of the material.

One might imagine, for example, that a course in solid geometry, with its three-dimensional patterns, would be based around 3-D animated communicative-response systems, and that some of the experts on the teaching of solid geometry should better be employed in industry than in the school. Those teachers who would be employed in the schools themselves would be individuals able to handle the more difficult problems that are left for the human teacher and the analysis of the processes that involve the use of the machine.

From the standpoint of the student, I no not know that his life need be changed in any fundamental way. It may be, of course, that the evenings and weekends would cease to be times for doing homework. The equivalent of homework, as well as the basic presentation periods, would be done perhaps during the normal working day, five days a week, with the evenings and the weekends used for the broader cultural, social, and athletic events. That is, the evening would be a time for a more relaxed participation in the learning and broadening programs.

I think it is true that, with this kind of an educational system, the student need not feel that he is dealing with cold machines in place of warm human teachers any more than he feels that way today when he reads a book by himself instead of listening to an oral presentation by a human teacher.

An expensive operation

It is interesting now to look for a moment at the economics of such an educational system. In principle, it obviously has application to the lower grades, and certainly to the university as well. But, wherever it is applied, it is quite easy to show that it is an enormously expensive operation.

Use that course in trigonometry, for example. As a motion picture, it would involve not one hour or two hours but, say, one hundred hours of expensive teaching material. Unlike a motion picture, it would not be viewed by tens of millions of people all over the world. The audiences, for the most part, would be small, and unless we could unite all trigonometry students for a number of years in the common use of this same material, it is apparent that the cost would be rather large. If we pay something like 50 cents an hour to see an ordinary motion picture, then a trigonometry course would cost thousands of dollars per student, and the complete high school year would cost tens of thousands.

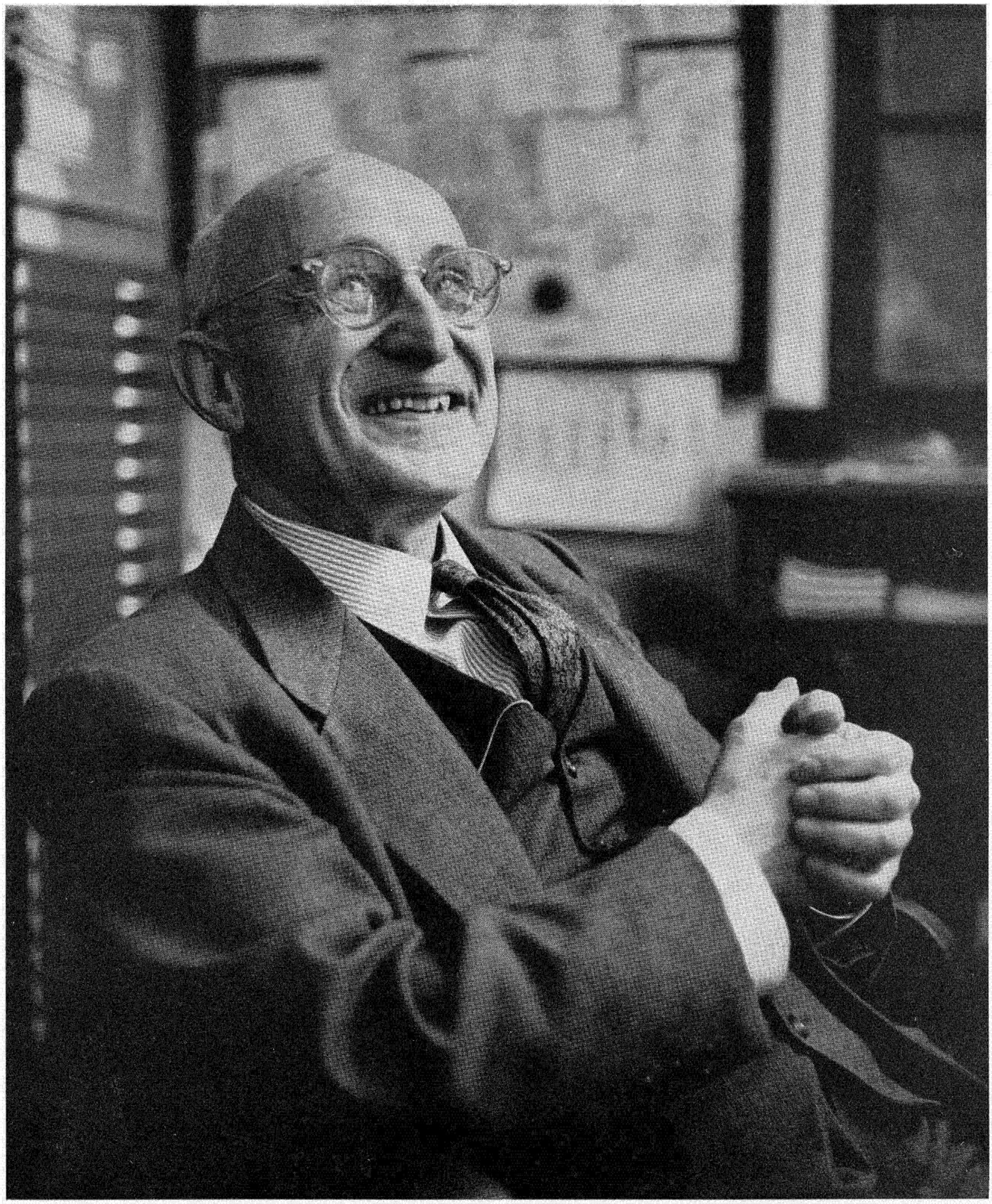
Slaves and machines

If we reflect for a moment on this matter of economics, we are reminded again that something is very wrong in the balance between that part of the national economy we devote to education and the part we are willing to devote to other things. To bring this point out, let us use the analogy of the Egyptians building the pyramids by the use of thousands of slaves pulling huge rocks—that is, by the most laborious and inefficient way possible in terms of the use of human beings. We imagine that we could have walked up to the Pharaoh and said, "This is not the way to build your huge monument. For this you should use bulldozers and cranes and steamshovels; why, a handful of men and a handful of machines would replace your thousands of human operators." But then the Pharaoh would have said, "Ah—but will it save me any money?" So we would figure it all out and discover that it would cost him much more if he changed to the machines because he paid his slaves so little.

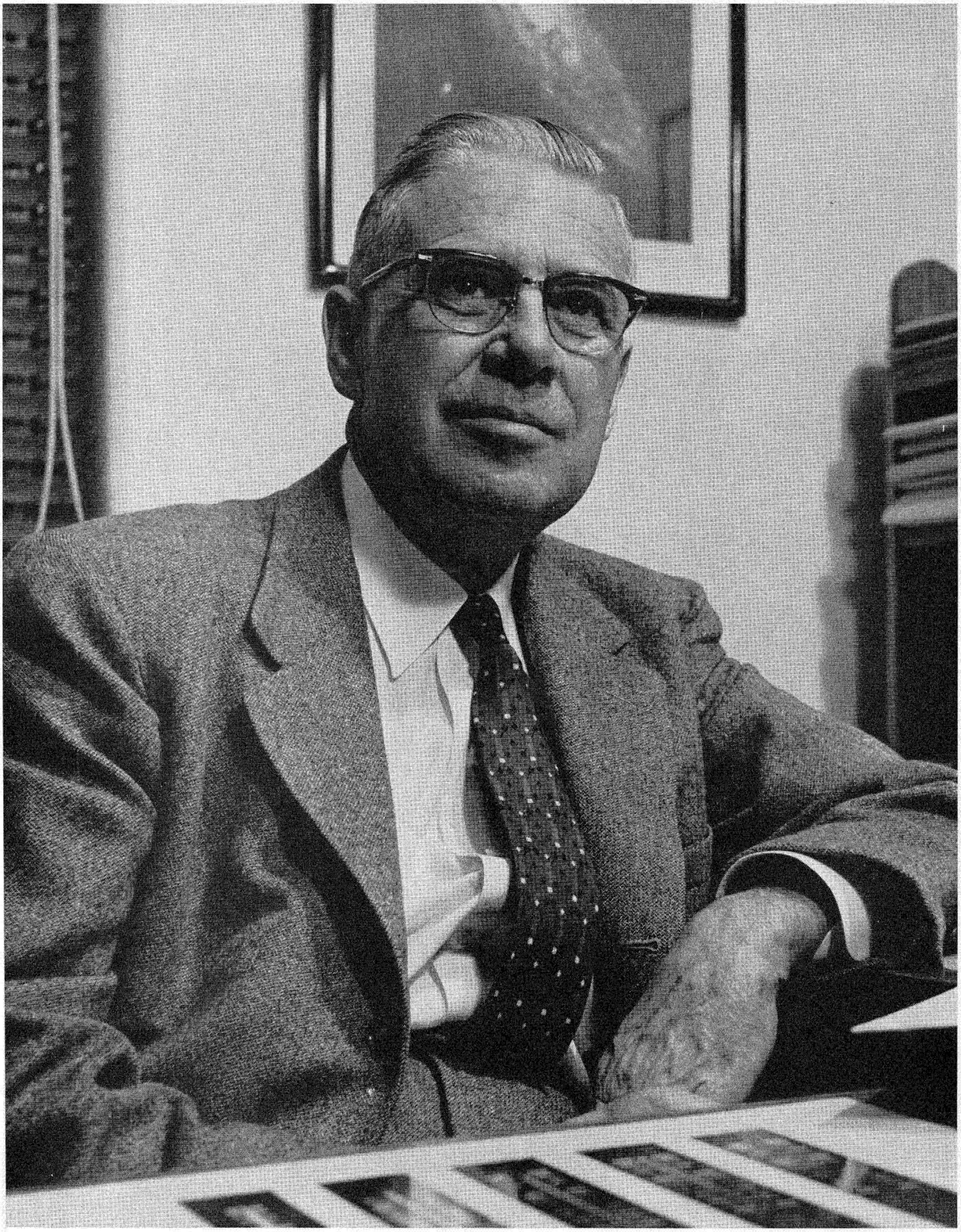
In this system that I have described, we seek to elevate the teacher to the exclusive use of the higher abilities and qualities he possesses. It is a system that makes possible more education for more people with fewer skilled teachers being wasted in the more routine tasks that a machine should do for them. And we come up against this economic question. Today, the teachers are doing all of these things—the routines, and the handling of those levels of teaching requiring the highest of intelligence and training—and they are doing them for less than the cost of the machines, which could only hope to replace the lower level of the teaching art and skill!

A ridiculous idea?

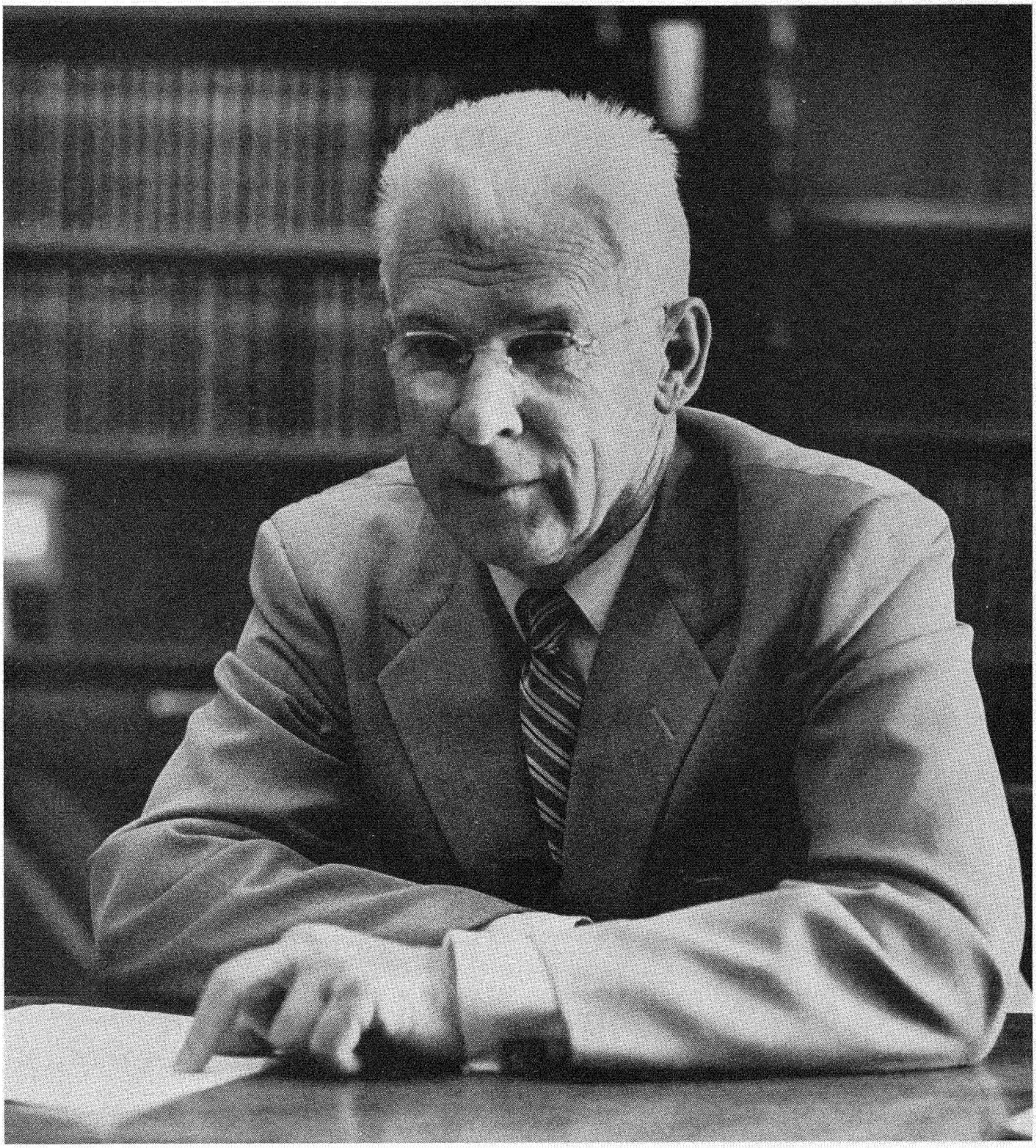
The examples I have presented here illustrate what I think is the most important point that can perhaps be contributed to a discussion of the relationship of the technological revolution and the educational process. While being defensive about these specific ideas, I won't go so far as to say that there is nothing in them. My work has accustomed me to the idea of being willing to allow imagination to roam freely, and my associates in science attribute a quotation to me which goes something like this: "Don't be ashamed to propose a ridiculous idea. Though worthless today, in ten years it may be of no value whatsoever."



BENO GUTENBERG, who has been on the staff of the Caltech Seismological Laboratory for 27 years, retired as director of the laboratory in June. Although his official appointment as director did not begin until 1947, Dr. Gutenberg was "in charge" of all activities at the laboratory from the start. A native of Darmstadt, Germany, Dr. Gutenberg was already an internationally recognized authority in the fields of seismology and geophysics when he came to Caltech in 1930. He made one of his most important contributions to seismology in 1912, at the age of 23, when he made the first correct determination of the structure of the earth's central core. His other contributions include work on the investigation of seismic waves, and on structural differences between continents and ocean bottoms.



MILTON L. HUMASON, staff member and secretary of the Mount Wilson and Palomar Observatories, retired in June after 40 years of service. Dr. Humason went to work as a janitor at the Mount Wilson Observatory in 1917. By 1920 he was functioning as a night assistant to the astronomers, and in 1922 he was made a member of the observatory's staff of investigators. His remarkable techniques for photographing the spectra of very faint objects, and his long and painstaking observations provided most of the supporting evidence for the late Dr. Edwin P. Hubble's theory of the expanding universe.



SETH NICHOLSON, who joined the staff of the Mount Wilson Observatory in 1915, retired this June after 42 years of service. A large part of Dr. Nicholson's work at Mount Wilson has been devoted to solar observations, and he has developed a detailed knowledge of the complex phenomena of the sun's visible surface. He has supervised the systematic collection of data on sunspots, including the polarity and strength of their magnetic fields. Over the years, he has made observations of Jupiter's satellites. At the Lick Observatory in 1914 he discovered the ninth of these objects; at Mount Wilson he went on to find the tenth, eleventh and twelfth.

Hugo Benioff, professor of seismology, is on the IGY's Technical Panel on Seismology and Gravity.

by HUGO BENIOFF

CALTECH AND THE IGY

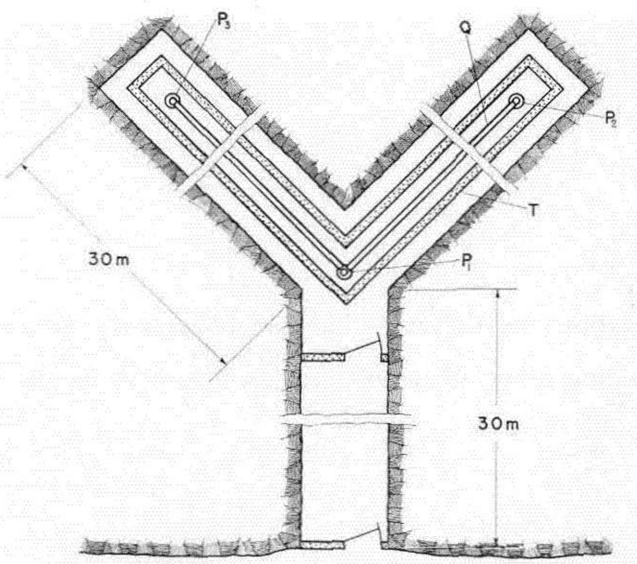
SEISMOLOGICAL RESEARCH

ONE OF THE IGY PROJECTS conducted by Caltech's Seismological Laboratory is the construction of two fused quartz extensometer installations in South America.

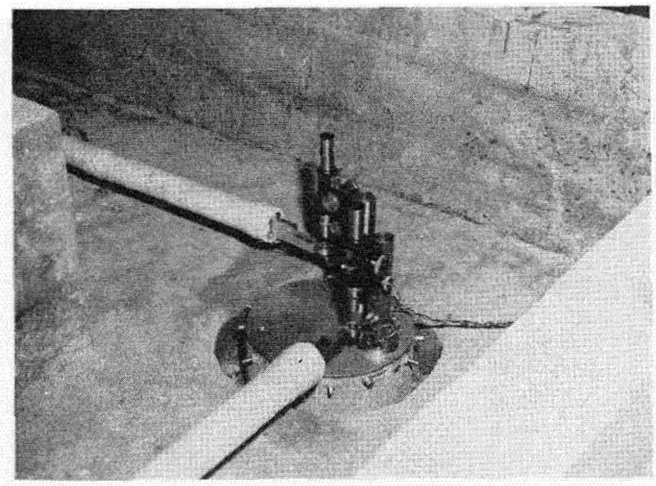
When completed, the extensometers will provide three kinds of observational data. First, measurements of secular strain changes occurring in the great Andes mountain range; second, measurements of the tidal strains of the earth produced by the gravitational action of the sun and moon; and third, recording of ultra-long-period seismic waves, including possible free vibrations of the earth excited by earthquakes. It is possible that measurements of secular strains made at an adequate number of stations over a long enough time interval may give sufficient information to determine the nature of the strain pattern habit of a region, and so provide the basis for the prediction of earthquakes. The time required for such a study may well run into several centuries.

One of the new extensometers is located in the outskirts of Santiago, Chile, and the other is in Chosica, a small settlement some 30 kilometers from Lima, Peru. Both installations are being done with the cooperation of local agencies, the University of Chile at Santiago, and the Peruvian Committee of the IGY at Chosica.

