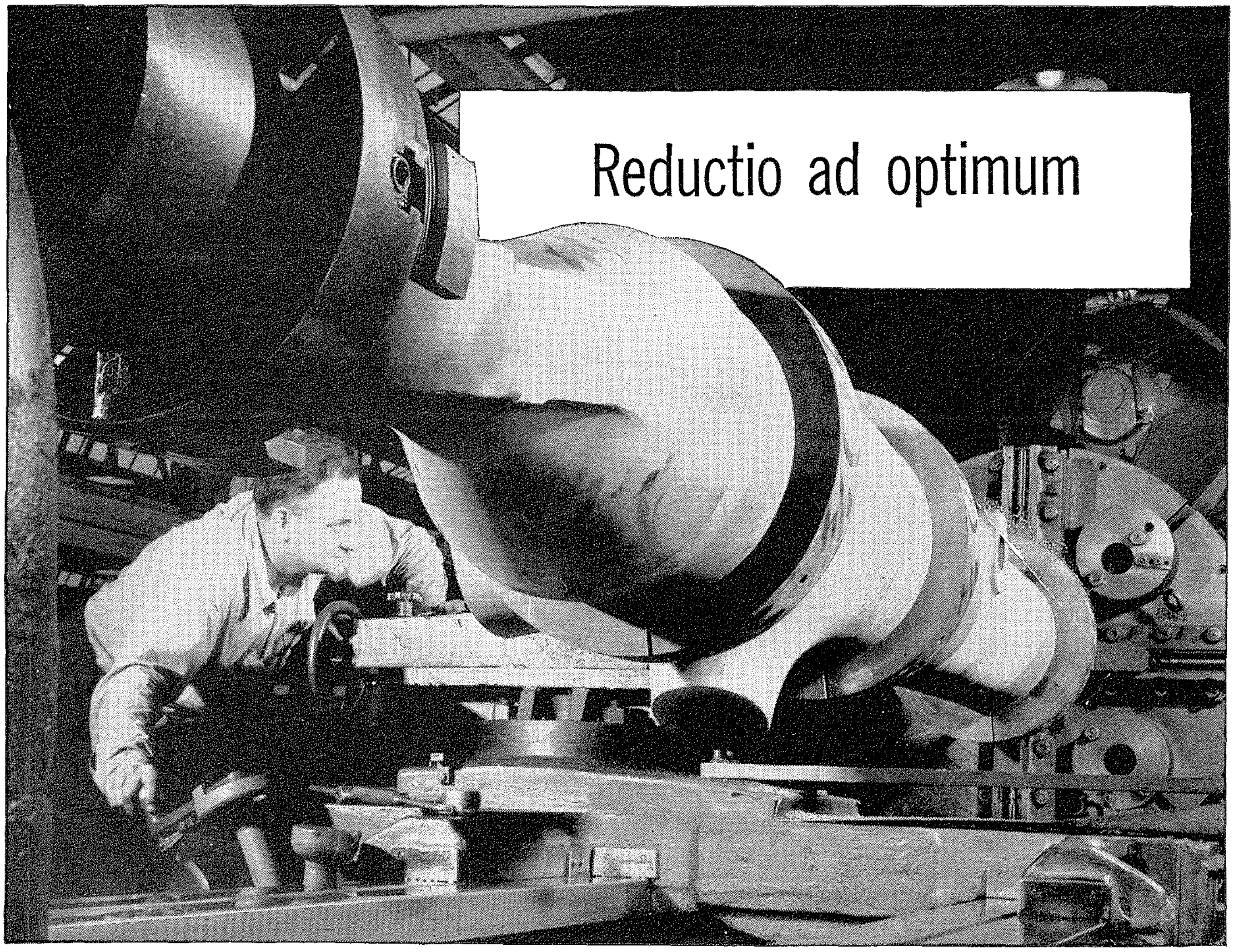
ENGINEERING | AND | SCIENCE

NOVEMBER/1953

Earthquakes . . . page 13

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



U·S·S **CARILLOY** electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment it gets at Cleveland Pneumatic Tool Company complete the job.

● "Reduced to the most favorable degree" describes exactly what happens to the huge U·S·S Carilloy steel ingots from which are formed the rugged main columns in the landing gears of *every* B-36.

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That U·S·S Carilloy steel has been exclusively selected for this application—one of the most exacting in the aircraft industry—is, we believe, highly significant. The same care and skill, the same ability to meet requirements that are beyond the ordinary, go into every order of Carilloy steel we make—whether it's an ingot of giant size or a few tons of special steel.

U·S·S Carilloy is just one more example of the better steel products developed and produced by United States Steel. If you are interested in additional engineering training, why not investigate *your* opportunities with U. S. Steel? For more information, contact the Placement Director of your school, or write to United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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The prof who put off a trip to Europe

He had his tickets. He was all set to sail.

Then this professor of engineering at one of America's leading educational institutions received an invitation to General Motors Engineering Educators Conference.

So, having heard reports on the success of the 1952 conference, he put off his trip and joined in the two-week session of meetings and field trips.

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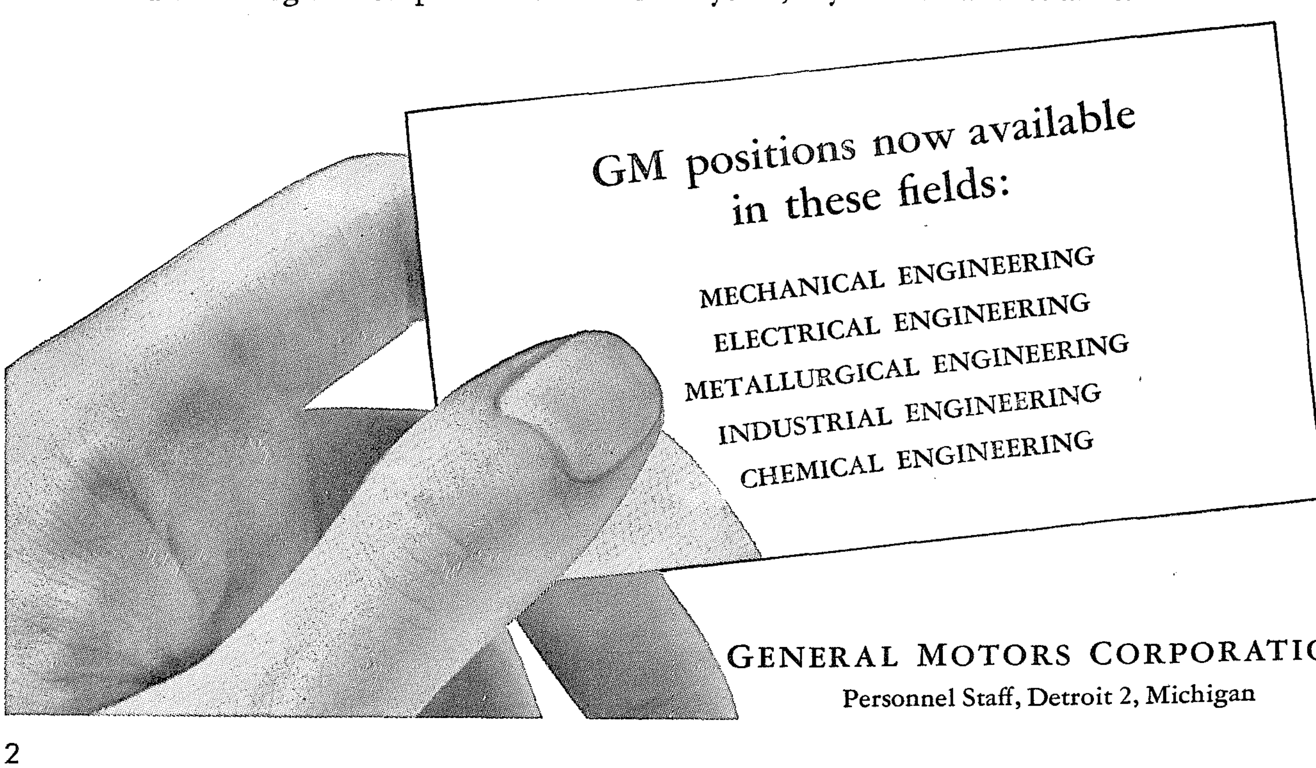
Why? Because, like his fellow educators, he found GM executives meant what they said when they told their guests:

"One of the principal objectives of this Conference is to make us better acquainted with each other's problems. We hope that you will develop personal contacts during the Conference that will assist you in the future. By developing better mutual understanding and cooperation between education and industry, together, we can do a better job of solving the engineering problems of the future and maintaining our Nation's technical leadership."