For their contribution to the joint effort, the local



Schematic plan view of the extensometer installation in Chosica, Peru.

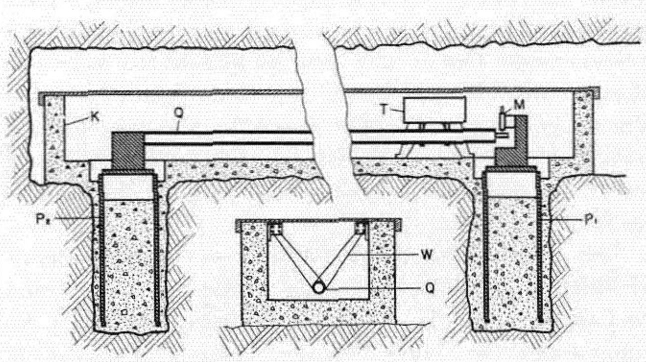

The pier of the Santiago installation showing the ends of the quartz standards and the measuring microscopes.

agencies have excavated the tunnels in which the instruments are located and are providing electric power at the sites: In addition, they are supplying personnel for operation of the stations.

Construction of both installations is under the direction of George Mace, who was contractor for the original Caltech fused quartz installations at Dalton Dam (Los Angeles County), and Isabella (Kern County). Dr. Cinna Lomnitz, who received his PhD in geophysics from Caltech in 1955, and is now a member of the staff of the University of Chile, is local scientific advisor for the Santiago work. Dr. J. A. Broggi is the scientific advisor for the Chosica site and chairman of the Peruvian Committee of the IGY.

Each installation consists of two mutually perpendicular horizontal extensometers mounted in tunnels bored in igneous rock as shown above. The length standards are constructed of fused quartz tubing 2.5 inches outside diameter by 0.25-inch wall and are 25 meters long.

The mounting of the standards is shown below in a schematic vertical section through one component. P_1 and P_2 are piers constructed of sections of 12-inch steel pipe sunk into the rock and cemented in with concrete. The quartz standard Q is rigidly fastened to one pier and is supported by a series of stainless steel wires as shown at W in the insert. These prevent transverse movements of the quartz standards without exerting effective longitudinal constraints. Secular measurements are made with the measuring microscope M mounted on the pier P_1. The microscope focuses on a graduated glass scale mounted on the end of the quartz tube.



Schematic vertical section of one extensometer component.

Changes in the state of strain in the ground between the two piers displace the graduated scale relative to the microscope cross-hair. The amount of the displacement is read directly from the scale and the corresponding strain increment is given by the ratio of displacement to the pier separation.

The photograph above, taken at the Santiago installation, shows the pier P_1, the end sections of the quartz standards, and the two measuring microscopes. The transducer for the tidal strain recorder, shown at T, is of the variable capacity resonant bridge type and operates with a carrier frequency of 5 megacycles per second. It is constructed with transistors exclusively. Output from the transducer actuates the ink writing recorder.

Fused quartz was chosen for the standards, owing to its low thermal expansion (above 5×10^{-7} per degree C.) which, with the expected annual temperature variation within the tunnel of not more than one or two tenths of a degree, should permit secular strains to be measured with an accuracy of approximately one part in 10^7. Since the diurnal temperature variation of the tunnel is very much smaller, tidal strains can be measured to within about one part in 10^9.

Recordings made with the extensometer tidal strain recorder at Isabella, California, indicate that the sensitivity of the transducer recorder assembly is such that one division on the record represents a strain increment of 8.6×10^{-10}—equivalent to 1/10 of an inch in 2000 miles. The South American tidal strain recorders are similar to this one in design and are expected to produce similar recordings.

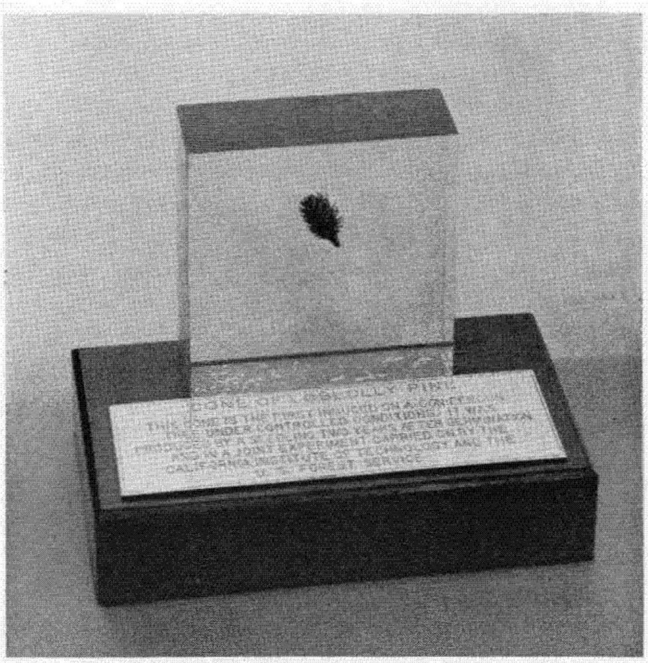
PINE TREE PROJECT

Research in progress in Caltech's Earhart Laboratory marks the beginning of a new era in scientific forestry

A SMALL PINE CONE, mounted in lucite, was sent off from Caltech this month to Dr. George Jemison, of the Branch of Research of the U.S. Forest Service in Washington, D.C. It was a pretty special pine cone. It marked the beginning of a new era in scientific forestry, because it had been produced in Caltech's Earhart Plant Research Laboratory.

The pine cone was the result of a project set up two years ago by Dr. Jemison, in which Caltech and the U.S. Forest Service have been jointly studying "important and difficult problems of forestry." One of the most difficult of these problems has been to find a way to produce early flowering in pine trees.

The reproductive cycle of the pine tree is so long that geneticists are not ordinarily able to study it. The breeding cycle of the Western yellow pine, for example, is like that of a human being; it takes 30 years from seed to tree to pine cone to seed again. This means that, if a 30-year-old forester crosses a pine tree, by the time he finally obtains the seeds produced by his hybrid tree, he will be just about old enough to retire from work.



The first pine cone to be produced under controlled conditions in the Earhart Plant Research Laboratory.

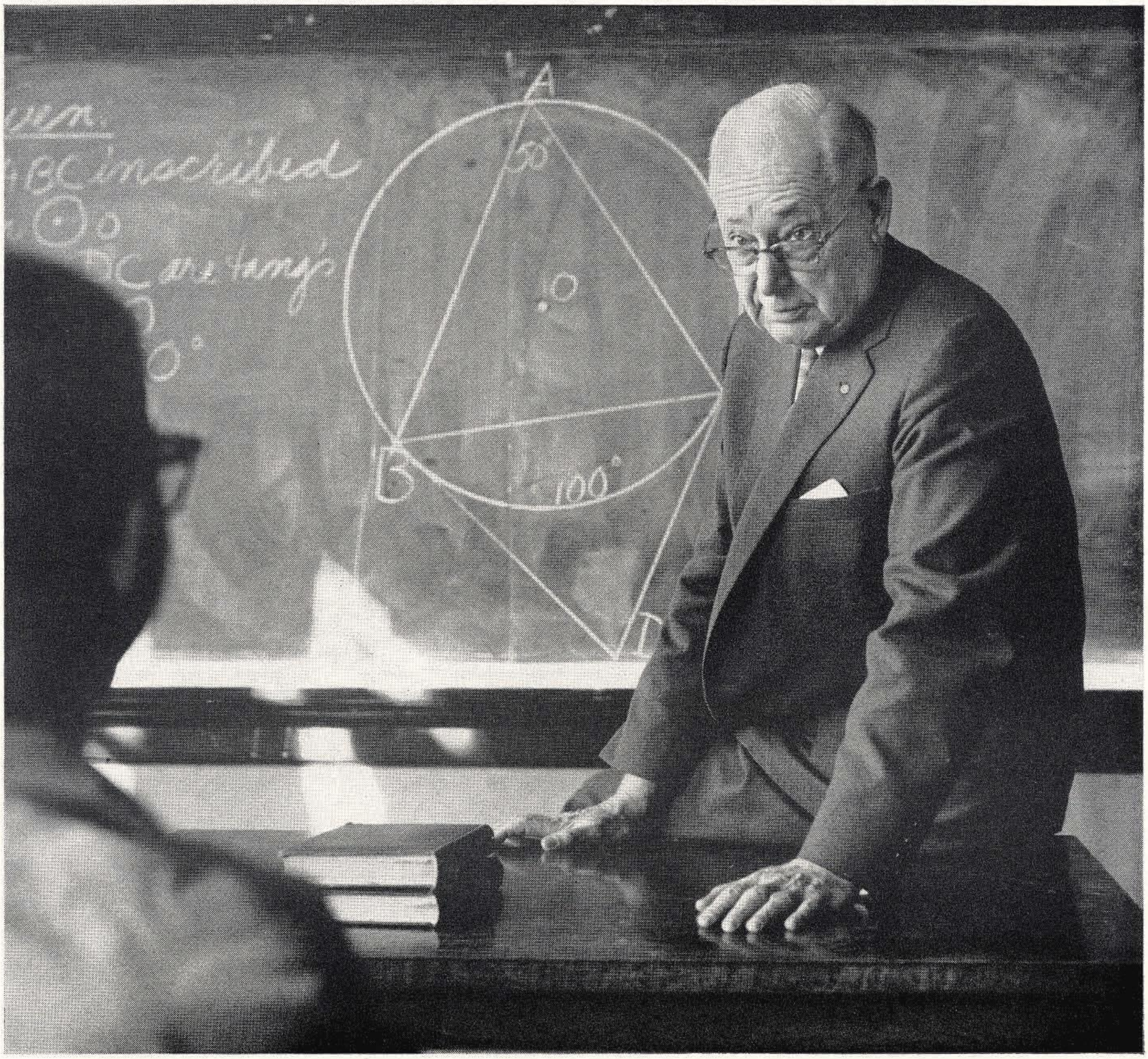
When the Caltech and U.S. Forest Service researchers started their pine tree project, they chose a Southern pine to work with. This variety not only flowers much earlier than the Western yellow pine, but it is of great commercial interest besides. In fact, the Southern pine is the most important pulp wood in the United States today, and it is now even grown as a crop, like cotton.

The researchers started with selected seeds from single trees of the Southern pine. The seeds were planted in the Earhart Plant Research Laboratory at Caltech, where climatic conditions can be controlled. Some of the small trees were placed under conditions of continuous summer, so that they grew rapidly in size. Some were planted under conditions of alternate summer and winter, so that several yearly growth cycles were consummated in each 12-month period. Finally, some of the trees were first grown to large size in continuous summer, then given a long winter period of dormancy before being returned to summer conditions—in which they resumed their growth.

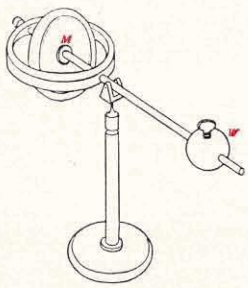
Two years after the seeds were planted, this third group of trees produced three female flowers, or pine cones. This is believed to be the first deliberate induction of flowering in a pine tree.

The fact that cones have been produced in the Southern pine in two years—instead of the usual 10 to 15 years—means that it may now be possible to hybridize through repeated generations in the time-span of a single human generation. In other words, it may soon become practical to breed trees for faster growth, for better wood, for resistance to disease and pests, or for growth in varied climates.

The research is being carried on by Dr. Henry Hellmers—a scientist of the U.S. Forest Service assigned to Caltech, where he is a senior research fellow in biology—and Dr. James Bonner, Caltech professor of biology.



A Teacher affects eternity...
he can never tell where his influence stops



. . wrote historian Henry Brooks Adams—a truth that today demands universal recognition. America is losing to industry many of those best able to inspire and mold youthful minds—the dedicated teachers of high school subjects prerequisite to engineering training.

The value of a teacher's influence in a boy's selection of a career cannot be over-estimated, yet all too often the rewards of teaching are more spiritual than material. Compensation fitting the importance of their work can help keep teachers in their classrooms, where they prefer to be.

America gains every time teaching is chosen as a career. It also gains whenever a teacher finds it possible to remain in the profession.

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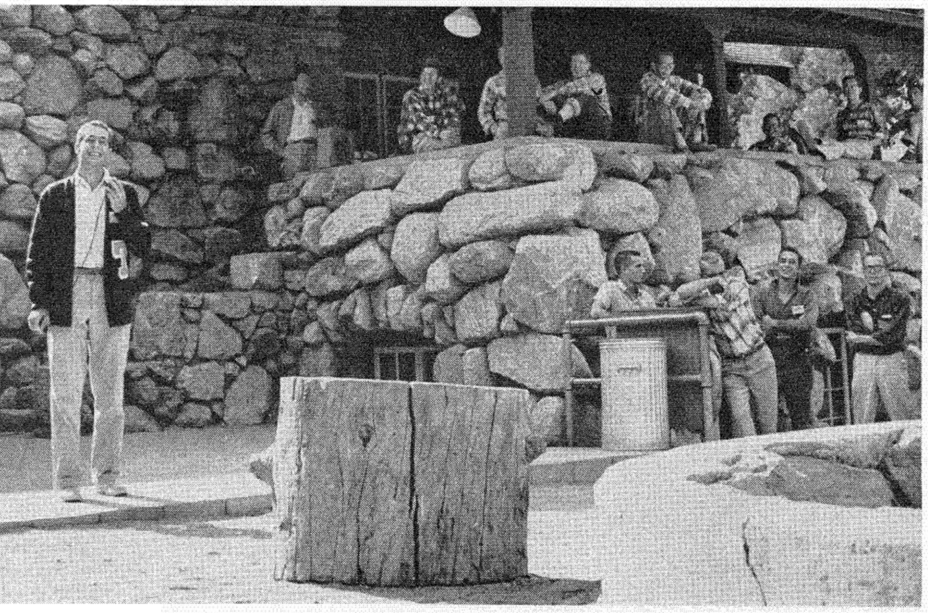
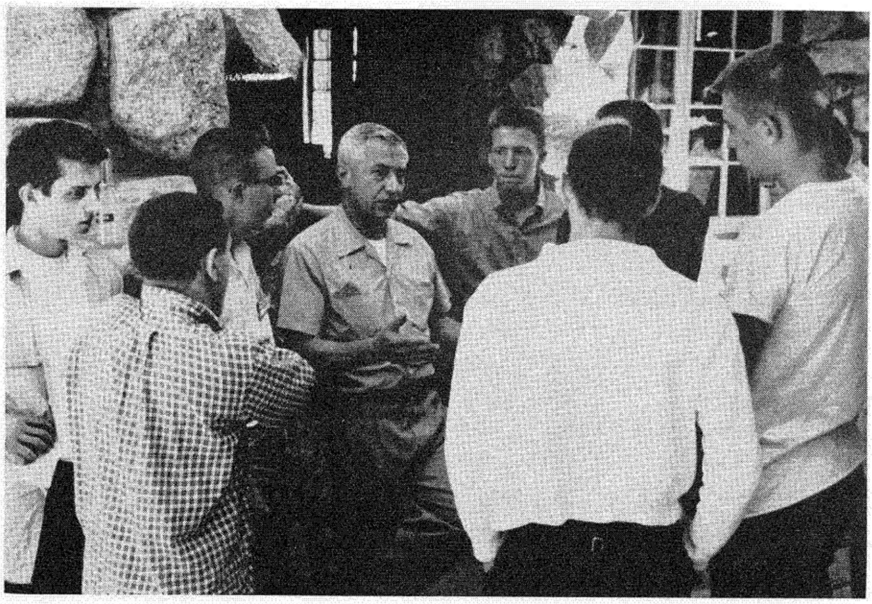
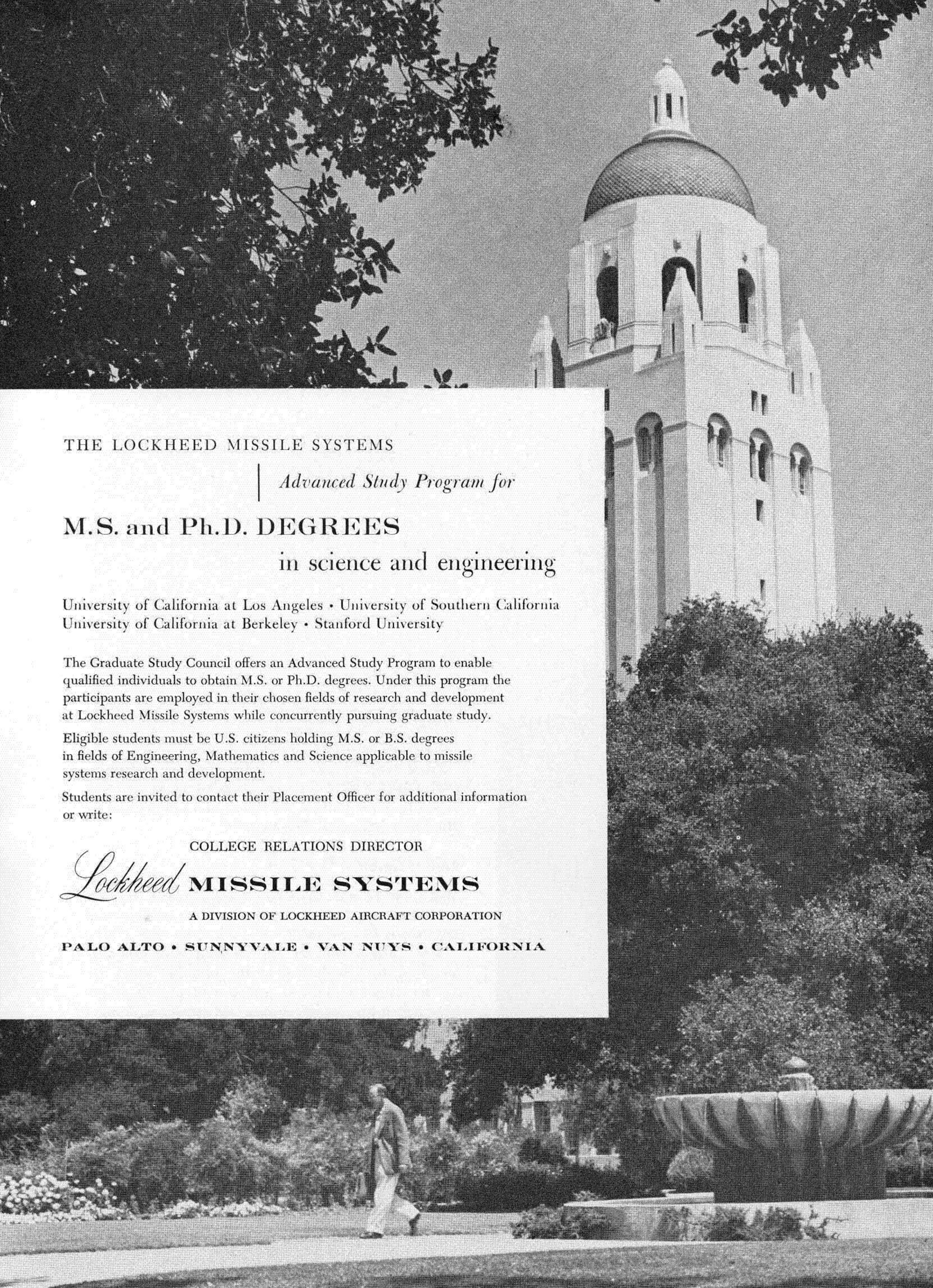


FRESHMAN CAMP

THE CLASS OF 1961 started its Caltech career this fall with the traditional three-day trip to Camp Radford in the San Bernardino Mountains. They listened to speeches by faculty members and student leaders (like Keith Brown, above, delivering himself of a talk called "Any Questions?"), met President DuBridge (below) and produced a pick-up talent show which included (left) upperclassman Tony Iorillo on trumpet and Dr. Richard Feynman, professor of theoretical physics, on the bongos.