Yes, the engineering mind is bound to find a congenial intellectual climate at General Motors. For we respect the engineering point of view. As proved by the number of key GM executives in both divisional and top management who began their careers as engineering graduates on GM drafting boards.

So to you faculty members we say: please feel free to write us or ask our College Representative, who periodically visits your campus, any questions, however detailed, on the subject of GM jobs for your talented students.

And to you soon-to-graduate engineers, we say, better think seriously about a GM future. It's yours, if you have what it takes.



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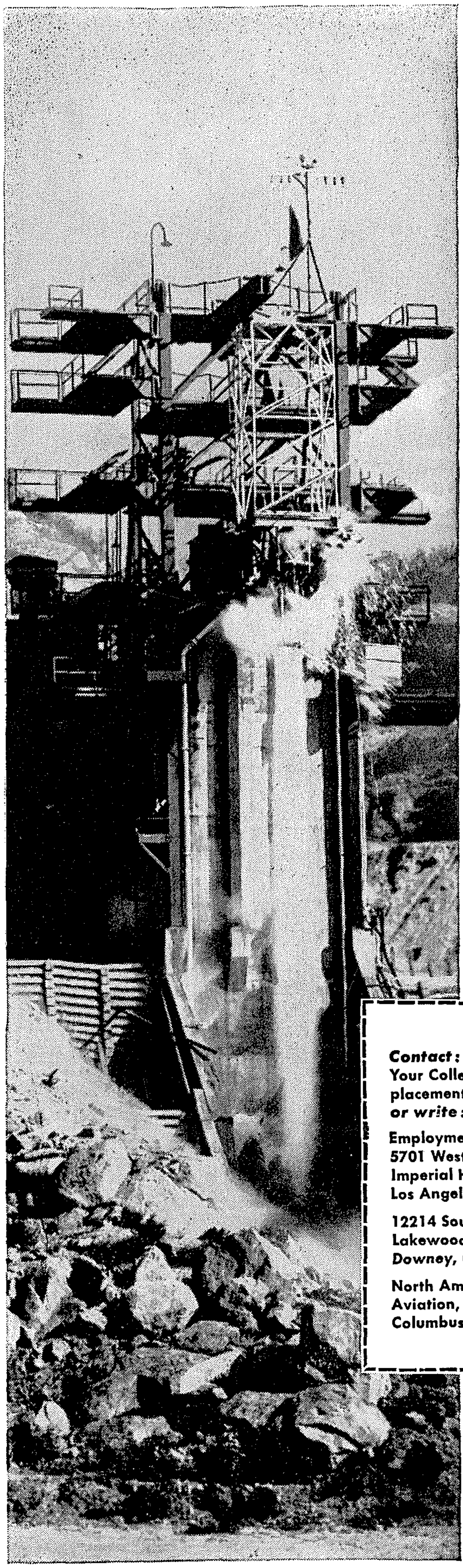
Personnel Staff, Detroit 2, Michigan



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America's security in the air may one day depend upon the kind of fresh ideas you supply . . . to solve problems that are still unknown or dimly seen. Already we have conquered the sonic barrier ... now we're working on the heat barrier.

North American needs engineers who can work on the team that built the great planes of WW II . . . the F-51 Mustang, B-25 Mitchell . . . the record-smashing F-86 *Sabre* Jets. Other careers are in the making in North American's pioneering programs in guided missiles, jets, rockets. electronics, atomic energy . . . each years ahead to keep America strong in the air.

When you are prepared to enter the engineering profession, consider the well-paid career opportunities at North American. Meanwhile, feel free to write for any information concerning your future in the aircraft industry.

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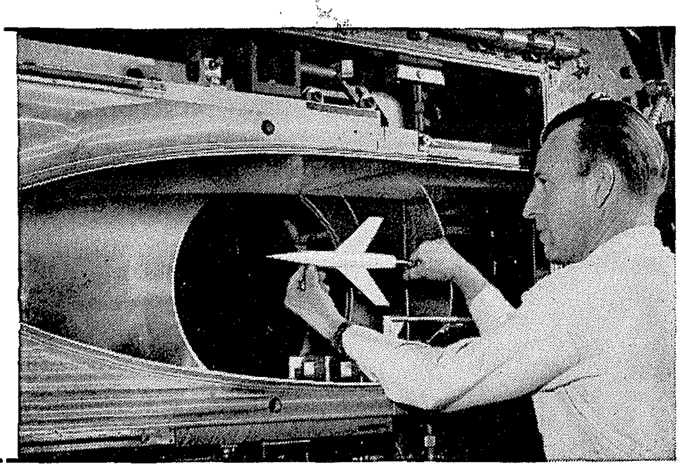

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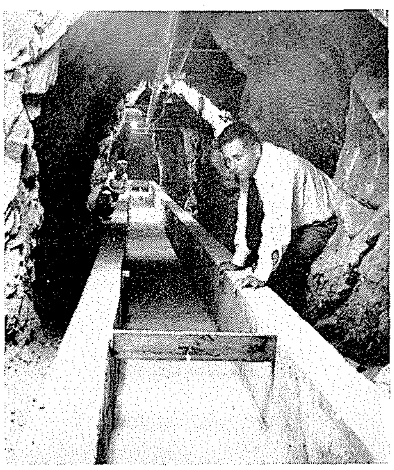
ENGINEERING AND SCIENCE

IN THIS ISSUE



This month's cover shows Dr. Hugo Benioff, Caltech Professor of Seismology, checking the installation of his new earth-strain meter in a tunnel below the Big Dalton Dam, near Glendora. The instrument—an 80-ft-long quartz pipe which lays in the concrete trough shown on the cover—is so sensitive that it will record a 1-inch squeeze between New York and Los Angeles. It's another big step toward the day when earthquakes may be scientifically predicted. For more earthquake data, see Dr. Benioff's story on page 13. This article has been adapted from a talk given by Dr. Benioff at Town Hall, Los Angeles, on August 11, 1953.

Inga Howard, who wrote the tribute to Mrs. Millikan on page 22, was Dr. R. A. Millikan's secretary for 30 years. She retired in 1952.

Horace N. Gilbert, Professor of Business Economics at Caltech, wrote a report on Germany for E&S (May, 1951) after serving on the staff of the U. S. High Commissioner there in 1950-51. On page 24 of this issue he brings that report up to date, after a recent return visit to Germany.

D. S. Clark's hard-hitting article on the drafting of graduate students on page 40 has gone out as an open letter to General Hershey.