THE SUMMER AT CALTECH

W. B. Munro

William B. Munro, trustee of the Institute, and professor emeritus of history and government, died at his home in Pasadena on September 3. He was 82 years old.

One of the early organizers of the Institute, Dr. Munro was a nationally-known authority on history and government. He was the author of 26 books used in colleges here and abroad.

Born in Almonte, Ontario, Canada, he got his BA, MA, and LLB degrees at Queen's University in Kingston, Ontario, then went on to take MA and PhD degrees at Harvard. For three years he taught history and political science at Williams College in Williamstown, Massachusetts, then joined the faculty at Harvard, where he remained for 24 years.

W. B. Munro

He was Jonathan Trumbull Professor of history and government at Harvard, and chairman of the department of history, government and economics, when he came to spend a sabbatical year in Pasadena in 1925 and, at the invitation of R. A. Millikan, agreed to divide his time between Harvard and Caltech.

In 1927 he became a member of the Institute's Executive Council, and in 1929 came to devote his full time to Caltech. In addition to teaching, he made plans, let contracts, and supervised construction of most of the buildings on campus. He became a member of the Institute Board of Trustees in 1945, and served as treasurer of the Institute from 1945 to 1954.

Besides serving as a director of a number of business organizations, Dr. Munro was a trustee of Scripps College, Claremont College, the Huntington Library and the Huntington Memorial Hospital.

Ruth Tolman

Mrs. Ruth Tolman, psychologist and widow of Dr. Richard Tolman, died at her home in Pasadena on September 18. She was 64 years old.

Mrs. Tolman and her late husband were extremely active in the development of the Institute, which Dr. Tolman joined in 1921 as professor of physical chemistry and mathematical physics. He served as dean of the graduate school from 1934 to 1946. After his death in 1948 Mrs. Tolman established the Richard Chace Tolman Fellowship in theoretical physics in his honor.

Mrs. Tolman was a director of the American Psychological Association and served on its committee on professional and scientific ethics. She had been president of the Western Psychological Association, and was a director of the American Board of Examiners in Professional Psychology. She was also on the staff of the

How RCA tracking equipment will escort first man-made moon into its orbit

"Ten . . nine . . eight . . seven . . six . ."

At the launching site, and for 2,000 miles down range, RCA men stand by U. S. Air Force equipment, listening to the countdown.

In seconds – just five now – their tracking data will begin to pour like a flash flood into the Central Control room at the Air Force Missile Center. And the first man-made moon in all history will be rocketing toward its orbit in outer space.

Rocket speed, position, angle of climb, course, and much, much more must all be resolved into one vital decision by the men in Central Control: *Whether and when–to the split second–to trigger a ground command that can aim the satellite into its orbit or, if necessary, destroy it.*

The tracking data will come from the most ingenious and accurate instruments it is now possible to devise. From start to finish they have been planned, engineered, installed, maintained and operated by RCA.

In helping bring man to the threshold of The Space Age, RCA helps fulfill the promise of untold benefit to people the world over – and proves again that there is real meaning in the slogan–"RCA–*Electronics for Living.*"

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Electronics for Living

Mental Hygiene Clinic of the Veterans Administration, and was their consultant on training staff psychologists.

She served on a number of California State committees, including the Governor's Advisory Committee on Mental Health. During the war she served with the Office of Price Administration, the Office of War Administration, and the Office of Strategic Services.

Ruth Tolman

New Director

FRANK PRESS, professor of geophysics, is the new director of Caltech's Seismological Laboratory, succeeding Beno Gutenberg, who retired this summer (p. 23). Dr. Press, who is 32, has been a member of the laboratory staff since 1955. He was formerly associate professor of geophysics and a member of the research staff of the Lamont Geological Observatory at Columbia University.

Faculty Changes

NEW MEMBERS of the Institute's staff of instruction and research for 1957-58 include:

Fred C. Anson, instructor in chemistry, who received his BS here in 1954 and his PhD from Harvard this June.

Halton C. Arp, staff member of the Mount Wilson and Palomar Observatories, from Indiana University, where he has been a research associate in astronomy since 1955. He received his BA from Harvard in 1949 and his PhD from Caltech in 1953.

George M. Brown, senior research fellow in chemistry, on leave from the University of Maryland, where he is associate professor. Dr. Brown, who is at Caltech on a National Science Foundation Fellowship, received his BA and MS degrees at Emory University in Georgia and his PhD at Princeton in 1949.

James C. Findley, instructor in history, is at Caltech on a part-time basis while working for his PhD at Claremont Graduate School. He received his BA and MA from Occidental College and has been a member of the faculty at Fullerton Junior College for the past two years.

Ludwig E. Fraenkel, visiting assistant professor of aeronautics, from Imperial College in London, England, where he has been a lecturer in aeronautics since 1953.

Joel Franklin, associate professor of applied mathematics, from the ElectroData Corporation, where he was senior mathematician.

Milton Gordon, associate director of the Management Development Center of the Industrial Relations Section, from Marquette University in Milwaukee, Wisconsin, where he has been associate director of The Management Center for the past four years.

Brian F. Gray, A. A. Noyes research fellow in chemistry, from Manchester University in England, where he received his BSc in 1954, his MSc in 1956, and his PhD in 1957.

Fred Hoyle, visiting professor of astronomy for one full term each year on a five-year appointment, from St. John's College and Cambridge University in England, where he is a lecturer in mathematics.

Eugene Jansen, research associate in biology, from the Albany, California, branch of the Agricultural Research Service of the U.S. Department of Agriculture, where he is head of the fruit processing section.

Leland H. Jenks, visiting professor of history, from Wellesley College, where he has been a member of the faculty for 27 years.

Edward L. King, senior research fellow in chemistry, on leave of absence from the University of Wisconsin, where he is associate professor. Here on a Guggenheim Fellowship, Dr. King is a graduate of the University of California, where he received his PhD in 1945.

Dennis V. Long, instructor in civil engineering, received his BS in 1949 and his MS in 1955 from Caltech, and is working for his PhD here.

Major Francis R. MacKenzie, assistant professor of air science, from Rhein Main, Germany, where he has served as control officer with the Military Air Transport Service since 1954.

Jon Mathews, instructor in physics, who received his PhD here this June.

Walter E. Meyerhoff, senior research fellow in physics, from Stanford University where he is associate pro-

fessor. Dr. Meyerhoff received his PhD at the University of Pennsylvania in 1946.

E. Mollo-Christensen, senior research fellow in aeronautics, from MIT, where he is assistant professor of aeronautical engineering. Dr. Mollo-Christensen received his MS in 1949 and his ScD in 1954 from MIT. A native of Norway, he was senior scientific officer of the Norwegian Defense Research Establishment at the University of Oslo for two years.

John H. Richards, assistant professor of chemistry, from Harvard, where he was an instructor in chemistry. Dr. Richards received his BA in 1951 and his PhD in 1955, from the University of California. He received his MA from Oxford in 1953, when he was a Rhodes Scholar there.

Robert L. Sinsheimer, professor of biology, from Iowa State College, where he has been a member of the faculty since 1949. Dr. Sinsheimer was graduated in 1941 from MIT, where he served as a staff member of the radiation laboratory from 1942 to 1946 and received his PhD in 1948.

Dwight M. Smith, instructor of chemistry, from Pennsylvania State University, where he received his PhD in June.

John Todd, professor of mathematics, from ten years with the National Bureau of Standards in Washington, D.C. Professor Todd received his BS from Queen's University in Ireland in 1931. His wife, *Olga Taussky Todd,* is also at Caltech, as a research associate. She is known as one of the world's leading women mathematicians.

C. H. E. Warren, senior research fellow in aeronautics, from England, where he is senior member of the scientific staff of the Royal Air Force Establishment. He received his BA in 1940 and his MA in 1944 from Trinity College in Cambridge.

Charles P. Wells, research associate in mathematics, from Michigan State University where he has been professor of mathematics since 1938.

The following promotions have been made in the Caltech faculty for 1957-58.

To Professor:

Norman R. Davidson—Chemistry
Robert V. Langmuir—Electrical Engineering
Frank E. Marble—Jet Propulsion and Mechanical Engineering
Stanford S. Penner—Jet Propulsion
J. Harold Wayland—Applied Mechanics
Charles H. Wilts—Electrical Engineering

To Associate Professor:

Alfred C. Ingersoll—Civil Engineering
Theodore Wu—Applied Mechanics
Caleb W. McCormick, Jr.—Civil Engineering

To Senior Research Fellows:

Saul Kaplun—Aeronautics
George T. Skinner—Aeronautics
S. R. Valluri—Aeronautics
William Willmarth—Aeronautics
Justine Garvey—Chemistry

To Assistant Professor:

Calvin H. Wilcox—Mathematics

On leave of absence:

Gunnar Bergman, assistant professor of chemistry and mechanical engineering, for a year of study at the Max Planck Institute in Stuttgart, Germany, and the University of Innsbruck, Austria, on a Guggenheim Fellowship.

Leverett Davis, Jr., Professor of theoretical physics, to conduct research on the origin of cosmic rays and magnetic fields in astronomy at the Max Planck Institute for Physics in Göttingen, Germany, on a National Science Foundation Fellowship and a Fulbright travel grant.

Renato Dulbecco, professor of biology, to study the problems of RNA chemistry and structural function at the Molteno Institute and the Cavendish Laboratory at Cambridge University in England.

Ray Owen, professor of biology, for one year as a research participant in the biological division of the Oak Ridge National Laboratory.

Ernest H. Swift, professor of analytical chemistry, to study freshman college courses in general chemistry at other institutions, on a Guggenheim Foundation grant.

Alvin V. Tollestrup, assistant professor of physics, to Geneva, Switzerland, for one year, where he will be working with the European Council for Nuclear Research, on a National Science Foundation Fellowship.

Cornelis A. G. Wiersma, professor of biology, to the University of Cambridge in England, for one year, as visiting professor of zoology, on a Guggenheim Fellowship.

H. Dan Piper, associate professor of English, to Burlington, Vermont, to complete a biographical study of F. Scott Fitzgerald, on a Guggenheim Fellowship.

Departures:

Peter Kyropoulos, associate professor of mechanical engineering, left this summer to assume a new post as executive in charge of technical development of General Motors Styling in Detroit, Michigan. After receiving his BS from the University of Göttingen, Germany, in 1936, Dr. Kyropoulos came to Caltech, where he got his MS in 1938 and PhD in 1948. He has been on the Caltech faculty since 1943.

Richard S. Schweet, senior research fellow in biology, to the City of Hope Medical Center in Duarte, California, where he will be chief of the section of cardiac chemistry.

John L. Stewart, associate professor of electrical engineering, to the University of Southern California where he is an associate professor.

Yes, we want engineers,

BUT

. . . we don't want just any engineer. We want engineers with ideas, engineers with drive, engineers who can stick with a job and work with other people to get it done. Scientists, business and liberal arts graduates, too.

Union Carbide has a marvelous potential. It's a top producer of many things, from petrochemicals to titanium, from molecular sieves to flashlight batteries. Its sales have soared from a half a billion in '47 to one and a third billion in '56.

And we plan to keep on growing. That's where you come in.

We need creative people. We spend a good portion of sales profit on research, but it takes creative people to make research effective.

We need people with initiative. They are the key to opening up new markets and to get production rolling. We introduce new products at the rate of two a month, and the rate is accelerating.

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY Plastics, including polyethylene, epoxy, fluorothene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

HAYNES STELLITE COMPANY Special alloys to resist heat, abrasion, and corrosion; cast and wrought. L. E. Denny, 725 South Lindsay Street, Kokomo, Ind.

LINDE COMPANY Industrial gases, metal-working and treating equipment, synthetic gems, molecular sieve adsorbents. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY Industrial carbon and graphite products. PRESTONE anti-freeze, EVEREADY flashlights and batteries. S. W. Orne, P. O. Box 6087, Cleveland, Ohio.

SILICONES DIVISION Silicones for electrical insulation, release agents, water repellents, etc.; silicone rubber. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE CHEMICALS COMPANY Synthetic organic chemicals, resins, and fibers from natural gas, petroleum, and coal. W. C. Heidenreich, 295 Madison Ave., New York 17, N. Y.

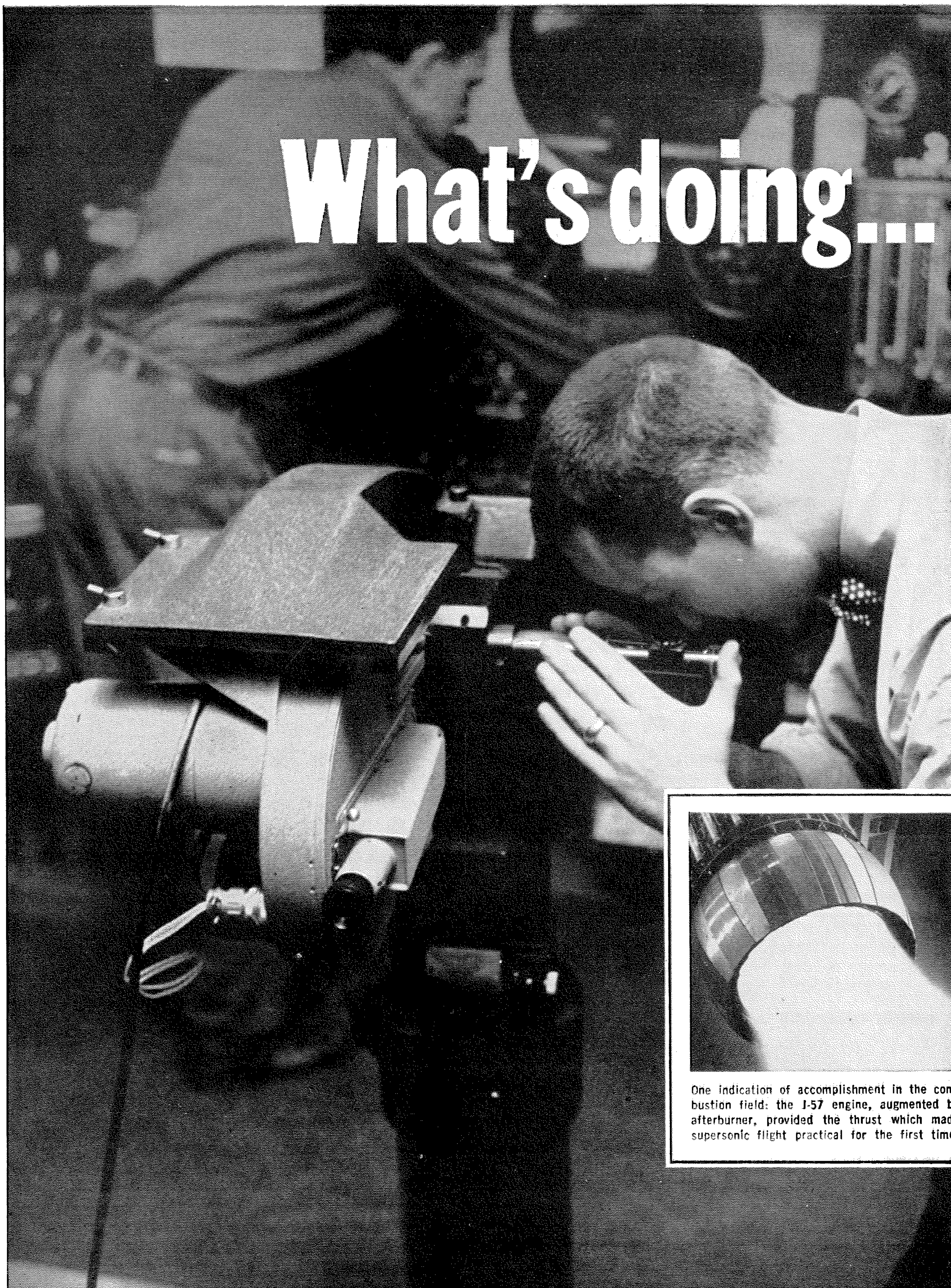
UNION CARBIDE INTERNATIONAL COMPANY Markets UNION CARBIDE products and operates plants overseas. C. C. Scharf, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE NUCLEAR COMPANY Operates Atomic Energy Commission facilities at Oak Ridge, Tenn., and Paducah, Ky. W. V. Hamilton, P. O. Box "P", Oak Ridge, Tenn.

VISKING COMPANY A pioneer in packaging—producer of synthetic food casings and polyethylene film. Dr. A. L. Strand, 6733 West 65th Street, Chicago, Ill.

GENERAL OFFICES—NEW YORK Accounting, Electronic Data Processing, Operations Research, Industrial Engineering, Purchasing. E. R. Brown, 30 East 42nd Street, New York 17, N. Y.

What's doing...



One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.

This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

at Pratt & Whitney Aircraft in the field of Combustion

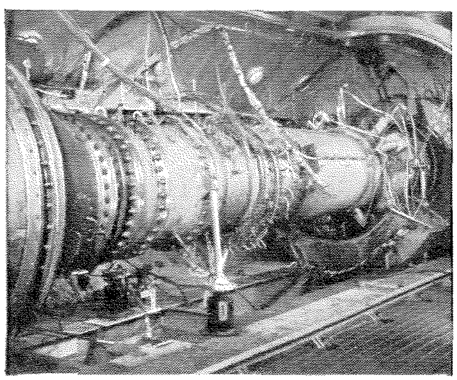
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

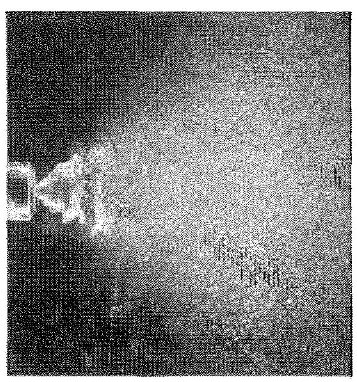
At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events ocurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aerodynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

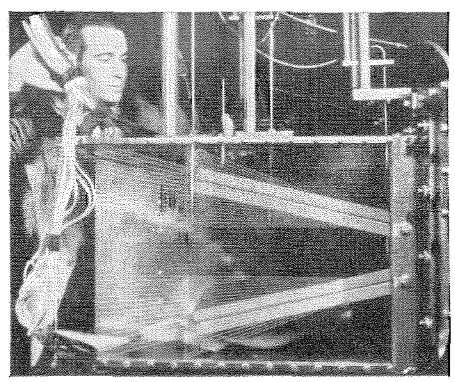
While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design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



Mounting an afterburner in a special high-altitude test chamber in P&WA's Willgoos Turbine Laboratory permits study of a variety of combustion problems which may be encountered during later development stages.



Microflash photo illustrates one continuing problem: design and development of fuel injection systems which properly atomize and distribute under all flight conditions.



Pratt & Whitney Aircraft engineer manipulates probe in exit of two-dimensional research diffuser. Diffuser design for advanced power plants is one of many air flow problems that exist in combustion work.

World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

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ALUMNI NEWS

Homecoming

CALTECH'S ANNUAL HOMECOMING GAME is set for November 15, when the Beavers meet the Occidental Tigers in the Rose Bowl. After the game, alumni and undergraduates, with their dates, will get together at the Homecoming Dance in the Scott Brown Gymnasium. There will be coffee and doughnuts and a chance to exchange all the news with the gang—so save the date—Friday, November 15.