PICTURE CREDITS

Cover	Los Angeles *Examiner*
p. 16	Spence Air Photos
p. 17	Thomas F. Bullock: San Francisco *Chronicle*
p. 19	Byron Johnson '56
p. 20	Pasadena *Star-News*
p. 21	Zaharias, Ipswich
p. 22	Hawthorne Studios

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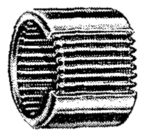
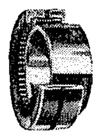
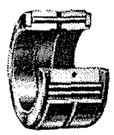
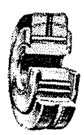
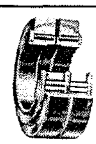
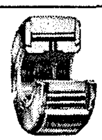
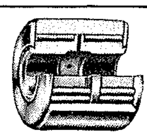
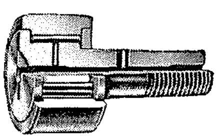
The Torrington Needle Bearing... many types for many needs

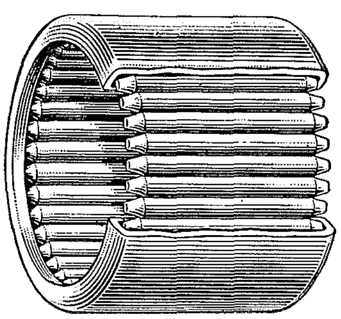
In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*	 	Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*	 	Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.



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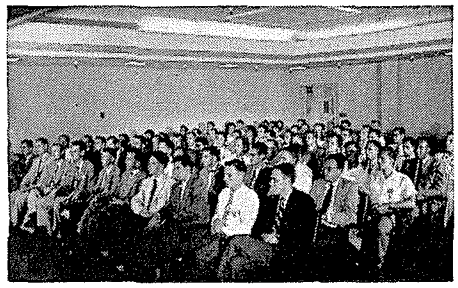
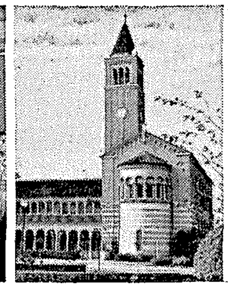
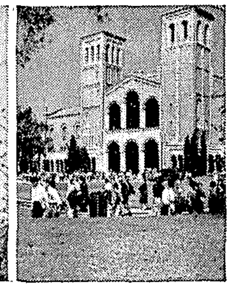
ENGINEERS

and PHYSICISTS

To those interested in advanced academic study while associated with research and development in industry, the following practical programs are offered:

1 HUGHES COOPERATIVE FELLOWSHIP PROGRAM

for Master of Science Degrees

A group of participants in the Hughes Cooperative Fellowship Program (above left). Fellows study for Master of Science degrees at either University of Southern California (center) or University of California at Los Angeles (right).

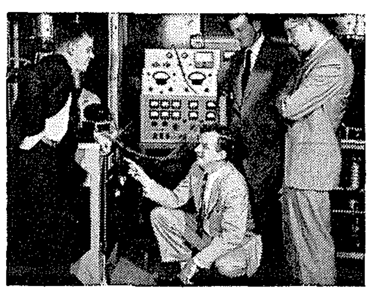
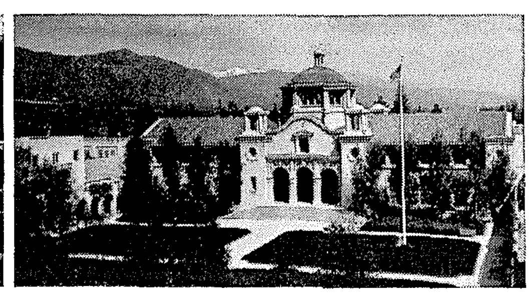
This program is to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. It is open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year and to members of the Armed Services being honorably separated and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time at the Laboratories during the summer, and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

The salary will be commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance will be provided. Provision is made for an allowance to assist in paying traveling and moving expenses from outside the Southern California area.

2 THE HOWARD HUGHES FELLOWSHIPS

in Science and Engineering

(From left to right) Hughes 1952 Fellows Truman O. Woodruff and Allen I. Ormsbee discuss tube processing station in Electron Tube Laboratory with 1953 Fellows Roy Gould and Baxter H. Armstrong. Their advanced study is at California Institute of Technology (above).

Eligible for these fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy in physics or engineering. In summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Fellows may pursue graduate research in the fields of physics, electronics engineering, electronic computing, aerodynamics, propulsion engineering, mechanical engineering, or information theory.

Each appointment is for twelve months and provides a cash award, a salary, and tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program.

HOW TO APPLY: *For complete information concerning either of these Hughes Fellowship programs, consult your Placement Officer or write directly to us. Please indicate the particular program in which you are interested. A detailed explanatory brochure and application forms will be mailed promptly.*

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RESEARCH AND DEVELOPMENT LABORATORIES
COMMITTEE FOR GRADUATE STUDY
Culver City, Los Angeles County, California

EXPLORERS AND CREATORS

A consideration of the true role of the scientist and engineer in the world today

by L. A. DuBRIDGE

A NUMBER of years ago Dr. A. A. Noyes, in formulating the educational policies for the newly reorganized California Institute of Technology, enunciated the following proposition:

"The undergraduate course in engineering shall be of a general fundamental character with a minimum of specialization in the separate branches of engineering. It shall include an unusually thorough training in the fundamental sciences of physics, chemistry, and mathematics and a large proportion of cultural studies; the time for this being secured by eliminating some of the more specialized subjects commonly included in the undergraduate engineering courses. . . . It is hoped in this way to provide a combination of fundamental scientific training with a broad human outlook—avoiding narrowness on the one hand and, on the other, superficiality and lack of purpose. . . . "

Needless to say I subscribe heartily to this statement which has been the "credo" of Caltech for the past 32 years. On the basis of this policy the California Institute has turned out some fairly creditable scientists and engineers! It has also turned out men who have risen to positions of responsibility, influence, and leadership in science, engineering, and industry, as well as in community and national life. In an individual, in a university, in a company, in a community, and in a nation we need knowledge and competence of many types; we need breadth of vision, we need not only intelligence but wisdom, not only intellectual but also moral leadership.

That is my philosophy and I want to lay it on the table at the outset, for I do not want to be misunderstood in the things I am about to say. I don't want anyone to dismiss the remarks which follow by saying "Oh, he is just a scientist; he doesn't understand the finer things of life."

That very statement, in fact, is as good a place to take off as any. Who is it that thinks he has a monopoly on the "finer things of life"? Who says that the poems of Omar Khayyam are any "finer" than Newton's Laws of Motion? I'll take my "loaf of bread" and "jug of wine" along with the next fellow. But I'll deny they are any "finer" than the elliptical orbit of the planet Mercury, and far less grand than Einstein's Theory of Relativity. I am quite willing to use the terms beautiful, noble, majestic in speaking of the plays of Shakespeare, the paintings of Rubens, the music of Brahms. But I claim the right to use the same terms in describing the great scientific achievements of Newton, of Darwin, of Einstein, and of Bohr.

But my friends the humanists say "no." Art, music,

"Explorers and Creators" has been adapted from an address delivered at the semi-annual meeting of the American Society of Mechanical Engineers in Los Angeles, June 30, 1953

and literature are beautiful; science and engineering are crass, materialistic, earthy, practical. And besides they are too technical! Then comes the punch line. It goes like this: "Furthermore," they say, "science is the cause of all the world's troubles. If we only had less science and more literature, or art, or music, or religion, or something, the world's troubles would all be cured."

I believe firmly that statements of this sort, even though widely repeated and believed, are sheer nonsense. And it is time that scientists and engineers pointed out the nonsense in no uncertain terms.

In designating the nonsense it is not necessary to make any derogatory remarks about any nonscientific area of human endeavor. It is no reflection on Brahms' music to see beauty in other things too. It should not offend those who receive inspiration from art and literature to suggest that others receive just as true and fine an inspirational experience from astronomy or physics.

I happen to believe that knowledge, truth, and beauty are to be found by traveling down many avenues. Most people cannot travel more than one avenue at a time (though a few do). We should, however, neither envy nor disdain those who have chosen other approaches from the one we prefer.

Physicists and poets

Nor do I think it is possible to say that one avenue is better or finer or more useful or more valuable than another. Any particular human mind and spirit must seek to fulfill its dreams in its own way. Civilization as a whole needs the knowledge, the inspiration, the material products of all lines of effort, of all kinds of people. Physicist and poet, engineer and artist, astronomer and historian, biologist and economist—all men who seek knowledge, truth, beauty, understanding are adding in equal measure to the welfare of men.

Nor do these men work independently. The social scientist cannot hope to see his ideals of a more effective and peaceful social structure come to pass without the tools provided by medicine, public health, science, and industry. Nor is the engineer very effective or useful in a social organization which is unable to provide rudimentary civic orderliness, to say nothing of economic resources. Nor do men live happily, even with physical comfort and social and political stability, if they do not have also access to beauty, inspiration, love.

In short, men, individually and collectively, need intellectual *and* spiritual advancement. We should all encourage all paths which lead to this end.

In this total picture the scientist and engineer have a vital part to play. They can play that part effectively only if the true nature of their role is understood—first by scientists and engineers themselves—and secondly by the public at large.

What is the role of the scientist and the engineer? To make radios, automobiles, bathtubs, deep freezers, jet airplanes, and atomic bombs? Well, I regret to say, to hear many scientists and engineers talk you would think that's all they are good for. We have bragged so much about the gadgets we have produced that people are getting a little tired of hearing about them. Even our fellow Americans in other pursuits have caught the fever and brag to the world about American gadgets—implying a rather noticeable disdain for other nations that have fewer gadgets to display.

But do we ever stop to raise the question as to whether the inhabitants of other countries even want the gadgets of which we are so proud? The Hindus of India, I understand, do not want bathtubs. They believe it is unclean to sit in water that has already been soiled. (Personally I agree with them!) They are understandably rather mystified therefore when we brag about how many bathtubs we have.

Again there are many people whose standards of *values* differ from ours. They may want certain things but not at the price they would have to pay. I mean not only the price in dollars but in the way of living. A Chinese peasant on his farm might not care to work in a factory even at a very handsome monetary wage. I have even heard residents of southern California wonder whether the smog is not too high a price to pay for the industrial community we have created. I know many people who wish that no one else would drive a car! I am quite convinced that many a resident of Europe is glad that his highways are not as choked as ours. Is not each group of people entitled to its own wants and tastes?—its own collection of things it does not want?

And so, what is the scientist and engineer for? To turn out endless supplies of things, no matter how much they clutter up the place or how much smoke and dirt they produce or cause, or how much they cost?

I claim it is time to call a halt to our continuing oratory about our wonderful gadgets. We need to ask what these gadgets are for and how they came into being. Most of all we should shed our egotistical assumption that, because we like certain gadgets, people on other continents are depraved if they do not long for them also.

What are they for?

So now I can give my version of what scientists and engineers are for.

Let us start with a scientist.

I begin by asserting that curiosity is one of the most sublime of human attributes. I shall always have a grudge against the man who invented the assertion that "curiosity killed the cat." That phrase has been a menace to the advancement of learning for generations. I personally don't believe it is true. I'll bet the cat was killed either looking for food or for another cat. Most likely the phrase was invented as an outright lie by an impatient parent seeking to terminate a torrent of questions from an alert 10-year-old boy. What a tragedy it is that such boys have been so treated by parents and teachers that by the time they are 18 the natural tendency to ask questions has been thoroughly drilled out of them!

Yet I insist that man as an intelligent human being moves forward intellectually and spiritually solely because some men keep on asking questions all their lives. Some men have a divine curiosity which no one can destroy—and the sum total of human knowledge consists of the answers those men have found to the questions they have asked. Down through the ages scholars have asked many questions about many things. They have found many answers; some were right, others turned out to be wrong. But in the process man's knowledge and understanding grew.

Asking questions of nature

Those scholars who ask questions of *nature*, questions about the physical world, and who then seek nature's answers, are called scientists. Some ask questions about the sun, moon, and stars, others about the structure of the earth. Some inquire about the behavior of living things, others about the nature of matter. All are seeking knowledge, seeking to understand.

One man climbs to the top of Mt. Everest—because Everest is there and he wishes to conquer it. A scientist performs experiments with atoms, because atoms are there and he wishes to understand them. Both men are impelled by a basic human urge. The urge to explore, to conquer, is closely akin to the urge to know, to understand.

That is what scientists are for—to enlarge man's understanding of the physical world.

Why enlarge it? Simply because men are so built that they will never rest until they do understand, until they do conquer their ignorance and satisfy their sublime curiosity.

Yes, I am familiar with the argument that knowledge has practical value too—it enables men to keep warm, to prevent hunger, to make money. But tonight it is my thesis that the conquest of ignorance is good for its own sake, good because it satisfies man's intellectual and spiritual desires. And all men everywhere, as they learn to appreciate art and music and literature, should learn also to appreciate, to understand, and to promote the work of the scholar and the scientist as they continue their quest for knowledge.

And how about the engineer? What is he good for? Is he the one whose job it is make things, to desire gadgets, to build structures? Is it true that while the scientist seeks truth the engineer seeks cash?

Sadly enough many people, including many engineers, think of it in just that way. Naturally we are all proud of the things our engineers have created. It is not unnatural that we brag about them. But just what do we brag about? As I have already said, bragging to a Hindu about a bathtub leaves him wholly mystified. And this leads me to state a rule we too often forget: A gadget is not something that is good (or bad) for its own sake; it is something that is good (or bad) only to the extent that it satisfies an important human want, an important human need, an important human desire.

For example, men need a certain minimum amount of food each day. Therefore devices or techniques which enable them to produce more food, to produce it more economically and to transport it to where it is most needed, quickly and economically, are things to brag about. But they are worth bragging about not because they are cute or ingenious, or because they make the inventor a lot of money, but because they save human lives, reduce human suffering, enable human beings to devote energy to things other than the sheer satisfaction of hunger. Similarly with things that keep men warm when the weather is cold, or cool when the weather is warm, dry when it rains, and so on; these things satisfy basic human needs.

Down through the ages the job of the technologist, the engineer, the applied scientist, has been to develop methods of satisfying human needs.

Now, when a device is invented which does satisfy such a need, the people who have the need will work to acquire the device. They will pay for it. Hence somebody makes some money. And there is nothing wrong about that either. But it is wrong to put the importance of the medium of exchange through which a need is met above the importance of the need itself. We will be doing a favor to everyone if in our own thinking and in our public statements we express the engineers' contributions to society in terms of human needs rather than solely in terms of American dollars. This will have also the advantage that we will examine the real needs of people in this and other countries and the price they would have to pay to fulfill them before we criticize them for not using the things that we invent.

Agents of destruction?

Now, as all of us are only too-well aware, there may arise periods in the history of any country when it must resort to force of arms to defend its independence or to preserve its very existence. Patriotic citizens of that country will use their talents and energies to assist their country to carry on the fight successfully. And so it will come about that scientists and engineers of the country will abandon their normal peacetime pursuits and turn their attention to devising weapons and techniques of warfare. No one disputes the great success these endeavors have achieved in recent years.