—Howell N. Tyson, Jr.
Chairman, Homecoming Dance

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Shell Oil Company, Martinez

Vice President — Jules F. Mayer '40
Chemical Division, Standard Oil Co., Richmond

Secretary-Treasurer — Norman Bulman '52
Shell Oil Company, Martinez

Meetings: Informal luncheons every Thursday.
Fraternity Club, 345 Bush St., San Francisco

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Northwestern University, Evanston

SACRAMENTO CHAPTER:

President — Wayne MacRostie '42
State Department of Water Resources, Box 1079, Sacramento

Vice President — Charles M. Herd Ex. '30
State Division of Architecture, 1120 "N" Street, Sacramento

Secretary — John Ritter '35
State Division of Highways, 1120 "N" Street, Sacramento

Meetings: Luncheon first Friday of each month.
University Club, 1319 "K" St., Sacramento

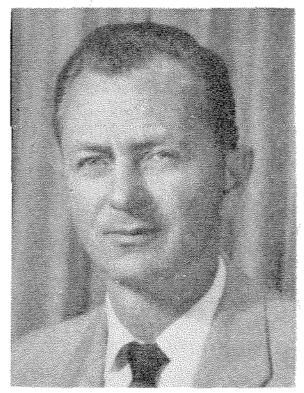
SAN DIEGO CHAPTER:

Chairman — Maurice B. Ross '24
3040 Udal Street, San Diego 6, Calif.

Secretary — Frank John Dore, Jr. '45
Consolidated Vultee Aircraft Corp., San Diego

Program Chairman — Herman S. Englander '39
U. S. Navy Electronics Laboratory

Fall Dinner



E. O. RODEFFER, president and owner of San Gabriel Ready Mixt, will be the speaker at the Fall Dinner Meeting of the Caltech Alumni Association, to be held on October 17 at Eaton's Santa Anita Restaurant, 1150 West Colorado St., in Arcadia. Mr. Rodeffer's subject will be "Vision, Planning and Determination — the Keys to Success of Small Business Enterprise."

Eleven years ago Mr. Rodeffer founded San Gabriel Ready Mixt—one of the many small firms to enter the concrete industry at that time. Today, his associated rock, sand and concrete enterprises gross over $5,000,000 per year. Mr. Rodeffer is an active member of the Young Presidents' Organization, a national group of outstanding young executives. To be eligible, an executive must have become president of his company before reaching his 40th birthday and—among other requirements—the minimum gross sales of his firm must exceed $1,000,000 annually.

Sole owner and president of nine corporations, Mr. Rodeffer's training has been of the "do-it-yourself" variety. His formal education stopped with several semesters of junior college. In his October 17 talk, he tells how vision, planning and determination can result in business success—and why the independent businessman has a greater opportunity today than ever before.

—Frederick W. Drury, Jr.
Chairman, Fall Dinner Meeting

Placement

FROM JULY 1, 1956 to June 30, 1957, the Institute Placement Office obtained jobs for 24 alumni, and for 103 students who wanted permanent work after receiving their degrees. The office also found part-time work for 95 students during the school year, and summer jobs for 159 more.

The median number of job offers for those receiving the BS degree this year was 3 per man. Salaries went up again and the median of offers to men receiving the BS degree jumped by $50—compared to a $30 increase the year before. The median salary accepted by BS men was $470-$479 a month, for an MS it was $590-$599, and for a PhD it was $700-$709.

A total of 183 organizations sent representatives to the campus for interviews with students during the year—which is the largest number in the 22-year history of the Placement Office.

PERSONALS

1922

Hallan N. Marsh, manager of the production engineering and equipment section of the General Petroleum Corporation in Los Angeles, was honored at a luncheon last May, and was presented with the first major modification of an oil drilling instrument he invented over 25 years ago. The original invention, known as the Marsh Funnel, was the first practical device to measure the viscosity of mud during a drilling operation.

1926

Brig. Gen. Ivan L. Farman, MS '39, retired from the U.S. Air Force in June and is now living in Fishing Creek, Maryland.

1927

H. Fred Peterson, manager of the Shell Oil Company's Pacific Coast area survey and drafting department, died of leukemia on June 13. He was 55 years old.

Fred was active in the Caltech Alumni Association and served as a member of the board of directors from 1934 to 1937; as vice president in 1935-36; as president in 1936-37; as a member of the program committee in 1947-48; and as chairman of the Alumni Seminar Weekend in 1941. He was formerly on the faculty of USC, and also served on the extension faculty at UCLA.

1929

William G. Young, PhD, professor of chemistry and dean of the physical sciences of the College of Letters and Sciences at UCLA, was named vice chancellor of the university in June. A member of the faculty for 27 years, Dr. Young is also serving his second term as a member of the board of directors of the American Chemical Society. He was elected to the National Academy of Sciences in 1951.

1933

Robert G. Macdonald, civilian chief of the branch of the U.S. Army which is in charge of construction and maintenance of facilities for all Army Quartermaster installations in the U.S., recently received a citation and cash award from the Quartermaster General for "sustained superior performance." Bob lives in Alexandria, Virginia.

1938

Sidney Bertram joined the technical staff of the electronic instrumentation division of the Ramo-Wooldridge Corporation in Denver, Colorado, last month. He was formerly assistant professor of electrical engineering at Ohio State University.

John R. Baker, chief production and design engineer for Baker Oil Tools, Inc., in Los Angeles, writes that "we adopted a son, David Paul, who was born on the 4th of July. We also have a son, Johnny, who is six."

1939

Warren E. Wilson, MS, dean of the engineering school of the Pratt Institute in Brooklyn, New York, has been appointed acting president of the school. He was George Westinghouse professor of engineering at Pennsylvania State University before joining the Pratt Institute in 1956.

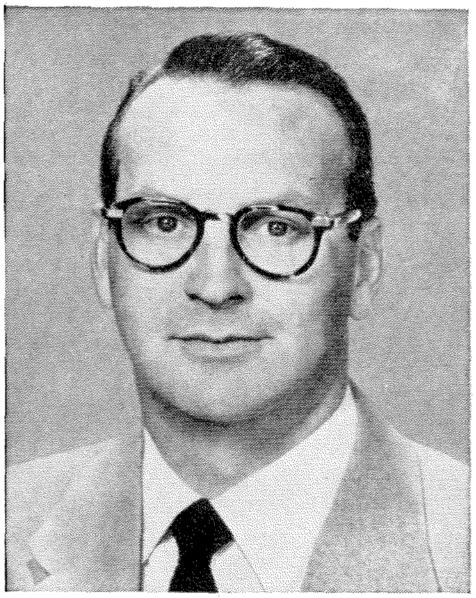
1941

Livingstone Porter, Jr., writes from San Francisco: "After graduating from Tech, I spent a year as a geologist with the U.S. Gypsum Company at Midland, California, then two years with the Ground Water Division of the U.S. Geological Survey in Santa Barbara. Following two years in the Navy, I married Patricia McCorriston of Honolulu. We have four children—Larry,

CONTINUED ON PAGE 46

Left to right: Lou Bernardi, Notre Dame, '54; Norman Lorenson, Mich. St., '55; Ernest Schurmann, M.I.T., '53; Dick Swenson, Purdue, '50.

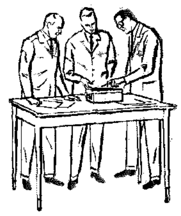
Highlights of your future with Honeywell



Glenn Seidel, Vice President in Charge of Engineering, BME, Minnesota, '36

The many

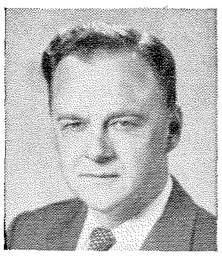
People, Places, Projects



"The story of Honeywell, as I know it, is a story of growth—from a thermostat to over 12,000 products; from a handful of employees to more than 30,000; from a basement in Minneapolis to a world-wide organization. For Honeywell, world leader in automatic controls, has expanded as rapidly as this exciting field. And employment, sales and income have increased steadily year after year.

"The future is even more challenging. Planned diversification puts Honeywell in such new fields as office and factory automation, process control, plastics, atomic energy, electronics, missiles and satellites. Whole new areas of opportunity are waiting for today's engineering graduates in each of Honeywell's divisions. Here are some division representatives to tell you about them."

CORPORATE RESEARCH
HOPKINS, MINNESOTA



Dr. Finn Larsen, PhD,
Iowa State, 1948
Director of Corporate Research

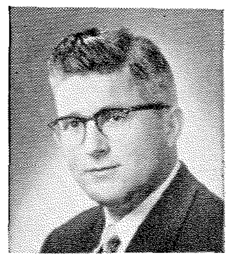
"Our Research Center is a focal point for Honeywell's over-all research program. Here, Honeywell scientists and engineers conduct basic research into areas such as Heat Transfer, Metallurgy, Thermodynamics, Solar Energy, Radioactivity, Electronics, etc. This research supplements other research carried on by Honeywell's separate divisions, plays an important part in the company's development program. There's certainly plenty of opportunity for the imaginative scientist or engineer here."

AERONAUTICAL DIVISION
MINNEAPOLIS; LOS ANGELES; ST. PETERSBURG

E. H. Olson, BA,
U. of Minnesota, 1937
Director of Aero Engineering

"In the past six years our engineering force has trebled through our expansion into such advanced fields as inertial guidance, jet engine control, computers, fire control and bombing systems, fuel management, and precision gyros. We have developed and produced more autopilots than any other manufacturer, and built the reference system for the Earth Satellite Rocket. The diversity and wide acceptance of our products indicates the boundless opportunities we have for engineers and scientists."

ORDNANCE DIVISION
MINNEAPOLIS; SEATTLE; MONROVIA, CALIF.

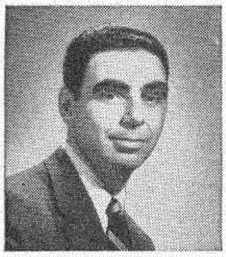


Clyde A. Parton, BSEE,
U. of Alabama, 1940
Director of Ordnance

"Here at Honeywell Ordnance we're putting all our experience and imagination into maintaining America's technological lead. We work in such new fields as infrared sensors, missiles, servo mechanisms, new types of turret control systems. We've developed proximity and mechanical fuzes, antiaircraft fire control systems, underwater warfare equipment and other products in widely diversified fields. Our more advanced products, naturally, are still classified, but they offer outstanding challenges and opportunities."

sides of Honeywell

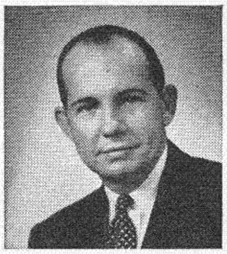
BOSTON DIVISION
BOSTON, MASSACHUSETTS



George J. Schwartz, MIT, '42
Vice President
and General Manager

"Our Honeywell division is making the brains of automation. We turn out such small, but complex and important components as gyros, flight controls, servos, synchros, electronic amplifiers and magnetic controls. Engineering projects now in progress point to many new products and applications from our division, including development of new transistor applications. Opportunities? They're here by the score."

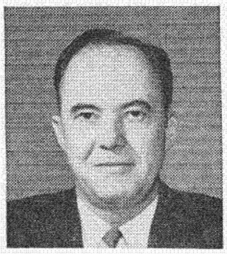
MICRO SWITCH DIVISION
FREEPORT, ILLINOIS



R. W. Pashby, BSEE,
U. of Illinois, 1932
Director of Product Research

"Products of our Micro Switch Division help giant aircraft land safely, interlock machine tool operations, feed instructions into electronic computers. These are just a few of their applications—applications which are growing year after year. The development of these precision switches requires high engineering skill, puts a premium on your imagination, offers you tremendous opportunities for advancement and recognition."

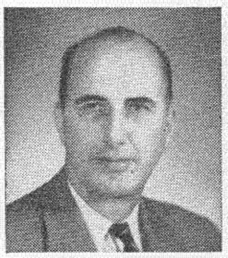
RESIDENTIAL, RETAIL AND
COMMERCIAL DIVISION
MINNEAPOLIS, MINNESOTA



H. T. Sparrow, BSEE,
U. of Minnesota, 1930
Director of Product Research

"We specialize almost entirely in comfort control. Typical of the advances our division has made recently is the Supervisory Data Center* which enables one man in one location to read and control the temperature of every room in a large building. Our other new products include Air Blenders, Zone Control Systems, Electronic Air Cleaners and many more. Our business is a rewarding one for engineers!"

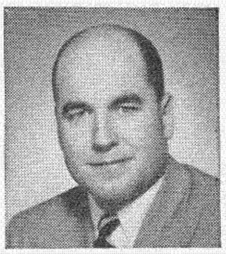
INDUSTRIAL INSTRUMENTS DIVISION
PHILADELPHIA, PENNSYLVANIA



C. L. Peterson, BSEE,
U. of California, 1924
Vice President and Gen. Mgr.

"No company in the fast growing instrumentation field is growing faster than Honeywell's Industrial Instruments Division. There's practically no physical quantity under the sun that Honeywell instruments cannot measure, and, in most cases, control, from open hearth furnaces to complex processes still on the designer's boards. Finding new applications and designing the instruments, computers and read-out devices of tomorrow, offer you a fascinating present and an unlimited future."

HEILAND DIVISION
DENVER, COLORADO



S. A. Keller, BS,
U. of Pennsylvania, 1941
General Manager

"This division of Honeywell manufactures two different classes of products: Instruments and Photographic Equipment. Our recording oscillographs—typified by the radically new 'Visicorder'—are used in a wide range of industrial, scientific, and military applications. Our famous 'Strobonar' electronic flash equipment is used by 5 out of 6 newspapers and all important press services. The variety of products and markets of the Heiland Division promises an ever-expanding field that challenges young engineers."

This is Honeywell: more than 12,000 highly engineered products, 14 separate divisions, locations sprinkled throughout this country and abroad, projects by the hundreds on the outposts of every major technological advance. It's a land of opportunity for the engineering graduate. Want to learn more about it? Send for our free booklet, "Your Curve of Opportunity." Write to:

R. L. Michelson, Dept. TC29C
Personnel Administrator
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Minneapolis 8, Minnesota

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*Trademark

Personals . . . CONTINUED

8; Danny, 7; Jimmy, 4; and Barbara, 1½. I have been a geologist with the Standard Oil Company of California for the past ten years. Most of that time has been spent in the San Joaquin Valley—but recently I was transferred to the San Francisco office as Senior Evaluations Geologist."

1942

Robert J. Clark, MS '43, has moved from Maryland to Geneva, Switzerland, where he is working as director of European operations for North American Aviation, Inc.

1943

Thomas S. Lee, associate professor of chemistry at the University of Chicago, received one of the University's annual $1,000 Quantrell awards for "excellence in undergraduate teaching" last spring. Tom has been on the faculty since 1949.

Philip E. Wilcox is now associate professor of biochemistry at the School of Medicine at the University of Washington in Seattle. He received a Guggenheim Fellowship recently and plans a six-month leave of absence from the University next year, to do research in the Carlsberg Laboratory in Copenhagen, Denmark. The Wilcoxes have a one-year-old son, Jason.

1944

Warren G. Schlinger, MS '46, PhD '49, chemical engineer at The Texas Company's research laboratory in Montebello, California, was transferred this summer to the Port Arthur, Texas, laboratory where he is now a project engineer in fuels research. Warren has been with Texaco since 1953.

David R. Jones is project leader on Diesel fuel research in the engine fuels division at the California Research Corporation's Richmond laboratory. The Joneses live in Walnut Creek, and have five children (2 boys, 3 girls) ranging in age from 4 to 12.

1945

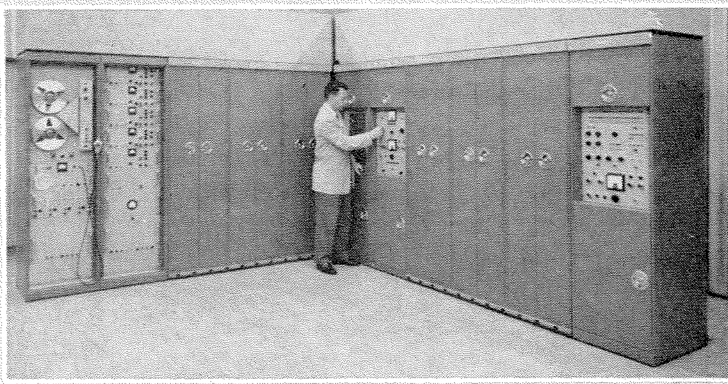
Charles R. Cutler, who is with the law firm of Kirkland, Fleming, Green, Martin & Ellis in Washington, D.C., has been elected chairman of the Junior Bar Section of the District of Columbia Bar Association.

Col. Jack L. Ridley, MS, stationed with the U.S. Air Force in Tokyo, Japan, is reported as having been missing in flight since March 12, 1957.

Albert A. Erkel writes that "I have recently terminated my association with Pereira and Luckman as director of engineering and supervising structural engineer to open my own offices in Los Angeles.

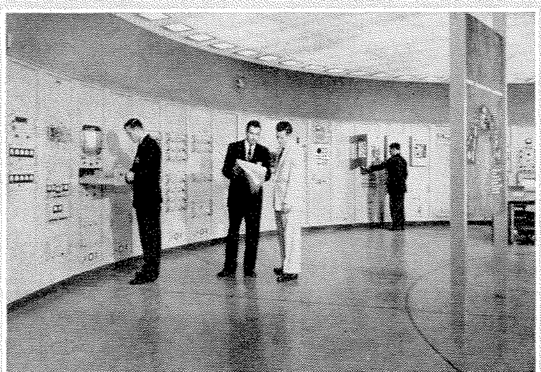
"While with the above firm, I have had the dubious distinction of returning to the scene of the crime (Caltech, that is) and supervising the design of the new Engineering Building. Other projects of really

CONTINUED ON PAGE 50

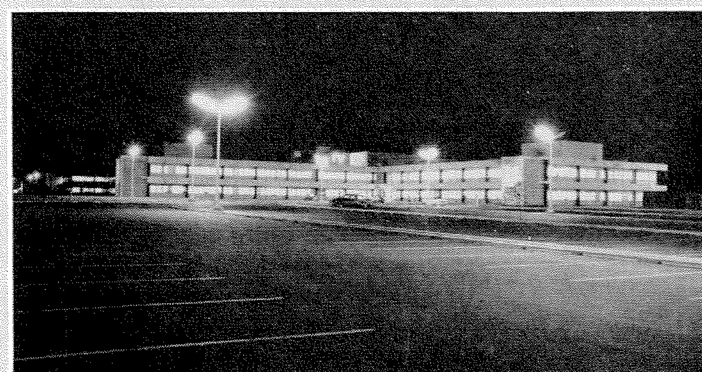


30-channel, analog-digital converter connecting 300-amplifier analog computer to 1103A digital computer

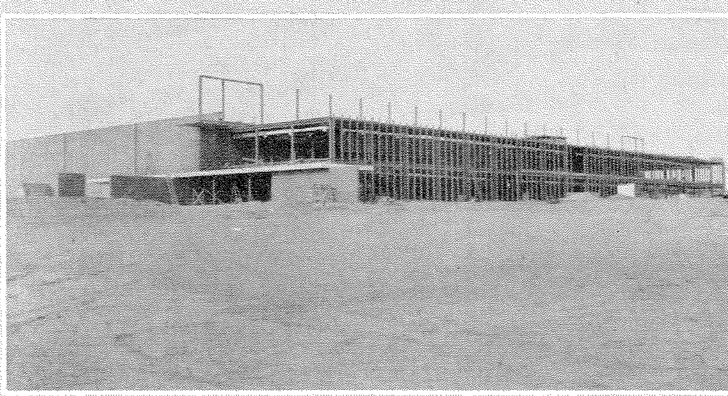
Production of communications equipment in new Los Angeles manufacturing plant



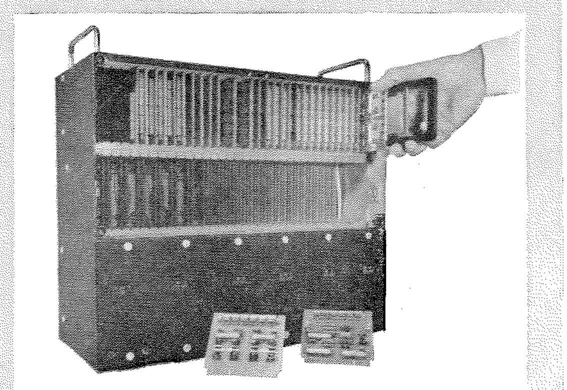
Data Reduction Center designed and built by Ramo-Wooldridge



One of three new research and development buildings completed this year



First unit of Denver manufacturing plant now nearing completion



Input-output unit of the Ramo-Wooldridge RW-30 airborne digital computer

Pictorial **PROGRESS REPORT**

The photographs above illustrate some of the recent developments at Ramo-Wooldridge, both in facilities and in products. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields of current activity:

- Communications and Navigation Systems
- Digital Computers and Control Systems
- Airborne Electronic and Control Systems
- Electronic Instrumentation and Test Equipment
- Guided Missile Research and Development
- Automation and Data Processing
- Basic Electronic and Aeronautical Research

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lesser importance that I have been associated with in a responsible professional status include the Marineland of the Pacific in Palos Verdes; the Union Oil Building in Los Angeles; the Northrop Complex in Hawthorne; Convair Astronautics in San Diego; and the IBM Office Building in Los Angeles.