This is fine, and scientists and engineers can be proud of the results of their work. But it has all added another difficulty to our problem of public relations and public understanding. For now the scientist and engineer are often looked upon not as patriotic citizens who helped preserve their country's freedom but as diabolical inventors of weapons of death. Again the existence of the thing has overshadowed the purpose for which the thing was developed, the human need which it was designed to meet. The scientist and engineer (I must continue now to use both terms because, in times of crisis, scientists become engineers, temporarily, in order to help get a job done), instead of being regarded as the protectors of human freedom, are looked upon as the agents of destruction. "Science has outrun human relations," it is said. What does that mean? Actually, science and engineering are our best instruments to promote human understanding. They are instruments to protect human freedom. They are instruments to satisfy man's wants and needs, to advance his welfare. The major objective of scientists and engineers is to make the world a better place in which to live. I somehow wish those words could be engraved in a place where all men could see them—especially those fearful men who, seeing the products of science and engineering, hysterically call for a stop to further invention lest evil men use these products for unintended purposes. Evil men there will always be. But they will not be curbed by asking good men to stop thinking!

Science and technology have become so important a part of the structure of modern American civilization that, like air and water, we have come to take them for granted and even ignore their intrinsic value. In the old days the public could ignore science and technology, for these activities were independent of public attention. The scientist would continue his work in the laboratory no matter what the taxpayer thought. The engineer also went about his business, unconcerned about government activities and policies.

Science and government

A depression and World War II have changed that. All citizens are daily more affected by government than they used to be. This is especially true of scientists and engineers. This is true in the first place because a large share of the nation's scientists and engineers turned their attention to war work during the war, thus bringing about a profound change in direction of the nation's technology. A large fraction of them are still at work on problems connected with war technology. Many others work in areas which were opened up or given a new turn through war developments. These developments created new demands—new needs for scientific and engineering effort. All of these things together greatly increased the need for scientists and engineers. The supply has also increased, though never as fast as the need. Thus there are far more scientists and engineers than ever before, spending far more money than ever before. A far larger fraction of them are working directly on government activities. Those still in private business are more dependent on government orders, or at least on government tax policies. The support of research in pure and applied science has been to a substantial extent assumed by government.

Now I am not trying to argue whether the present situation is right or wrong, sound or unsound. All I say is that it exists. And since it is also manifestly true that our nation needs science and engineering more than ever before, it is desperately important that taxpayers and voters understand more than ever the true role of the technical man.

If the taxpayer thinks of the scientist solely as a maker of weapons of war, he will expect him miraculously to appear when weapons are called for and conveniently to disappear from the tax bills when new weapons seem slightly less urgent. The taxpayer will not be happy, however if he finds that technologists in other nations have invented cleverer weapons than ours. And he will be impatient with any excuses such as "our funds were inadequate," "our equipment was obsolete," "not enough trained scientists could be found." The taxpayer wants things delivered on demand.

A healthy science and technology

So far the taxpayer has nothing to complain about. He has received high dividends on a modest investment. But the temptation to kill the goose is still strong. He forgets that golden eggs came, not because they were ordered, but because there was a goose. The task of our nation today is not solely to order science and technology to deliver certain weapons. It is to maintain a healthy science and technology. Weapons will then come when needed—and all the others things men will want and need will come besides.

The maintenance of a healthy science and technology is largely a matter for the private citizens and private companies, universities, and foundations to provide. But the government stake is so great that the government cannot shirk its responsibility. There is grave danger right now, for example, that a substantial fraction of the scientific research and development going on in nongovernment laboratories will be stopped within a year. When budgets are being cut it is only human nature that urgent, obvious, short-range activities will be cut the least. Scientific research—whatever its ultimate value—does not usually pay off within the fiscal year. Thus certain government agencies, such as the Office of Naval Research, which have carried a large share of the load of supporting research activities are being faced with the possible necessity of 30 or 40 percent cuts. A disruption in research projects would thus take place which years of future effort could not restore. Even from a very practical standpoint this is bad economics. From the standpoint of the long-term welfare and security of the nation it is disastrous.

In this particular emergency it may be necessary for all of us once more to call public attention to the dollar value of science and engineering. But if we confine our attention to this issue we shall only be meeting a series of future similar emergencies. For it is a paradoxical fact that in the long run people will not continue to spend money for things whose sole value is a dollar value. We don't very long spend dollars to buy dollars—we spend dollars to satisfy needs, to fulfill desires, to make dreams come true. The explorers and creators of the laboratory are doing more than creating material wealth; they are bringing the stars to earth, and lifting men to the stars.

EARTHQUAKES

Where they come from—why they occur —and what their effects are

by HUGO BENIOFF

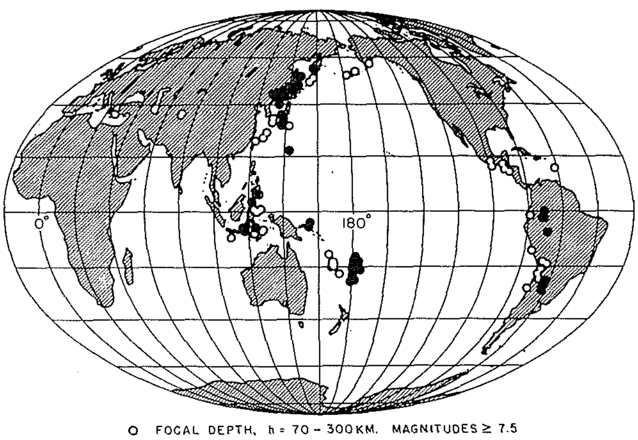
CALIFORNIA HAS HAD a long history of earthquakes going back for many hundreds of thousands of years—and since it is very likely that the state will continue to have earthquakes for a long time to come, we who live here must somehow learn to get along with them. To do this we must have some knowledge about them—where they come from, what produces them, and what their effects are.

Earthquakes do not occur throughout the whole body of the earth. They are absent in the core, which we believe to be composed of iron and nickel. They are also absent throughout most of the mantle surrounding the core. All the earthquakes which have been observed since seismographic instruments were developed have occurred within the outermost 400-mile layer of the earth.

Some of the earthquakes which occur at the maximum depth of 400 miles are quite large, but since they are at least 400 miles from the nearest man-made structure, they produce little or no damage. The most destructive shocks are shallow, originating within a thin surface layer, not more than 27 miles in thickness. California has only the shallow-type earthquakes.

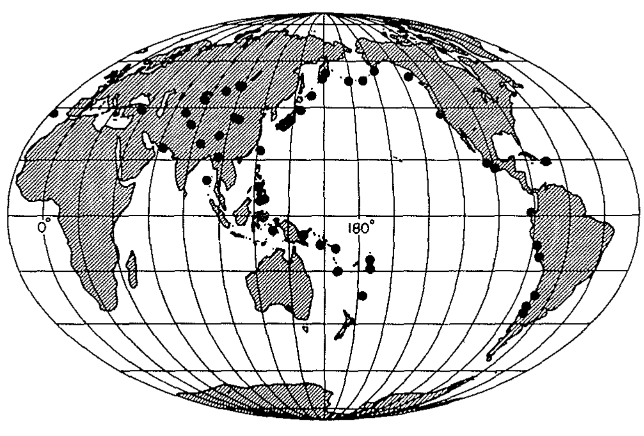
The deep earthquakes are not distributed uniformly over the globe but are confined to the circumpacific arc (left, below). Thus, in the western hemisphere, they occur along the coasts of South America, Mexico and Central America. There have been none on our California coast, and none along the Canadian coast. Beginning with the Aleutians, the active arc continues through Kamchatka, Japan, Manchuria, the East Indies and terminates in the southern end of the Tonga Islands near New Zealand. Earthquakes of intermediate depth (27-150 miles) occur along the circumpacific arc and, in addition, along a belt extending from Southern Asia through Asia Minor and the Mediterranean region.