"My wife, Rosemary, and I are enjoying Valley living in Northridge where we are raising our progenies—Bonnie Sue, 4, and Al, Jr., 3."

1947

Col. James H. Beddow, MS, started a ten-month course at the Army War College at Carlisle Barracks, Pennsylvania, last month. He arrived from an assignment as commander of the 502nd Engineer Group at Fort Carson, Colorado. Jim has been in the Army since 1938.

Donald B. Wheeler, Jr., PhD, has been promoted from assistant to associate professor of physics at Lehigh University in Bethlehem, Pennsylvania.

Harold M. Hipsh, MS '48, Phd '51, head of the department of aeronautical engineering at Pennsylvania State University, died at his home on May 23 after a long illness. He was 34 years old.

Morton Alperin, MS, is the director of advanced studies for Aeronutronic Systems Inc., in Glendale, the Ford Motor Company's west coast subsidiary engaged in the weapons systems field. Under his direction, the company will launch a rocket vehicle to heights never before achieved. Called Operation Far Side, the experiment will take place some time this fall.

1948

William J. Williamson, MS '49, AE '55, writes that he was married on June 18 to June Murdoch Baker of St. Louis, Missouri, and became the proud stepfather of a ten-year-old boy in the process. Bill is senior engineer in the preliminary design section of the Marquardt Aircraft Company in Van Nuys, California.

Arthur N. Cox is now a group leader in the test division of the Los Alamos Scientific Laboratory in New Mexico. He's been working at the laboratory since 1953.

Wakefield Dort, Jr., MS, is now associate professor of geology at the University of Kansas in Lawrence. He had been teaching at Penn State, where he was an assistant professor.

1949

Hugh C. Carter, president of the Hugh Carter Engineering Company in Long Beach, California, is teaching a two semester extension course in mechanical estimating at the University of Southern California this year.

Gaelen L. Felt, MS, PhD '51, is now an assistant division leader in the test division of the Los Alamos Scientific Laboratory in New Mexico. He has been at Los Alamos since 1945. The Felts have three children—Hugh Malcolm, John Hamilton, and Elizabeth Suzanne.

David K. Hayward, district petroleum engineer at The Texas Company, has been transferred from the Los Angeles Basin district to the Ventura district.

1951

Taylor B. Joyner, physical chemist at the U.S. Naval Ordnance Test Station at China Lake, California, passed his final oral examination for his PhD in chemistry at USC last spring. He's been at China Lake since 1955.

Ernest Dzendolet who received a BS in chemistry at Caltech in 1951, and one in biology in 1955, received his MS in psychology from Brown University in Providence, Rhode Island, in June.

Richard K. Smyth, senior research engineer in the Autonetics division of North American Aviation in Los Angeles, writes that his fourth child, David Elliott, was born on June 17. This makes three boys and a girl in the family. "I received an MS this year from USC," Dick says, "and am working on my PhD there at night class. I have almost earned my instrument license and my wife got her private pilot's license in December."

Albert S. Jackson, MS '52, received his PhD in electrical engineering at Cornell University last June and is now assistant professor there. He's teaching courses in computer and feedback control systems. The Jacksons now have three daughters.

1952

Jack I. Simmons, now at Greenville Air Force Base in Mississippi for basic jet training, recently received the Outstanding Cadet Trophy from Malden Air Force Base in Missouri for having the highest grade average in flying and academic and military training during his training period there.

1953

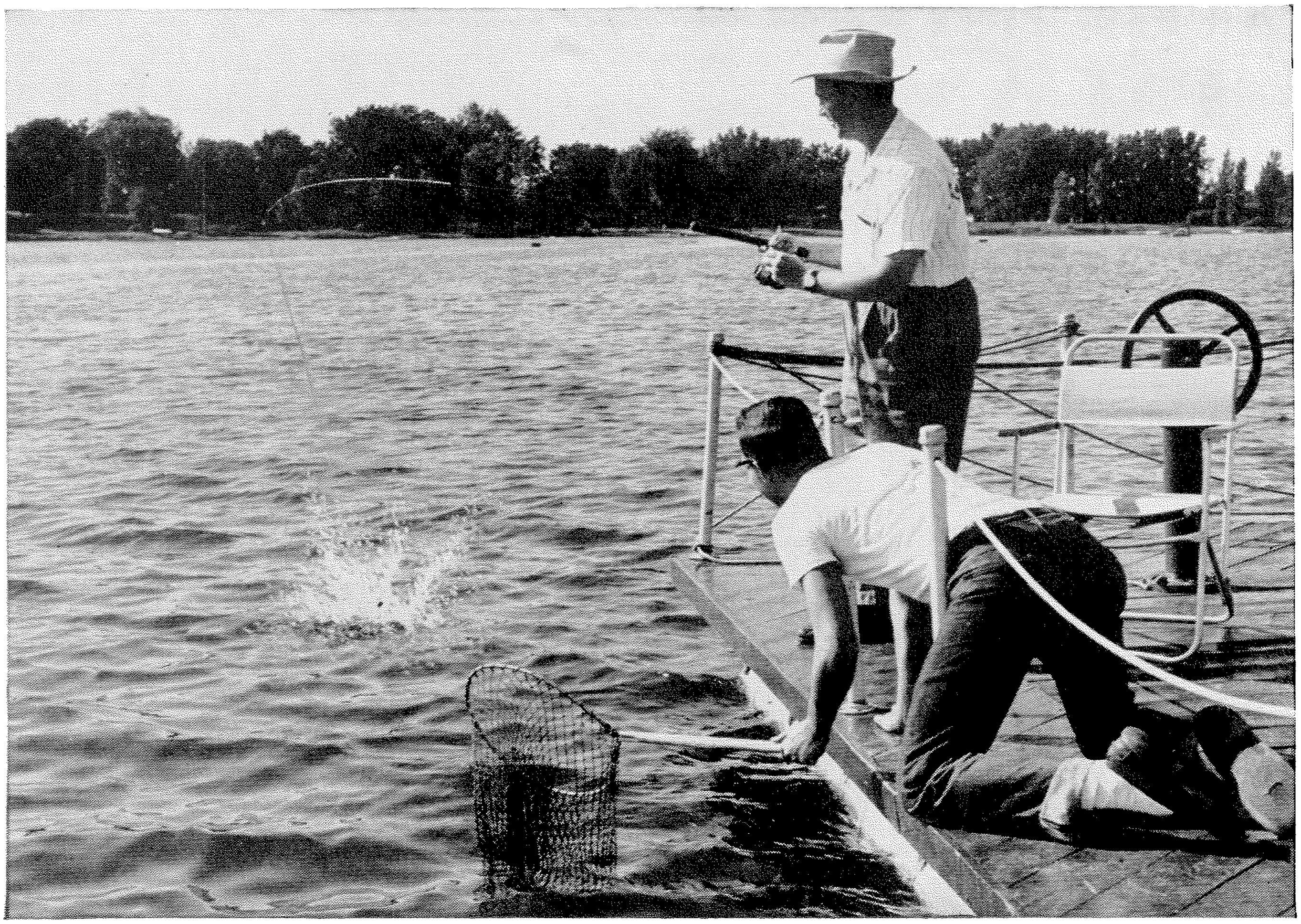
Thomas R. Slodowski received his PhD in geology at Princeton University in June.

Lt. Walter J. Eager, Jr., is now operations officer at the U.S. Navy's Engineer Research and Development Laboratories in Fort Belvoir, Virginia.

John D. Gee was married to Barbara L. Graham on May 25 in San Marino, California.

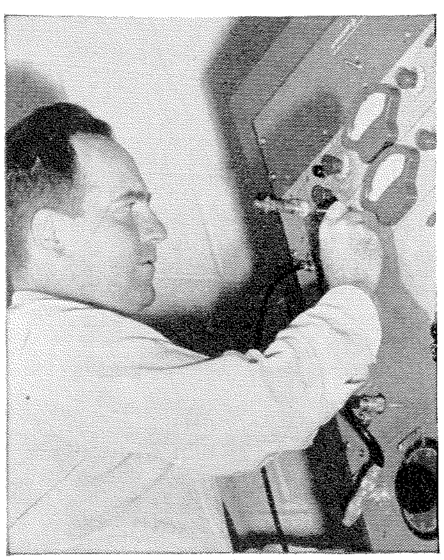
Alan H. Haber writes that he's now an alumnus of Wisconsin also and is doing

CONTINUED ON PAGE 54



There's fission and then there's fishin'...

just five minutes apart for 3M'er Jim Johnson



From the lab to the lake in only five minutes—that's 3M-land! It's a place where young men like Jim Johnson, with a talent for both engineering and happiness, find life good . . . to them and their families.

There's some kind of outdoor fun going on year 'round—golf, fishing, swimming, boating, hunting, skiing, skating. And never more than five miles from job or home.

There's work, too—vital, exciting, creative work geared to the future. For 3M is a research-minded company. Its scientific plant, including the new multi-million dollar Central Research Laboratory, is one of the finest. In this young, fast-growing company there's always been plenty of opportunity for young men to get ahead, and for new ideas to get a hearing. Witness such original products as "SCOTCH" Brand Cellophane Tape, and the "SCOTCHLITE" reflective signs that guide you safely on highways day and night. More than 22% of the products 3M sells were developed in the last five years.

And as for compensation, 3M engineers and executives are substantially above the average in take-home pay, home ownership, car ownership, and stock ownership! So, if you're interested write 3M, St. Paul 6, Minnesota.

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3M COMPANY

Personals . . . CONTINUED

postdoctoral work in biology at the Oak Ridge National Laboratory in Tennessee. The Habers are now parents of a four-month-old daughter, Lisa Anne.

1954

Ronald Ratney was married to Tanya Karten of New York City on June 2. At last report, Ron was still a grad student at Yale University.

Donald L. Turcotte has received a Guggenheim Fellowship for 1957-58 to continue his graduate work at Caltech's Jet Propulsion Laboratory.

George A. Baker, Jr. is now a physicist in the theoretical division of the Los Alamos Scientific Laboratory in New Mexico.

George L. Johnson received his Bachelor of Laws degree from Harvard in June.

Kenneth H. Olsen, MS, PhD '57, is now a physicist in the weapons division of the Los Alamos Scientific Laboratory.

1955

Charles S. St. Clair received his MS in geology at the University of Arizona in Tucson this spring.

1956

Jan L. Arps writes that "at present I'm working for the Shell Oil Company as an exploitation engineer in the tidelands area of southern Louisiana. We are living in the little town of Franklin, named after Benjamin Franklin. The town is in the heart of the Cajun (Acadian) country, and is near the home of Evangeline of poetic fame. The natives here speak a curious mixture of French and English with a Brooklynese accent. My wife, Peggy, is expecting our first baby at the end of October."

Roy A. Whiteker, PhD, writes: "As of July 1, I will be in Claremont as assistant professor of chemistry at Harvey Mudd College. We open our doors in September to our first class of freshmen. The first two years of study will be the same for everyone—chemistry, physics, math, English and history—and then the student may major in chemistry, physics, math or engineering science. We plan an even broader humanities program than Caltech and are even now actively competing with Caltech for students."

1957

Gordon R. Wicker, MS, is now an engineer in the experimental plants department of the Shell Development Company's California Research Center in Emeryville.

Frank Kofsky was married on September 6 to Sujenna Anderson of Arcadia and Occidental College. The Kofskys are now living in Berkeley, and Frank is doing graduate work in biology at Cal.

Alan F. Berndt, PhD, is now a research chemist at the Monsanto Chemical Company's inorganic chemicals division in St. Louis, Missouri.

ALUMNI FUND

Report of the 10th Year — 1956 - 1957

ON JULY 1, 1957, the Alumni Association established its fourth full-tuition four-year endowed scholarship for undergraduates. A total of $93,454.81 has been given by the alumni during the last four years for the purpose of establishing the four endowed scholarships. An additional $6,876.50, from interest and contributions by others, makes a total of $100,331.31. It is anticipated that earnings from this fund will provide four-year tuition for a selected, deserving member of each new freshman class starting at Tech.

Contributions to the fund this year amounted to $27,119.82. The names of all contributors for the year 1956-57 are listed on the following pages. We appreciate the cooperation of all who have made it possible to complete this Alumni Fund objective this year. We are sure all alumni will generously support the new goal of the Alumni Fund, of assisting the Institute in obtaining additional undergraduate housing facilities much needed on the campus.

—*Edward P. Fletcher*
—*Robert H. Bungay*
Directors in charge of the Alumni Fund 1956-57

TENTH YEAR — 1956 - 57
(As of June 30, 1957)
Alumni Who Took Undergraduate Work at C.I.T.

CLASS	AMOUNT	NUMBER GIVING	AVERAGE GIFT	NUMBER ELIGIBLE	PERCENT OF ELIGIBLE GIVING
Prior 1915	$ 61.00	8	$ 7.63	22	36.4
1915	140.00	5	28.00	8	62.5
1916	26.00	3	8.67	7	42.9
1917	40.00	3	13.33	7	42.9
1918	274.00	7	39.14	30	23.3
1919	41.00	3	13.67	3	100.0
1920	842.50	9	93.61	26	34.6
1921	225.00	13	17.31	34	38.2
1922	2,555.00	26	98.27	59	44.1
1923	448.00	18	24.89	47	38.3
1924	430.00	17	25.29	73	23.3
1925	1,260.60	30	42.02	78	38.5
1926	1,365.00	23	59.35	97	23.7
1927	352.00	34	10.35	89	38.2
1928	479.50	27	17.76	59	45.8
1929	479.00	31	15.45	82	37.8
1930	486.00	36	13.50	101	35.6
1931	507.00	33	15.36	97	34.0
1932	1,583.00	37	42.78	93	39.8
1933	313.00	17	18.41	92	18.5
1934	451.00	34	13.26	103	33.0
1935	1,063.00	37	28.73	110	33.6
1936	862.00	40	21.55	113	35.4
1937	321.00	28	11.46	111	25.2
1938	500.00	39	12.82	125	31.2
1939	318.00	29	10.96	112	25.9
1940	505.00	54	9.35	140	38.6
1941	594.00	36	16.50	128	28.1
1942	621.50	62	10.02	149	41.6
1943	766.00	51	15.02	123	41.5
1944	726.45	63	11.53	207	30.4
1945	883.00	45	19.62	190	23.7
1946	269.00	36	7.47	161	22.4
1947	479.00	45	10.64	143	31.5
1948	582.00	66	8.82	189	34.9
1949	531.50	70	7.59	211	33.2
1950	618.50	61	10.14	183	33.3
1951	378.00	46	8.22	158	29.1
1952	279.00	31	9.00	126	24.6
1953	322.00	41	7.85	135	30.4
1954	200.00	30	6.67	104	28.8
1955	220.25	38	5.80	126	30.2
1956	216.30	29	7.46	124	23.4
TOTAL	$23,614.10	1391	$16.98	4375	31.8

CONTRIBUTORS TO THE ALUMNI FUND 1956 - 1957

1906
H. W. Grinnell

1911
R. V. Ward

1912
N. E. Humhrey

1913
R. D. Andrews
R. Gerhart
L. J. Koch, Jr.
R. W. Parkinson

1914
E. Lavagnino
G. D. Young

1915
E. A. Burt
W. M. Holmes
H. B. Holt
C. H. Wilcox

1916
M. H. Carson
J. W. M. DuMond
K. W. Rich

1917
A. Kensey
P. D. V. Manning*
R. T. Richards
J. P. Youtz

1918
C. F. Andrews
F. R. Capra
L. F. Essick
W. R. Hainsworth*
G. B. Heywood
E. R. Hoge
F. W. Karge
N. R. Shade
A. K. Smith

1919
M. R. Coles
C. C. LaVene
R. Pollock

1920
P. D. Barton
J. R. Black
D. Ehrenfeld*
E. V. Hounsell
T. C. Hounsell
M. A. Sawyer
R. C. Smith
H. P. St. Clair
G. O. Suman, Jr.
E. H. Swift*
G. K. Whitworth
R. E. Woodbury

1921
R. M. Badger
H. R. Case
E. L. Champion
R. W. Craig
C. H. Dekker
E. G. Forgy
J. Fox
H. H. Honsaker
S. Lee
T. F. McCrea
E. H. Mintie
W. B. Mullin
A. J. Stamm

1922
G. A. Alles
P. R. Ames
R. E. Bear
C. J. Biddle
F. R. Bridgeford
A. C. Catland
D. W. Darnell
L. H. Erb
B. Essick
T. J. Fleming
E. A. Hathaway
J. Honsaker, Jr.
F. L. Hopper
W. Jasper
C. R. Keith
A. W. Knight
R. H. Kohtz
K. A. Learned
H. N. Marsh
H. S. Ogden
W. A. Schneider
G. K. Smith
H. G. Vesper
A. M. Whistler
W. F. Wilson

1923
J. R. Alcock
W. E. Baier
W. L. Bangham
H. A. Barnett
L. E. Blakeley
L. Dillon
O. H. Ensign
B. G. Evans
L. D. Fowler
W. E. Gilbert
D. G. Kendall
H. B. Lewis
D. H. Loughridge
J. R. North
F. F. Roberts
R. J. Schonborn
E. L. Smith
L. G. South
D. A. Stromsoe

1924
K. B. Anderson
R. S. Clark
R. O. Elmore
H. W. Goodhue
W. L. Holladay
E. M. Irwin
G. V. Jenkins
V. A. Kalichevsky
T. C. Losey
C. W. Maltby
R. Miller
C. N. Parker
C. W. Punton
W. S. Squiers
L. P. Stoker
C. M. Wakeman
H. M. Winegarden

1925
R. E. Alderman
T. L. Atherton
M. C. Brunner
C. A. Burmister
F. C. A. Clayton
R. H. Dalton
A. L. Erickson
A. J. Ferkel
H. R. Freeman
R. W. Fulwider
E. W. Hart
C. H. Heilbron, Jr.
L. P. Henderson
W. Hertenstein
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W. B. Jones
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L. B. Prentice
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M. E. Salsbury
G. M. Schlegel
W. D. Sellers
T. P. Simpson
G. C. Spelman
R. J. Stanton
E. D. Stewart
E. F. Thayer
W. G. Thompson

1926
A. Ball
G. W. Clapp
T. C. Coleman
M. W. Edwards
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D. J. Pompeo
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O. R. Wulf*

1927
W. W. Aultman
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M. A. Baldwin
E. R. Baxter
K. A. Belknap
R. C. Blankenburg
M. M. Bower
J. Boyd
A. E. Capon
J. G. Case
R. Creveling
H. K. Farrar
J. B. Forster
D. Z. Gardner, Jr.
T. L. Gottier
R. F. Heilbron
V. A. Hoover
V. P. Jaeger
E. P. Jones
G. R. Kaye
B. R. Loxley
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G. E. Moore
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L. W. Ralston
R. W. Reynolds
A. W. Root
L. W. Ross
M. N. Schultz
T. S. Southwick
W. L. Stanton
H. R. Starke
C. A. Swartz
R. B. Vaile, Jr.
A. H. Warner*
R. M. Watson
C. K. Wells

1928
R. C. Armstrong
A. O. Beckman*
J. Y. Berman
S. B. Biddle, Jr.
J. L. Bohn*
T. H. Brighton
G. L. Chilberg
R. I. Coulter
G. R. Crane
K. R. Crosher
R. W. Cutler
R. D. Evans
M. W. Gewertz
W. M. Jacobs
R. K. Jacobson
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G. S. Kaneko
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D. E. McFaddin
E. M. McMillan
C. G. Minkler
F. Noel
M. E. Nordberg*
J. F. Phillips
E. E. Sechler
C. C. Shaffer
H. Smith
E. W. Templin
E. E. Tuttle

1929
E. Atwater
B. Baker
I. Berman
K. R. Birge
C. A. Bosserman
D. S. Clark
F. R. Cline
D. E. Cole
P. Cravitz
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H. M. Huston
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R. J. Kircher
A. J. Larrecq
E. C. Lee
K. E. Lohman
G. S. Lufkin
W. H. Mohr
A. E. Myers
B. Roberts
A. Rummelsburg
M. H. Sperling
F. A. Wheeler

1930
R. B. Atkinson*
W. W. Ayers
D. P. Barnes*
I. C. Bechtold
C. L. Blohm
F. D. Bode
J. R. L. Boyle
R. H. Bungay
A. Butler
D. E. Carberry
C. F. Carlson
J. D. Clark
H. R. Crane
F. G. Crawford
E. L. Ellis
C. Giebler
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M. Silverman
R. I. Stirton
E. M. Thayer
J. W. Towler
H. W. Waite
N. D. Whitman, Jr.
W. D. Wilkinson
S. Zipser

1931
L. A. Alden
W. F. Arndt
W. A. Arnold
L. W. Bolles
P. M. Boothe
W. M. Cogen
J. S. Detweiler
S. C. Eastman
L. L. Ferguson
E. F. Green
C. H. Gregory
N. R. Gunderson
A. Horn
H. S. Ingham
E. S. Kinney
C. E. Kircher, Jr.
C. E. Knykendall
G. Langsner
L. D. Leeper
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E. S. Peer
L. D. Pratt
J. T. Sinnette, Jr.
M. S. Stein
P. M. Terry
R. Widess
C. A. Wilmot

1932
W. A. Adams
P. F. Arnerich
A. W. Atwood, Jr.
M. V. Barton
J. D. Bascom
W. L. Berry
W. M. Bleakney*
F. W. Bowen
W. H. Bowen*
G. E. Bowler
J. R. Bradburn
C. J. Breitwieser*
H. H. Bruderlin
R. V. Carey
J. V. Chambers
B. Fitch
R. E. Foss
R. B. Freeman
D. B. Graff
C. M. Harsh
F. J. Hibbs, Jr.
M. S. Hodge
C. W. Jones
W. L. Kent
P. B. Lyons
T. E. Mathews, Jr.
W. B. Oswald*
P. G. Parsons
W. F. Pruden
J. T. Reilly
H. Roach
B. H. Rule
J. G. Shaafsma
C. P. Schoeller
M. A. Schuhart
J. Sheffet
W. Shockley
G. O. Shull
R. W. St. Clair
W. J. Thomas
M. P. White
C. E. Wilson

1933
W. H. Barlow
G. M. Berkley
A. H. Clifford*
E. F. Cox*
R. Cromley
M. E. Czamanske*
O. D. Hofmann
J. S. Johnson
K. V. Keeley
P. H. Kemmer*
W. H. Lewis
A. Mathewson, Jr.
J. D. Mendenhall
J. E. Meskell
T. S. Mitchel
W. W. Moore

* *graduate degree only*

Fund . . . CONTINUED

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L. E. Root*
R. L. Russell
W. Scholtz
J. N. Sparling
D. D. Taylor*
M. B. Widess

1934

R. C. Anderson
R. D. Boche
A. Charters
M. C. Childers
D. L. Cleveland
S. Cogen
C. C. Craig
P. H. Dane
R. A. Dietrich
W. R. Donahue
R. H. Escherich
R. C. Felt
G. Gordon
H. E. Gulick
R. W. Haskins
E. R. Howard
E. L. Kanouse*
E. B. Lien
G. McCann
W. C. McFadden
G. O. Miller
C. V. Newton
H. M. O'Neil
E. W. Paxson
J. F. Pearne
F. A. Schaak, Jr.
R. P. Sharp
J. E. Sherborne
D. H. Sluder
L. Stevenson
A. E. Thompson
N. T. Ugrin
G. W. Weaver
C. White

1935

H. W. Baker
L. W. Baldwin
C. C. Chivens
H. W. Davenport
L. B. Davenport
N. B. Dewees
O. C. Dunbar
H. Estes
A. N. Etz
G. R. Ewing
R. G. Fussell
H. P. Gluckman
R. H. Jahns
W. J. S. Johnson
R. G. Jones
M. C. Ketchum
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R. O. La Rue
E. L. Leppert, Jr.
H. A. Levy
C. W. Lindsay
W. B. McLean
N. P. Nies
K. S. Pitzer
L. T. Rader*
A. A. Ray
E. H. Reynolds
H. S. Ribner
J. M. Roehm*
J. R. Rossum
J. W. Schwartz
S. D. Sheff
A. L. Slater
J. C. Stick, Jr.
L. J. Stuppy
J. C. Taylor
C. F. Thomas
B. B. Watson*
D. C. Webster
V. W. Willits

1936

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E. Bollay*
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G. R. Carley
F. W. Davis
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R. W. Dodson
M. E. Douglass
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C. F. Goodheart
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D. Harker*
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W. E. Swanson
T. Thompson
K. Unholtz
T. Vermeulen
D. M. Whipp
D. L. Young

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W. Farnham
S. I. Feuer
C. F. Gates
J. W. George
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D. G. Schuman
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J. L. Sullwold
M. Summerfield*
B. Walley
M. H. Webster
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W. A. Wickett
H. F. Wiley*
W. G. Wylie

1938

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R. J. Barry
S. Bertram
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C. W. Clarke
R. H. Cowie
R. S. Custer
D. D. Davidson
L. Davis*
B. A. Dixon, Jr.
A. F. DuFresne
H. B. Ellis
H. D. Evans*
J. D. Farneman
C. F. Friend
P. C. Henshaw*
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C. L. Horine
P. T. Ives*
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A. E. Juts, Jr.
S. H. Keller
W. L. Koch*
P. R. Kyropoulos*
Y. Lee
J. T. McGraw
J. G. McLean
W. E. Milburn
L. T. Nagamatsu
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H. Q. North
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R. H. Olds
E. F. Osborn*
H. H. Reamer*
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R. Rosencranz, Jr.
C. N. Scully
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G. Wald, Jr.
S. E. Watson, Jr.
G. P. Wilson
H. J. Wood

1939

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C. F. Carstarphen
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C. H. Craft
G. O. Crozier
P. S. Devirian
R. A. Fischer
D. E. Flint
J. H. Goodell
H. A. Goodin, Jr.
H. V. Hance
F. C. Hoff
F. D. Knoblock*
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M. N. Levet
F. E. McCreery
J. R. McKinlay
C. K. Morikawa
J. E. Osborn
K. A. Pullen
B. V. Roudebush
R. J. Ruggiero
R. A. Sanders
P. L. Smith
P. E. Smith
W. M. Snyder
J. E. Stones
A. J. Stosick*
A. C. Tregidga*
L. W. Van Dusen
J. N. Wilson*
R. W. Winchell
L. R. Zumwalt*

1940

G. H. Arvin
R. C. Baird
F. F. Baker, Jr.
G. C. Barber
R. J. Blackinton
A. F. Brewer
L. Brewer
G. R. Brown
W. E. Brown
F. C. Brunner
C. C. Burton
R. O. Cox
G. Daams
C. E. Davies
E. O. Dickerson
R. Doolittle*
L. I. Epstein
S. W. Fox*
R. B. Glassco
R. W. Grigg
A. V. Guillou
J. C. Harper
R. Helfer*
W. C. House
J. W. Jongeneel
J. H. Keyser, Jr.
E. Lapin
W. R. Larson
E. G. Laue
W. Lemm
D. E. Loeffler
P. A. Longwell
B. Love
W. R. V. Marriott
A. B. Mewborn*
R. B. Meyer
R. S. Moore
D. E. Nagle
C. T. Newby
C. S. Palmer
R. A. Phillips
M. W. Quarles, Jr.
H. W. Reynolds, Jr.
R. G. Richards
C. D. Russell*
H. D. Samuel, Jr.
P. L. Sandiford, Jr.
W. B. Scarborough
R. Smith
T. B. Smith*
J. B. Stevens
N. C. Stone
W. A. Stoner
F. Streightoff
R. A. Stroud
H. C. Sumner*
G. J. Todd
K. Tomiyasu
G. Van Dyke, Jr.
D. B. Waring*
A. R. Wasem
R. W. Wayman
G. B. Weir
R. L. Wells*
V. Wouk*
R. B. Young

1941

R. M. Acker
F. W. Billmeyer, Jr.
R. R. Bowles
L. J. Brandenburger*
P. D. Brooks

* *graduate degree only*

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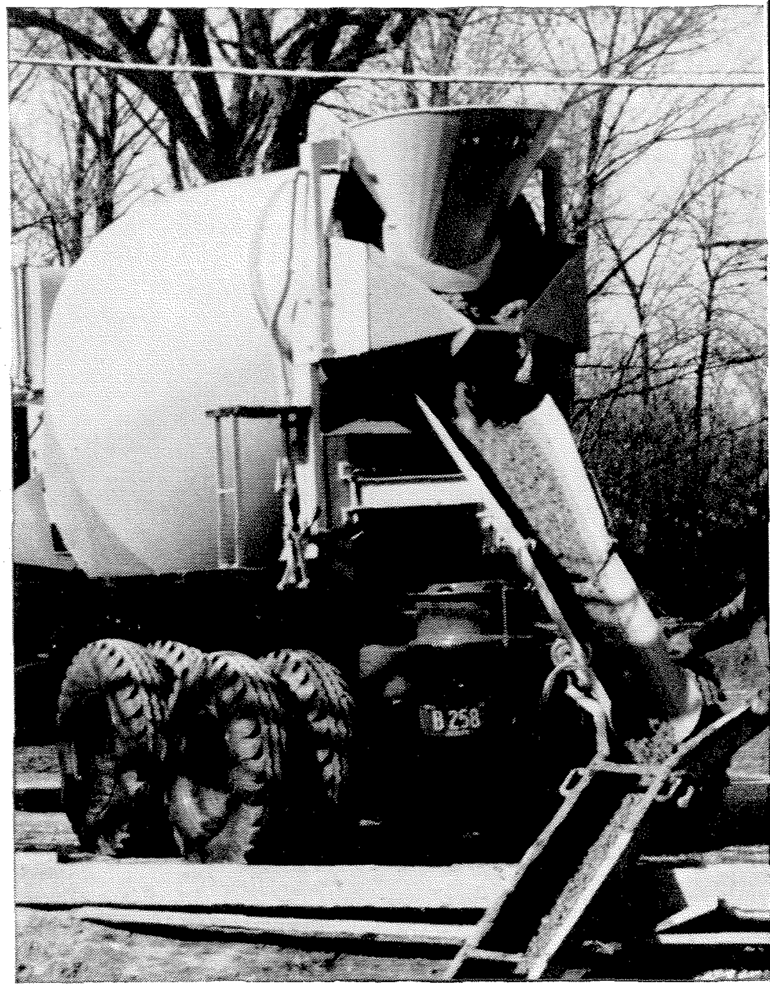
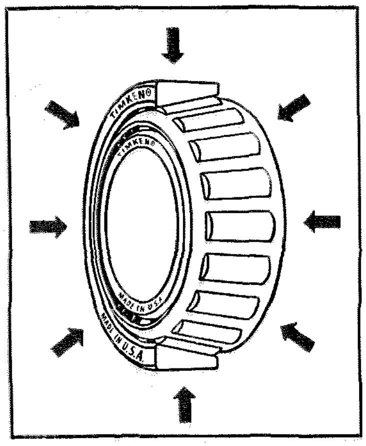
How to lick a mixing problem

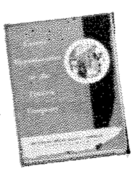


IN designing the bearing mounting for the drum axle of this heavy-duty mixer, the engineers had to consider the punishing radial and thrust loads as the drum rotates at an angle. And heavy shock loads from the impact of driving on rough roads had to be considered, too. To handle these loads simultaneously, keep the drum shaft aligned, the engineers specified Timken® tapered roller bearings. Result —free rolling, longer life, less maintenance.



Tapered design lets Timken® bearings take both radial and thrust loads

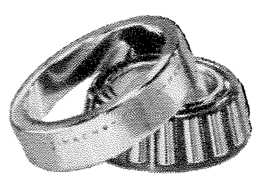
The taper enables Timken bearings to take radial and thrust loads in any combination. And full line contact between their rollers and races gives Timken bearings extra capacity for the toughest loads.



Want to learn more about bearings or job opportunities?

You'll probably face some bearing problems after graduation. Why not learn about them now with our free 270-page General Information Manual on Timken bearings? And for job information write for "Career Opportunities at the Timken Company". The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN *TAPERED ROLLER BEARINGS*



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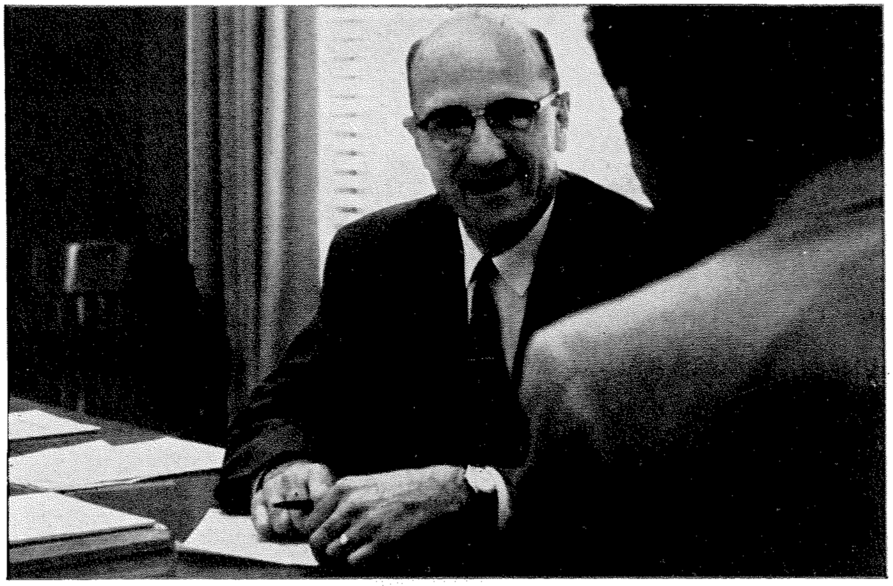
NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

CAREERS WITH BECHTEL



KARL BAUSCH, *Chief Electrical Engineer, Power Division of the Bechtel Corporation.*

ELECTRICAL ENGINEERING

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

QUESTION: *Mr. Bausch, in considering a position with Bechtel, or any other firm, isn't it true that what most college men want to know first of all is "What will I be doing?"*

BAUSCH: That's true, and it isn't an easy question to answer. So much depends on individual preferences and abilities and the way a man develops. On joining us, he would be asked if he'd like to work on the drafting board doing layout work. As an alternate, he might prefer a starting assignment involving helping out on calculations, requisitioning materials, writing specifications, etc.

QUESTION: *In other words you try to give the new man some freedom of choice?*

BAUSCH: As far as possible. We know that the beginning period is a difficult one. It takes some time for him to get his feet on the ground and we try to "expose" him to many different activities. In that way he gets needed experience and familiarity that help him decide the work for which he feels best qualified. It also gives us the opportunity to evaluate his potential.

QUESTION: *Assuming a man shows the necessary ability and begins to produce, how does he branch out?*

BAUSCH: Generally, in either of two ways. He may work on the electrical portion of power plants, designing circuits, control and relaying systems, unit protection, etc. The other way is on the physical layout of power plants—that is, location of equipment, conduit and raceway systems, etc. In either case he would be put in charge of one section of the project.

QUESTION: *And his next advance would be...?*

BAUSCH: Assuming he progresses satisfactorily, he would ultimately move into a lead job as a group supervisor in charge of the design of the electrical system of the complete plant.

QUESTION: *Could you give an estimate of the time involved in the various steps?*

BAUSCH: That's impossible. We have no hard and fast schedule. In general, we have found that it takes a man about a year to get his feet on the ground and become a real producer. From that point on, it's up to him.

QUESTION: *In other words, he can advance in keeping with his individual ability?*

BAUSCH: That's right. Of course, there are many other factors involved, including the vitally important one of the great advancements being made in every phase of the electrical industry. These create new jobs and new types of jobs involving new skills. And for every opportunity existing today, it is safe to predict there will be at least two tomorrow.

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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Vice President, Industrial Relations
220 Bush Street, San Francisco 4, Calif.

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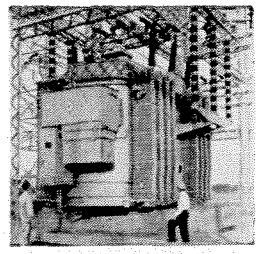
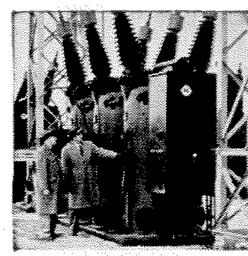
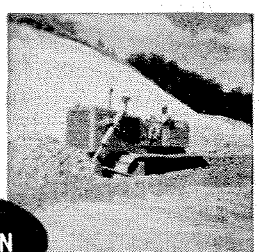
POWER EQUIPMENT

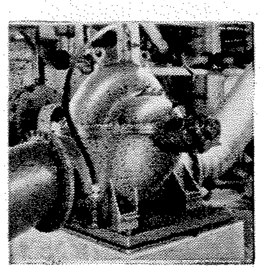

Steam Turbines


Transformers of all Types


Circuit Breakers

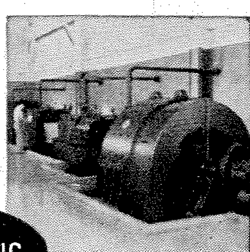
CONSTRUCTION

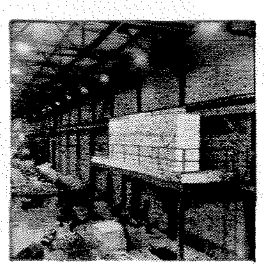

Road Building Equipment

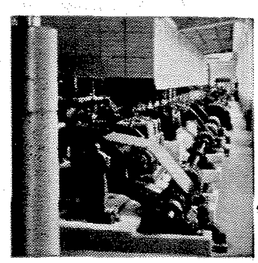

Pumps, Blowers


Cement-Making Equipment

MANUFACTURING


Motors


Control


V-Belt Drives

Opportunities in these fields

Thermodynamics
Acoustics
System Analysis (Electrical and Mechanical)
Stress Analysis
Hydraulics
Electronics
Process Engineering
Mechanical Design
Structural Design
Metallurgy
Nucleonics
High Voltage Phenomenon
Analog and Digital Computers
Fluid Dynamics
Basic Research

You can grow faster in a company that supplies the basic needs of growth! Power, construction and manufacturing *must* grow to supply the needs of our population which is increasing at the rate of 50,000 per week. Allis-Chalmers is a major supplier of equipment in these basic industries.