The distribution of the shallow earthquakes is, in general, about the same as that of the deeper ones, but somewhat more widespread. A chart showing the positions of all the great shallow earthquakes which have occurred on the earth since 1904—when the seismograph was developed—(below) shows locations on the coast of South America, in Mexico, Central America, California (the San Francisco earthquake of 1906), the Queen Charlotte Islands off the coast of Canada, the Aleutians and along the eastern coast of Asia and the East Indies to New Zealand. Additional locations appear

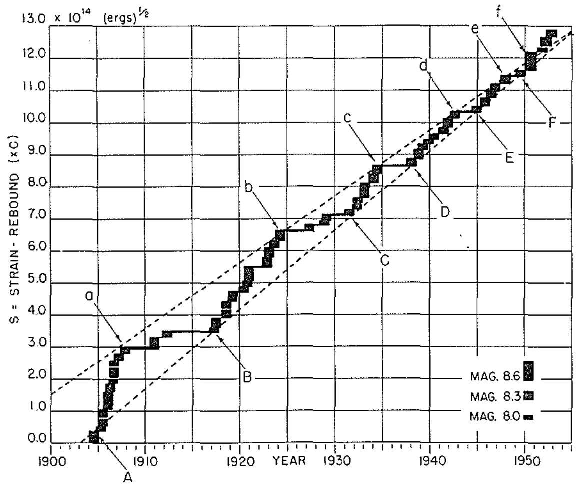


○ FOCAL DEPTH, h = 70 - 300 KM. MAGNITUDES ≥ 7.5
● FOCAL DEPTH, h = 300-650 KM. MAGNITUDES ≥ 7.0

LARGE INTERMEDIATE AND DEEP FOCUS EARTHQUAKES SINCE 1904.



SHALLOY EARTHQUAKES. MAGNITUDES ≥ 8.0 SINCE 1904.



ELASTIC STRAIN-REBOUND CHARACTERISTIC. SEQUENCE OF WORLD SHALLOW EARTHQUAKES. MAG. ≥ 8.0, SINCE 1904.

Distribution of great shallow earthquakes shows they occur in alternate periods of activity and quiescence.

along the southern part of Asia and continue westward through Asia Minor to the Atlantic Ocean in the vicinity of Portugal and Spain.

These great earthquakes do not occur uniformly in time but rather in alternate periods of activity and quiesence (above). Beginning before 1904 there was a period of great activity which lasted until 1908. This was followed by a rest period of 10 years with only two earthquakes. Following this rest period an active period began, and so on up to the present date.

Peculiarly, these alternate periods of activity have decreased regularly in amplitude and duration with time. We do not know the full meaning of this behavior. It does indicate, however, that the great earthquakes of the earth are related in a single global stress-strain system.

The chart shows that at the present time the active periods have become so short that the great earthquakes are occurring about as fast as the strain builds up—one great earthquake per year.

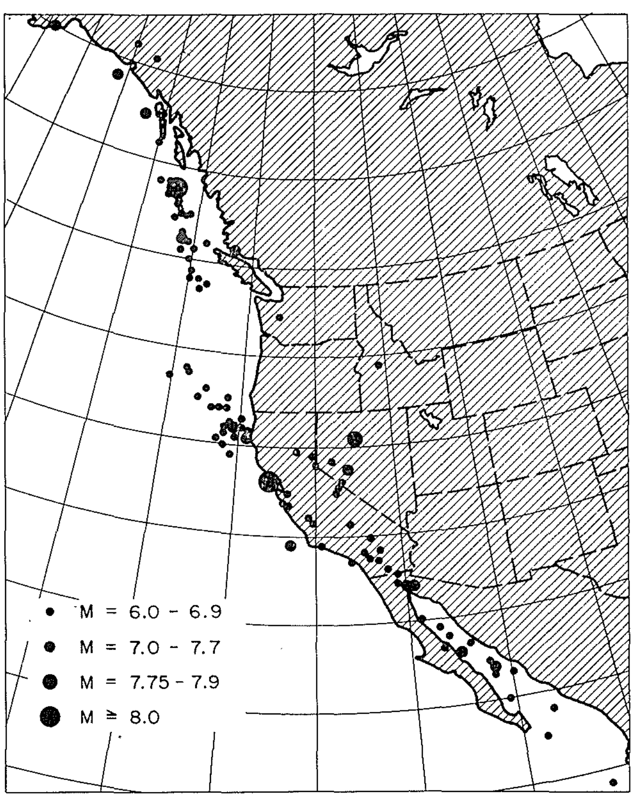
A map of all western North American earthquakes of magnitude 6 (the size of the Long Beach earthquake of 1933 and the Santa Barbara earthquake of 1925) or larger which have been instrumentally located is at the left below. It will be noted that the epicenters are concentrated along the Pacific coast. Actually, California and Nevada account for 95 percent of all the earthquakes in the United States.

In California approximately one earthquake of magnitude 6 or larger occurs every year. The reason why we don't hear more about these frequent occurrences is that the state is large and most shocks thus occur in areas of low population density.

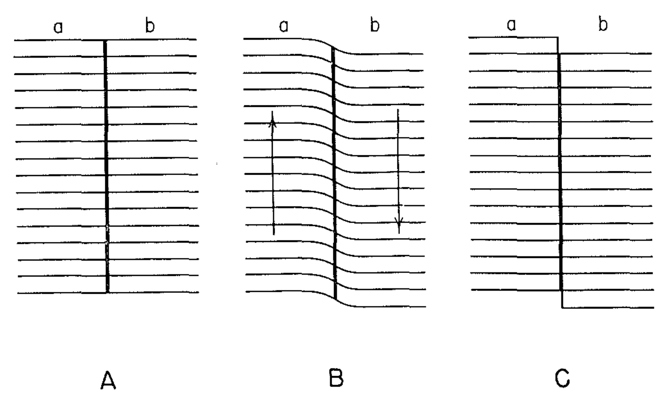
Earthquakes can be produced by volcanic activity, by blasts, even by the fall of meteorites, but the large destructive quakes are believed to be produced by slipping on faults. A fault is a fracture in the crust of the earth. The forces which presumably produce this fracture originally, may continue to operate for long periods of time afterward and so produce many additional slips along the original break.

The manner in which the fault mechanism operates is shown directly below. Following an earthquake such as that of San Francisco, in 1906, a series of parallel lines drawn across the fault (as at A) will be distorted at some later date, as shown at B of the figure, indicating that the block on one side of the fault has moved relative to the one on the other side. As a result of the high pressures which exist within the earth's crust the friction of the fault surfaces prevents slippage until the adjacent region is severely distorted.