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- Choose from a wide range of career possibilities

Allis-Chalmers graduate training course has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

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R. A. Andrews
T. G. Atkinson
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E. L. Kumm
E. B. Lewis*
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F. V. Lyle
W. MacRostie
P. M. Mader
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P. S. McKibben
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R. C. Van Orden
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1943

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J. W. Bacon, Jr.
A. S. Bishop
J. W. Buchanan
T. D. Buettell
C. L. Carter
W. L. Christianson
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S. A. Dunn
A. T. Ellis
D. A. Elmer
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E. W. Flavell
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A. H. Gardner
H. K. Garner
J. B. Graner
D. I. Granicher
G. D. Griffith
W. K. Hodder
K. W. Johnson
W. L. Jones
H. A. Lassen
T. G. Lawrence
T. S. Lee
R. P. LeVine
H. C. Lingle
E. J. Macartney
D. F. Mattson
A. O. McCoubrey
C. G. McGee
O. J. Mead
H. Miller
P. R. Moore*
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C. W. Stirling*
C. P .Strickland
F. Tenney
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1944

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R. E. Allingham
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R. V. McGarrity
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F. W. Morris, Jr.
R. T. Nahas
J. B. Nelson
J. R. Nicholas
O. S. Olds
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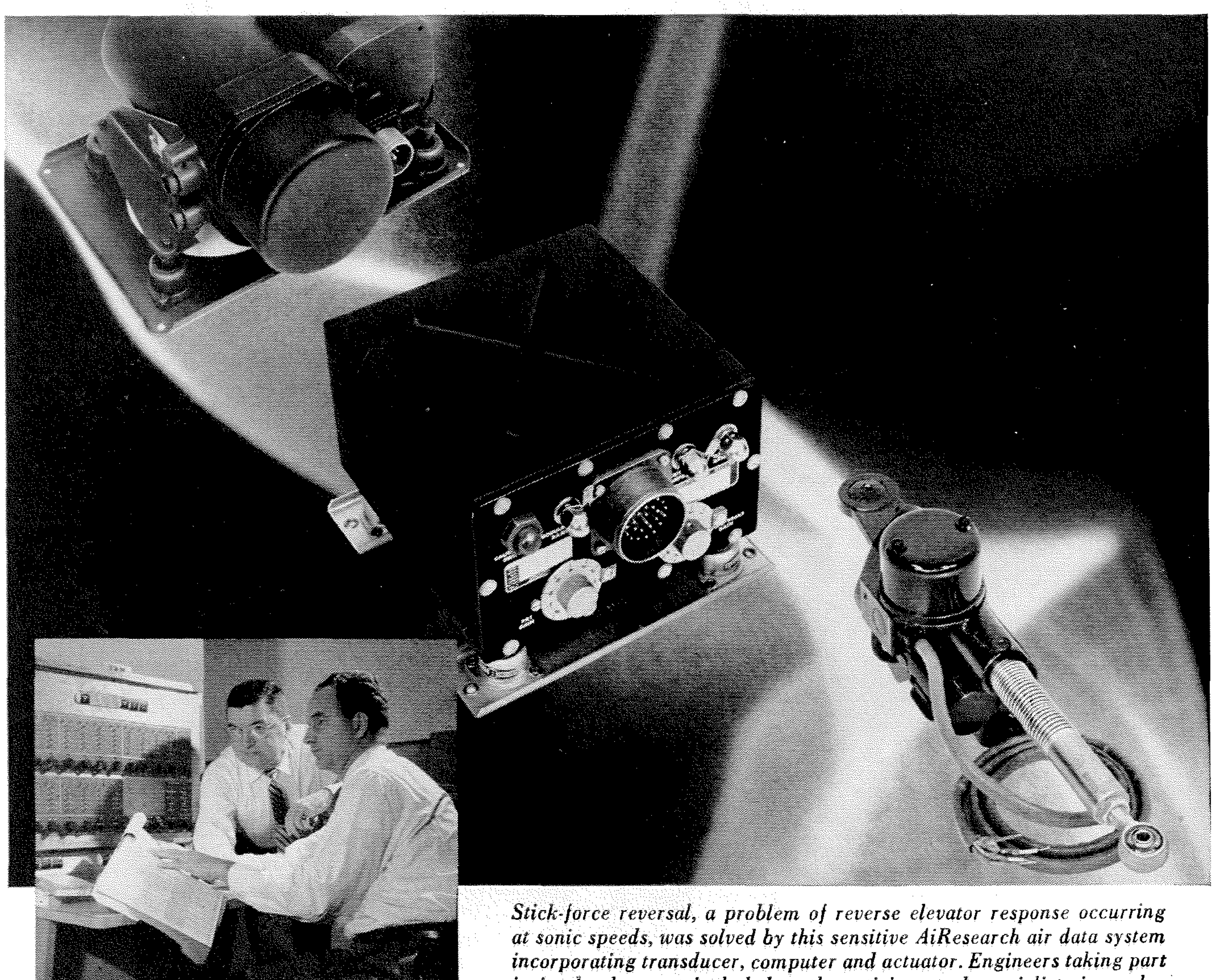

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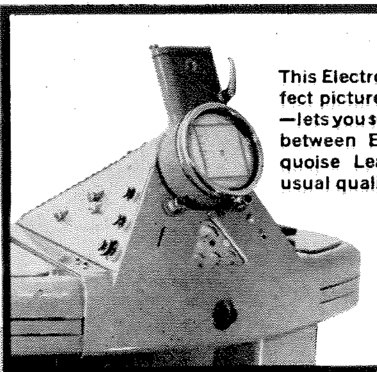
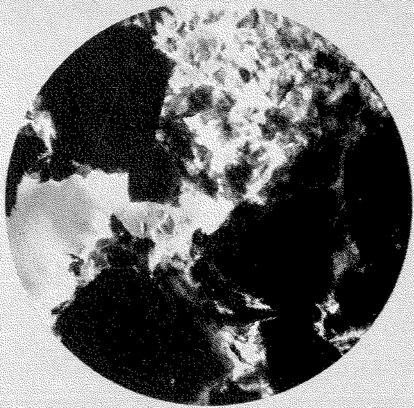


This Electron Microscope takes perfect pictures 7,500 times actual size—lets you see the startling difference between Eagle's "Electronic" Turquoise Lead and the lead in the usual quality drafting pencil.

Photographs courtesy of Ladd Research Industries, Inc.



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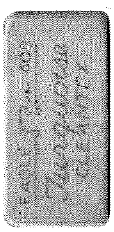

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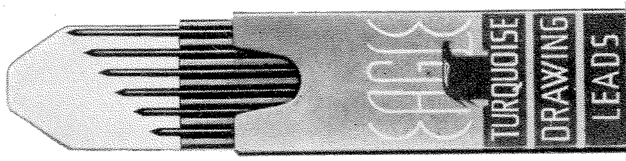

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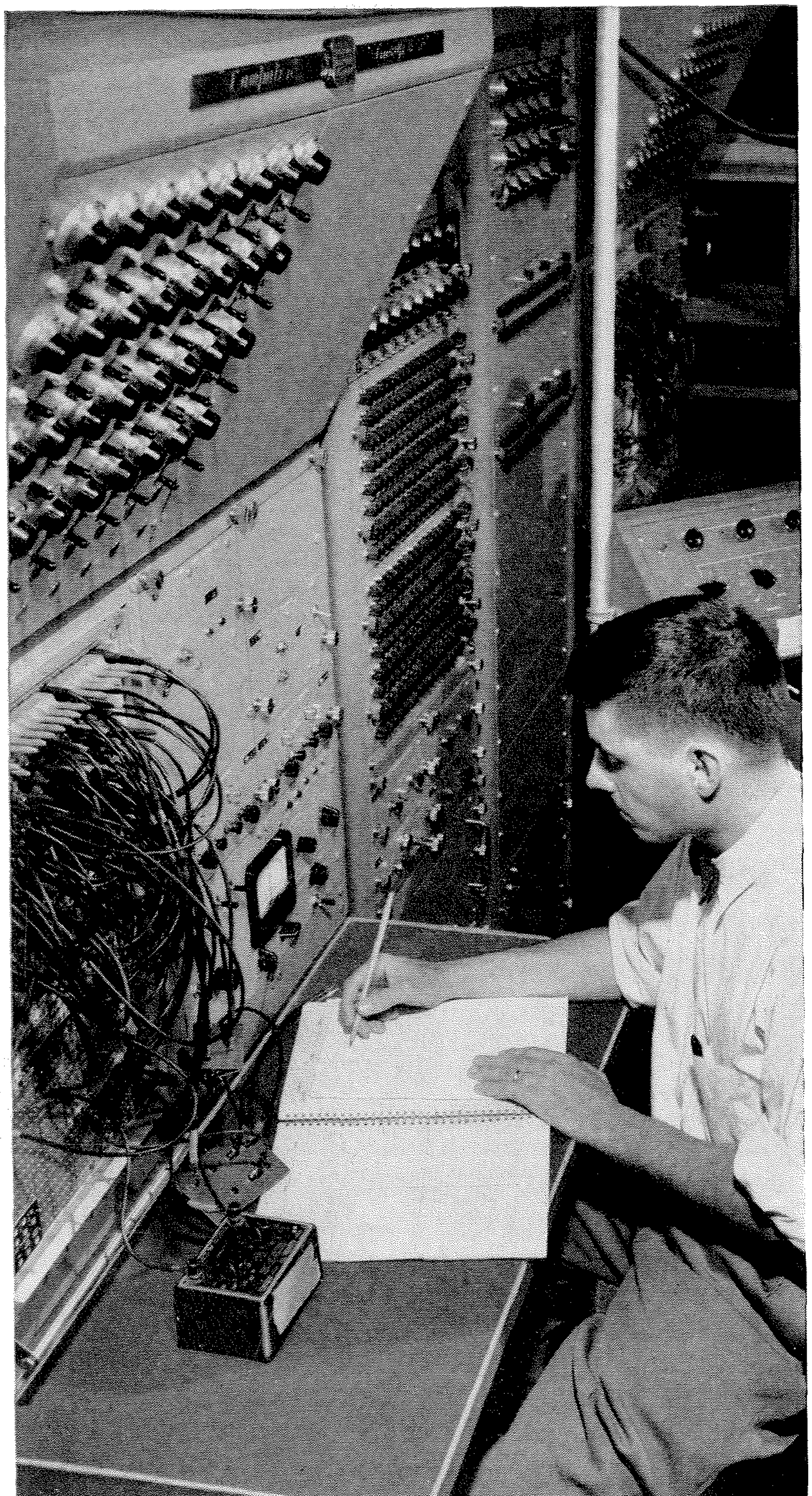

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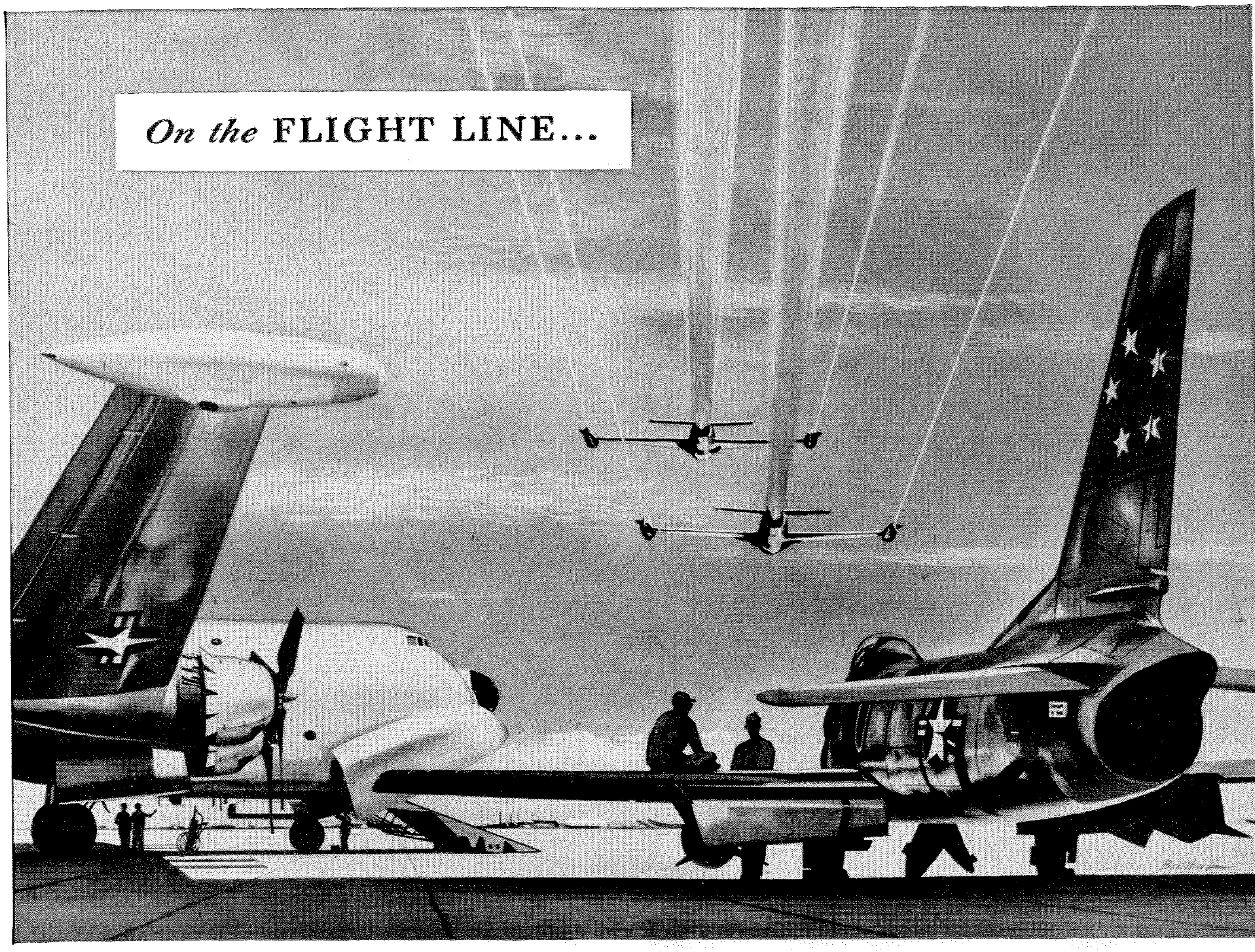

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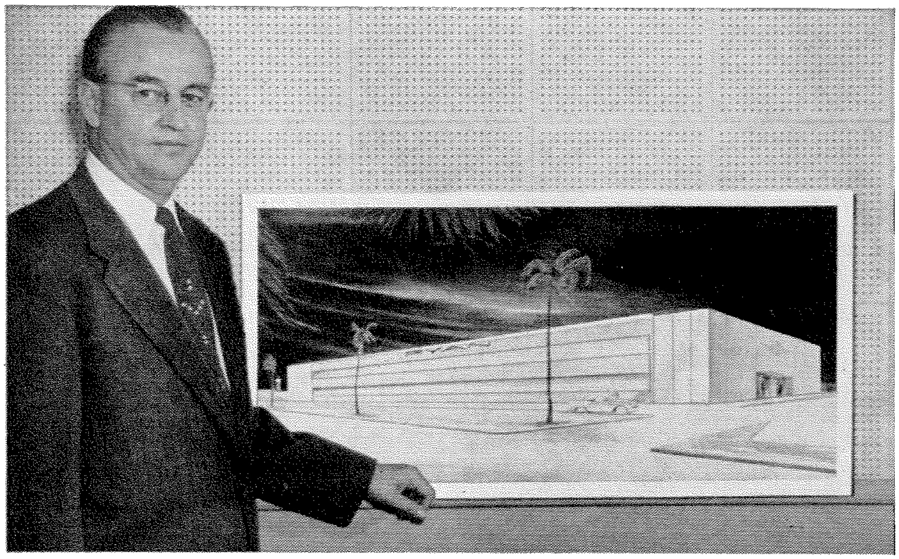

FRANK W. FINK, RYAN VICE PRESIDENT AND CHIEF ENGINEER inspects architect's drawing of new Engineering and Research Center.

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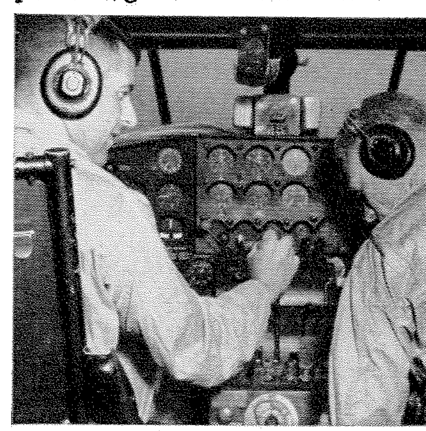

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DIVISIONS
Barrett
General Chemical
National Aniline
Nitrogen
Semet-Solvay
Solvay Process
International

▸ *new polyethylene pipe compound*
▸ *ammonia data book*

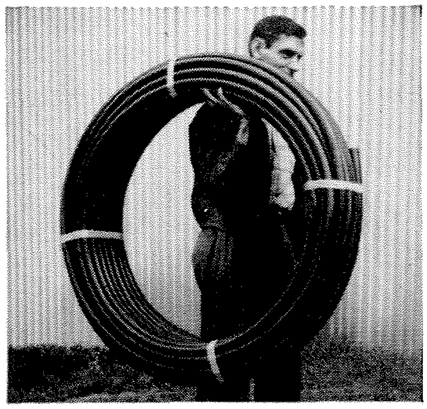
Polyethylene pipe

Flexible plastic pipe for water service and industrial applications. Chemical-resistant plastic pipe for transmission of solvents and hydrocarbons in the oil and gas fields. Pipe that is resistant to impact, heat and other stresses.

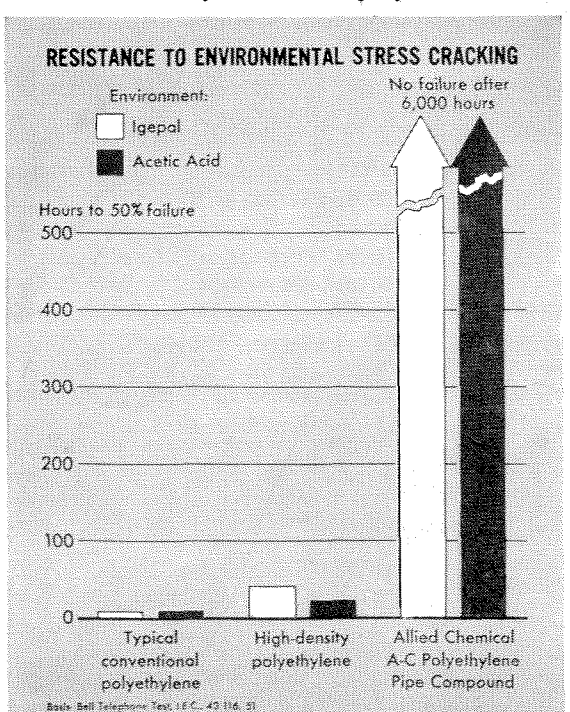
These are some of the advances made possible by a unique new polyethylene pipe compound developed by Allied Chemical. A very high molecular weight polyethylene, it is the successful culmination of 10 years of basic research at our Central Research Laboratories. It is now in commercial production.

Development work is now underway to find other uses for the resin's exceptional physical properties, for the time when the production rate permits sale beyond pipe manufacture. Likely candidates for new uses are tubings, films, sheets, tiles, moldings and fibers.

This distinctly different polyethylene resin made at low pressure is the best thing yet for extruding a superior polyethylene pipe. Pipe being made from the new A-C polyethylene pipe compound has high bursting strength, resistance to impact, shows no stress cracking, has superior heat resistance and resistance to chemicals, organic solvent and hydrocarbon liquids.



New plastic pipe made by Orangeburg Mfg. Co.



These properties are due to the high molecular weight — on the order of 750,000 — and structure of the polyethylene molecule, not present in any other known polyethylene. These new qualities will greatly expand the acceptance of plastic pipe for water service and industrial applications. A common fault of some polyethylene pipe has been environmental stress cracking; this is entirely overcome in pipe made of this new resin.

Also, tests indicate the pipe will be suitable for carrying solvents and hydrocarbons for oil and gas pipe lines, a use denied to conventional polyethylene pipe. There is a growing need in this field for a flexible, tough pipe, resistant to the corrosive conditions which attack steel pipe.

A-C polyethylene pipe compound has an unusually high melt viscosity, reflecting its great molecular weight, and requires special techniques for manufacture of pipe.

The new resin is a companion product to a line of low molecular weight polyethylene products introduced on a commercial scale in 1954 by Allied. These are used in the injection molding of many household items, and as additives in paper coatings, polishes and printing inks.

A-C is an Allied Chemical trademark

Ammonia data book

A new 68-page technical book on ammonia has been prepared by the largest ammonia producer, Allied's Nitrogen Division.

The comprehensive manual is actually a two-in-one piece: the first section on ammonia, and the second on ammonia liquor. Its contents include major uses, physical and chemical properties, specifications, shipping and storage procedures, physical tables, graphs and analytical procedures.

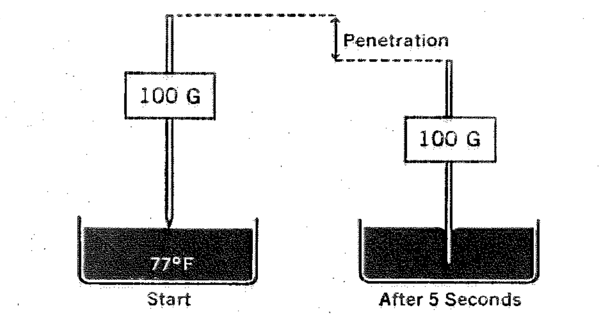
Major ammonia consumers — industries such as explosives, textiles, petroleum refining, refrigeration, pulp and paper, metallurgy and synthetic resin — will be interested in this up-to-date information.

Creative Research

These examples of product development work are illustrative of some of Allied Chemical's research activities and opportunities. Allied divisions offer rewarding careers in many different areas of chemical research and development.

ALLIED CHEMICAL
61 Broadway, New York 6, N. Y.

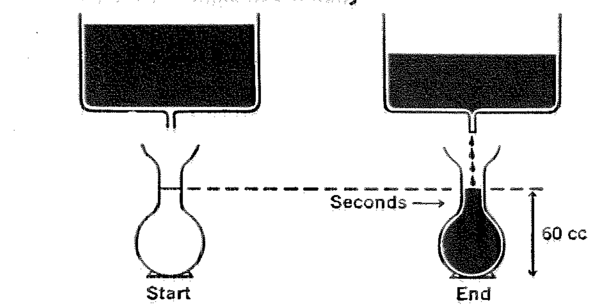
PENETRATION indicates consistency



Consistency is determined by measuring the **penetration** made in 5 seconds by a standard needle loaded with 100 grams. The test is normally run at 77°F and penetration is measured in units of 0.1 mm.

FIG. 1

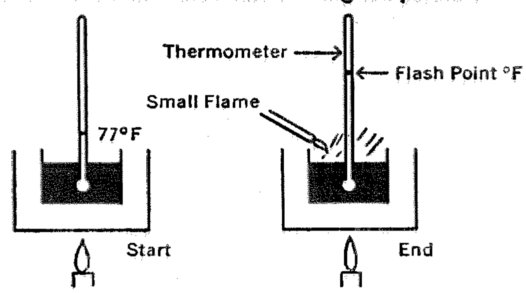
VISCOSITY indicates fluidity



Fluidity is determined at specified temperatures with a Saybolt-Furol Viscosimeter. Results are expressed as Saybolt-Furol Viscosity . . . the time in seconds for 60 cc of the product to flow into measuring flask through a precisely dimensioned orifice. The slower the flow, the higher the viscosity.

FIG. 2

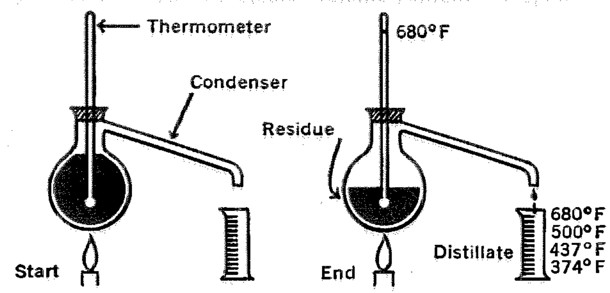
FLASH POINT indicates safe heating temperature



Volatile constituents evolve when the temperature of an Asphaltic product rises sufficiently. The temperature at which they "flash" or temporarily ignite when a small flame is passed through them, during heating of the product, is its **flash point.** This temperature is usually well below the **fire point** or the temperature which will support burning.

FIG. 3

DISTILLATION indicates volatile content...residue



Volatile Content is determined by gradually heating to 680°F, a measured volume of material in a distillation flask connected to a condenser. Relative amounts of volatile materials evaporating at different temperatures and of residual Asphalt are thus determined. Further tests are usually run on Asphalt residue to determine its characteristics.

FIG. 4

Tests on Asphaltic Materials

The suitability of an Asphaltic material for highway or other use depends upon characteristics which can be determined by a series of tests. Four of the principal tests are:

PENETRATION TEST (Fig. 1)

indicates the *consistency* or hardness of Asphalt cements (which are semi-solids) used in hot-mix Asphalt pavements. The softer the product, the greater its number of penetration units. On the basis of consistency . . . denoted by penetration ranges . . . Asphalt cements are classified into grades. Those paving grades now recommended by The Asphalt Institute are:

PENETRATION GRADES

60-70	85-100	120-150	200-300

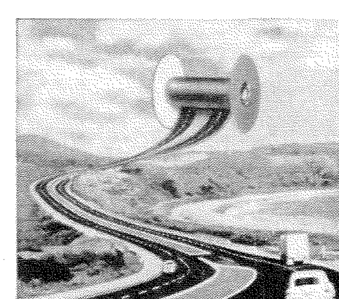
(a 40-50 penetration grade is recommended for special and industrial uses.)

VISCOSITY TEST (Fig. 2)
indicates the fluidity of liquid Asphalts. Viscosity measures the consistency of these products just as the penetration test measures the consistency of semi-solid products. Those liquids flowing too slowly for accurate measurements by the viscosimeter at 77°F are tested at higher temperatures—usually at 122°F, 140°F, or 180°F.

FLASH POINT (Fig. 3)
indicates the temperature at which vapor ignition may occur when heating and manipulating Asphaltic materials.

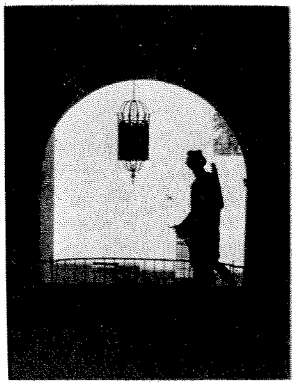
DISTILLATION TEST (Fig. 4)
indicates the amount of Asphaltic residue to expect in liquid Asphalts after lighter constituents volatilize under manipulation and use. It indicates, too, the relative rapidity at which these lighter constituents "cure" out of the Asphalt.

Be sure to cut out and file this data sheet, as well as future sheets and those previously inserted in this publication. Make them your professional reference material.



Ribbons of velvet smoothness . . .
MODERN **ASPHALT** HIGHWAYS

THE ASPHALT INSTITUTE, Asphalt Institute Building, College Park, Maryland



CALENDAR

ALUMNI EVENTS

October 17	Fall Dinner Meeting
November 15	Homecoming Game and Dance
January 16	Winter Dinner Meeting
February 22	Annual Dinner Dance
April 12	Annual Seminar
June 11	Annual Meeting
June 28	Annual Picnic

ATHLETIC SCHEDULE

VARSITY FOOTBALL

October 11—
Caltech at Redlands

October 19—
Caltech at Pomona-Claremont

October 26—
Caltech at Cal Poly (Pomona)

November 1—
Whittier at Caltech (Rose Bowl)

November 9—
Cal Baptist at Caltech

WATER POLO

October 15—
Santa Monica at Caltech

October 18—
L.A. State at Caltech

October 22—
Orange Coast at Caltech

October 25—
Caltech at Pomona

October 29—
L.A.C.C. at Caltech

November 1—
Caltech at Occidental

November 5—
Caltech at Fullerton

November 8—
Caltech at L.A. State

November 12—
Caltech at Long Beach C.C.

FRIDAY EVENING DEMONSTRATION LECTURES

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

October 25—
The Story of Palomar—
Dr. Seth Nicholson

November 1—
American Geneticists in the USSR—
Dr. Norman Horowitz

November 8—
Sex in Viruses—
Dr. Franklin Stahl

ALUMNI ASSOCIATION
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

BALANCE SHEET—As of June 30, 1957

ASSETS

Cash in Bank		$ 336.38
Postage Deposit		105.45
Accounts Receivable		8.45
Investments:		
Share in Consolidated Portfolio of C.I.T. 6-30-57 Prior to current year capital gain	$40,928.48	
Shares in Savings Accounts	11,500.10	
Total Investment		52,428.58
Furniture & Fixtures (at nominal amount)		1.00
Total Assets		$52,879.86

LIABILITIES

Accounts Payable	$ 483.86	
1957-58 Membership Dues Paid in Advance	6,700.00	
Total Liabilities		$ 7,183.86

RESERVES

Life Membership Reserves: Fully paid life memberships	$39,025.00

SURPLUS

Surplus, June 30, 1957	$ 6,671.00
Total Liabilities, Life Memberships, Reserves, and Surplus	$52,879.86

STATEMENT OF INCOME

For the year ended June 30, 1957

INCOME

Dues		$11,747.53
Less: Subscriptions to Engineering and Science Monthly for Association Members		8,916.25
Net Income from Dues		$ 2,831.28
Income from Consolidated Portfolio of C.I.T.	$ 2,098.29	
Investment Interest Income	485.36	2,583.65
Program and Social Functions:		
Income	$ 5,713.00	
Expense	5,876.94	(163.04)
Annual Seminar:		
Income	$ 2,606.90	
Expense	2,556.66	50.24
Sundry Income		13.52
Net Receipts		$ 5,315.65

EXPENSES

Administration:		
Directors' Expenses	$ 219.50	
Postage & Misc.	1,061.76	
Supplies & Printing	705.95	
Total Administration Costs	$ 1,987.21	
Alumni Membership Solicitation	617.29	
Fund Solicitation	756.44	
Total Expenses		3,360.94
Net Income		$ 1,954.71
Less: Directory & Supplement Appropriations		1,286.17
Net Income to Surplus		$ 668.54

AUDITOR'S REPORT

Board of Directors—Alumni Association—California Institute of Technology
Pasadena, California

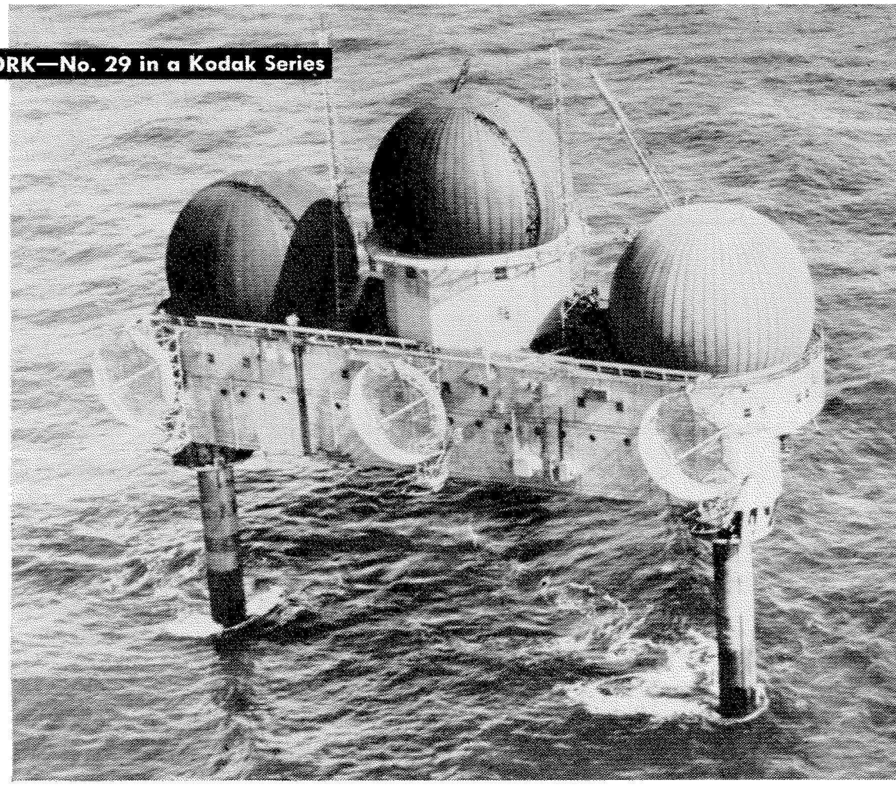
I have examined the Balance Sheet of the Alumni Association, California Institute of Technology as of June 30, 1957, and the related Statement of Income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

In my opinion, the accompanying Balance Sheet and Statement of Income present fairly the financial position of the Alumni Association, California Institute of Technology at June 30, 1957, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

September 23, 1957 DALE J. STEPHENS, Public Accountant, South Pasadena, Calif.

PHOTOGRAPHY AT WORK—No. 29 in a Kodak Series

Sturdy sea legs for Radar eyes



One of America's offshore radar warning towers—Texas Tower III—built by Walsh Holyoke Division, Continental Copper and Steel Industries, Inc.

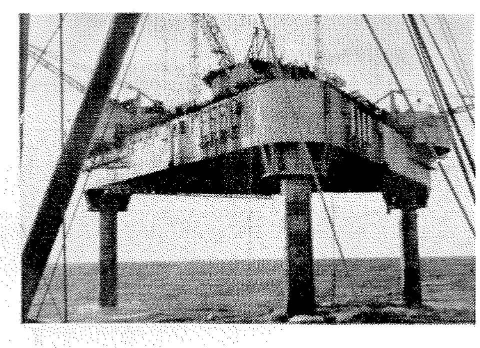
—with every seam proved sound on X-ray film

In record time, Continental Copper and Steel Industries, Inc. built and launched "Texas Tower III" and every weld was checked by radiography.

Here is a steel island 110 miles at sea—2700 tons of 2-deck platform setting on staunch and stalwart caisson legs 272 feet long. It is destined to stand against the hammering of giant seas and howling hurricane gales.

No place here for the tiniest flaw in a single weld! So the magic of radiography was called on to make sure. Two and a half miles of x-ray film hold positive proof that every seam has showed itself flaw-free and secure.

Everyday radiography is working like this for welders, large and small—for foundries interested in making sound castings—for any manufacturer who must know internal conditions of a product without destroying it. It is one example of the many ways photographic processes work for business and industry—how it helps make better products and improve manufacturing procedures.



CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production. If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

EASTMAN KODAK COMPANY
Rochester 4, N. Y.

Kodak
TRADEMARK

One of a series

Interview with General Electric's Frank T. Lewis Mgr., Manufacturing Personnel Development

The Next Four Years: Your Most Important

The United States is now doubling its use of electrical energy every eight years. In order to maintain its position as the leading manufacturer in this fast-growing electrical industry, General Electric is vitally interested in the development of young engineers. Here, Mr. Lewis answers some questions concerning your personal development.

Q. Mr. Lewis, do you think, on entering industry, it's best to specialize immediately, or get broad experience first?

A. Let me give you somewhat of a double-barreled answer. We at General Electric think it's best to get broad experience in a specialized field. By that, I mean our training programs allow you to select the special kind of work which meets your interests—manufacturing, engineering, or technical marketing—and then rotate assignments to give you broad experience within that area.

Q. Are training assignments of a predetermined length and type or does the individual have some influence in determining them?

A. Training programs, by virtue of being programs, have outlined assignments but still provide real opportunities for self-development. We try our best to tailor assignments to the individual's desires and demonstrated abilities.

Q. Do you mean, then, that I could just stay on a job if I like it?

A. That's right. Our programs are both to train you and help you find your place. If you find it somewhere along the way, to your satisfaction and ours, fine.

Q. What types of study courses are included in the training programs and when are the courses taken?

A. Each of our programs has graduate-level courses conducted by experienced G-E engineers. These courses supplement your college training and tie it in with required industrial techniques. Some are taken on Company time, some on your own.

Q. What kind of help do you offer employees in getting graduate schooling?

A. G.E.'s two principal programs of graduate study aid are the Honors Program and the Tuition Refund Program. If accepted on the Honors Program you can obtain a master's degree, tuition free, in 18 months while earning up to 75% of full-time salary. The Tuition Refund Program offers you up to 100% refund of tuition and related fees when you complete graduate courses approved by your department manager. These courses are taken outside normal working hours and must be related to your field of work.

Q. What are the benefits of joining a company first, then going into military service if necessary.

A. We work it this way. If you are hired and are only with the Company a week before reporting to military service, you are considered to be performing continuous service while you are away and you will have your job when you return. In determining your starting salary again, due consideration is given experience you've gained and changes in salary structure made in your absence. In addition, you accrue pension and paid-vacation rights.

Q. Do you advise getting a professional engineer's license? What's it worth to me?

A. There are only a few cases where a license is required at G.E., but we certainly encourage all engineers to strive for one. At present, nearly a quarter of our engineers are licensed and the percentage is constantly increasing. What's it worth? A license gives you professional status and the recognition and prestige that go with it. You may find, in years to come, that a license will be required in more and more instances. Now, while your studies are fresh in your mind, is the best time to undertake the requirements.

Your next four years are most important. During that period you'll undoubtedly make your important career decisions, select and complete training programs to supplement your academic training, and pursue graduate schooling, if you choose. These are the years for personal development — for shaping yourself to the needs of the future. If you have questions still unanswered, write to me at Section 959-6, General Electric Co., Schenectady 5, N. Y.

LOOK FOR other interviews discussing: • Salary • Advancement in Large Companies • Qualities We Look for in Young Engineers.

GENERAL ELECTRIC