There comes a time, however, when the stress at some point along the fault becomes greater than the friction holding the blocks together and they slip. Slip at one point increases the stress at neighboring points and consequently the slip is propagated along the fault up to



Western North American earthquakes—M6 and larger



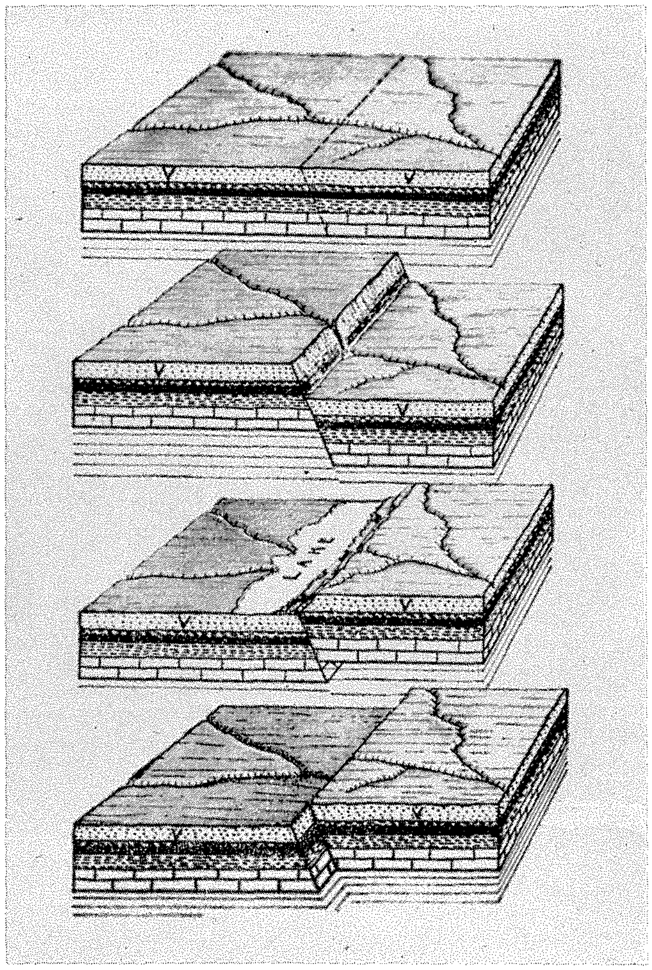
How the fault mechanism operates

distances of several hundred miles in great earthquakes. In the San Francisco 1906 earthquake the segment of the fault along which the slip occurred was approximately 180 miles in length, extending from some position off Point Arena in the north to San Juan Bautista in the south. The amount of slip at any point may vary from a few inches in a small earthquake to some 47 feet—the maximum which has been observed, in a large Alaskan earthquake. In the San Francisco 1906 shock the displacement was 21 feet. After the earthquake the parallel lines would appear as in C in the drawing. The blocks continue their relative movement after the shock and the earthquake generation process is thus repeated.

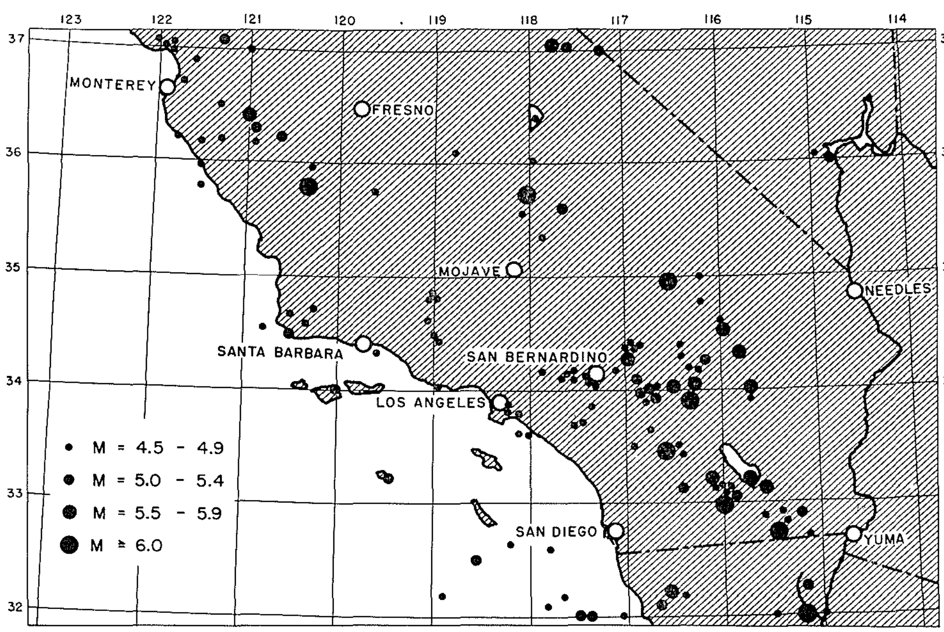
In the type of fault shown in the upper diagram at the right, known as a normal fault, the fault plane is inclined to the vertical and the upper block moves downward while the lower block moves upward. Generally faults of this type produce small earthquakes. No large shocks have occurred in California on this type of fault.

In a reverse fault, represented by the middle diagram, the upper side moves up and the lower side moves down. This is the type of fault which generated the 1952 earthquake in Kern County.

In the third type of fault, shown in the lower diagram, the blocks move horizontally. This movement is characteristic of California's San Andreas fault, which produced the great San Francisco earthquake of 1906, and a similar one in the southern part of the state in 1857. The San Andreas is the principal fault of California. It extends from a point off the coast of Oregon (page 18) through the California coast in the region of Point Arena, passing very near the city of San Francisco, and continues on through Gorman, Palmdale, Cajon Pass, San Gorgonio Pass and the eastern edge of the Coachella Valley. It ends in the Gulf of California.



Three types of faults. Top diagram shows a fault before the earth has slipped. Second diagram down shows a normal fault. Third: a reverse fault. Fourth: a fault in which the blocks move horizontally—a movement characteristic of California's San Andreas fault.



SOUTHERN CALIFORNIA EARTHQUAKES, 1934 - 1950. MAGS. ≥ 4.5

Map of southern California earthquakes from 1934 to 1950 shows eight quakes of magnitude 6 and larger. California and Nevada account for 95 percent of all earthquakes in the United States.

Air view of the San Andreas fault, looking approximately north from the vicinity of Indio. Though the structure at the lower left looks like part of that at the right, it is not. The motion of the fault is such that the oceanic (left) side is moving north relative to the continental side—at the rate of about two inches a year.

Another great fault, the Owens Valley fault, is connected with the rise of the Sierra block. In this fault the slip is both vertical and horizontal. There is another fault north of Los Angeles, known as the Garlock fault, which takes off from the San Andreas fault in the vicinity of Tejon Pass and extends at least 150 miles eastward. This fault has not been active in recent years, but the geological evidence indicates that it is very much alive. The San Jacinto fault, which is actually a branch of the San Andreas, has produced destructive earthquakes in the last 50 years. The small Inglewood fault was responsible for the 1933 earthquake in Long Beach. The White Wolf fault produced the earthquake of July, 1952.

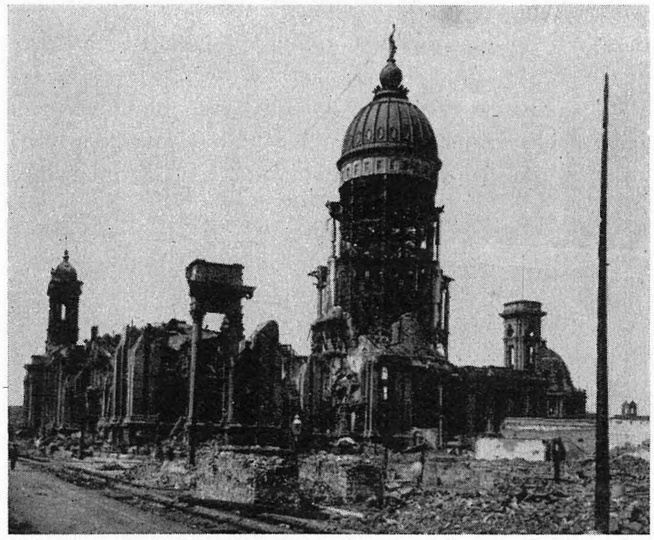
The first great earthquake in California since white man has lived here occurred in 1857 on the southern section of the San Andreas fault. The active segment extended from a point north of Gorman to some point near the Mexican border. In 1857 this region was thinly populated and the evidence we have for the size of the earthquake is not very extensive. However, in the vicinity of Gorman a rancher reported that his circular corral

THE SAN FRANCISCO EARTHQUAKE OF 1906

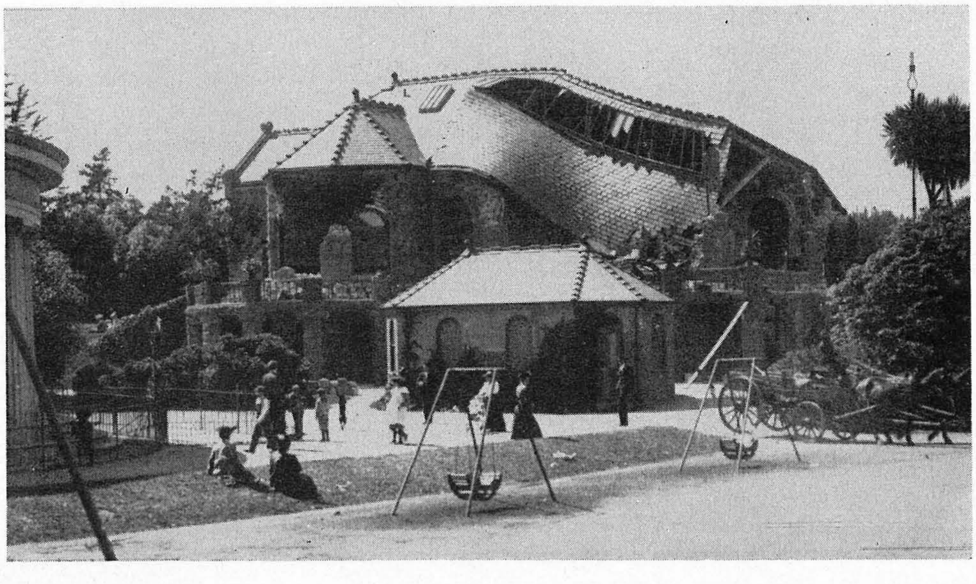
These pictures of the great earthquake which struck San Francisco at 5:13 a.m. on April 18, 1906 were taken by Thomas F. Bullock, an Oakland photographer. Filed away for years, they were brought in to the San Francisco Chronicle *this spring—on the 47th anniversary of the quake—by Mr. Bullock's daughter, Mrs. Mildred Lindquist. Though these are only a few samples of almost 100 pictures taken by Mr. Bullock, they gave an indelible impression of this historic earthquake.*

Right: Some homes were spared the fire which followed the quake—but many, like these, dropped into their basements when the quake struck.

Below: The one building left standing in this scene is the Hotel Hamilton—and it is nothing but a fire-scorched shell.



Above: The dome of the old City Hall was the only part of that building which came through the quake intact.



Left: The amusement center in Golden Gate Park. The structure was rebuilt, and is still in use.

became S-shaped after the earthquake. This indicates that the slip was of the same order of magnitude as that which produced the San Francisco earthquake of 1906. In fact, we feel rather confident from this and other evidence, that the 1857 shock produced violent shaking throughout the whole southern section of the state.

In 1872 there was a great earthquake on the Owens Valley fault in the vicinity of Lone Pine and Bishop. This earthquake shook down nearly all of the buildings at Lone Pine and killed a number of people.

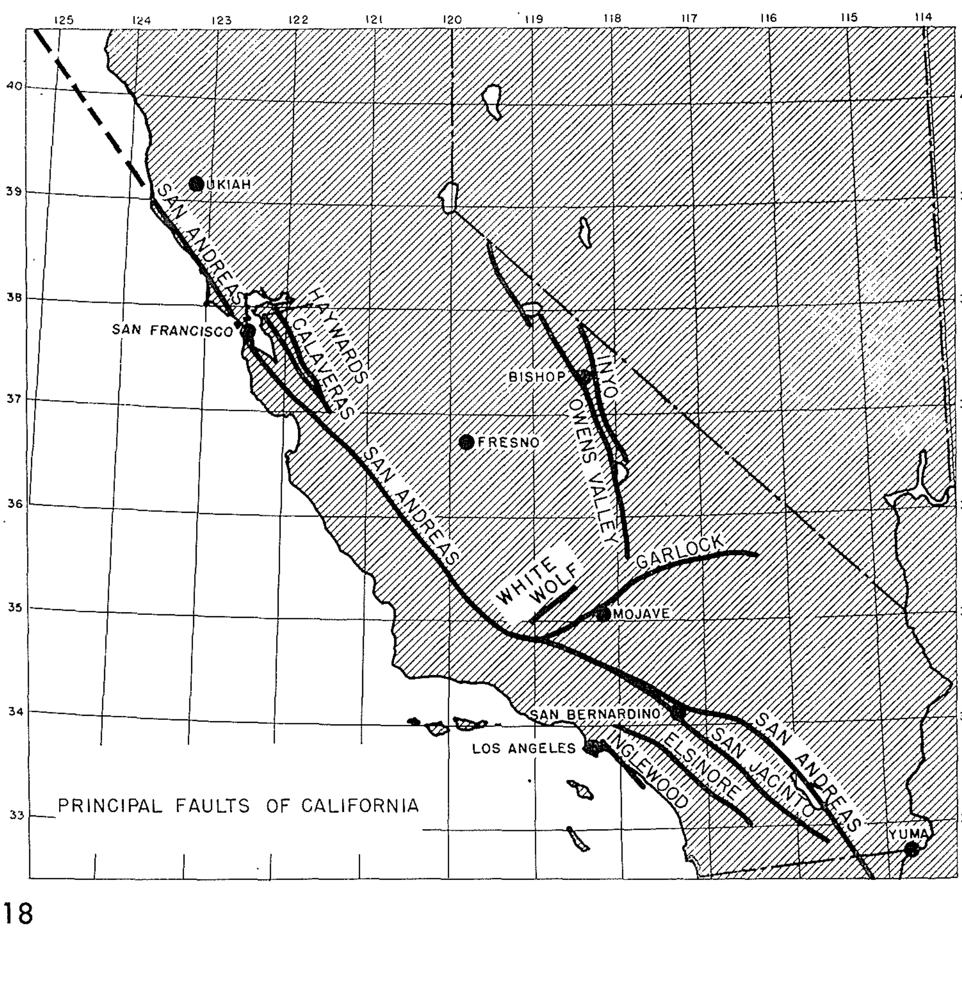
The motion of the San Andreas fault is such that the oceanic side is moving north relative to the continental side. Measurements by the U. S. Coast and Geodetic Survey indicate that the rate of this movement is roughly two inches a year. If this movement continues long enough, the day will come when Los Angeles will be opposite San Francisco. If the two inches a year is approximately correct, we may expect the stress in this fault to build up at such a rate as to repeat the slip about once per century and a quarter. A slip of the southern segment similar to that which produced the 1857 shock may thus be expected to occur any time within the next 25 or 50 years.

The San Francisco earthquake of 1906 liberated a thousand times as much energy as the Long Beach earthquake in 1933, but it was liberated over a much larger area, so that the intensity at any given point was not very much greater. We do not definitely know the total off-set on the San Andreas fault which has occurred since it started moving, but a recent paper by Hill and Dibblee indicates that it may be as much as 350 miles.

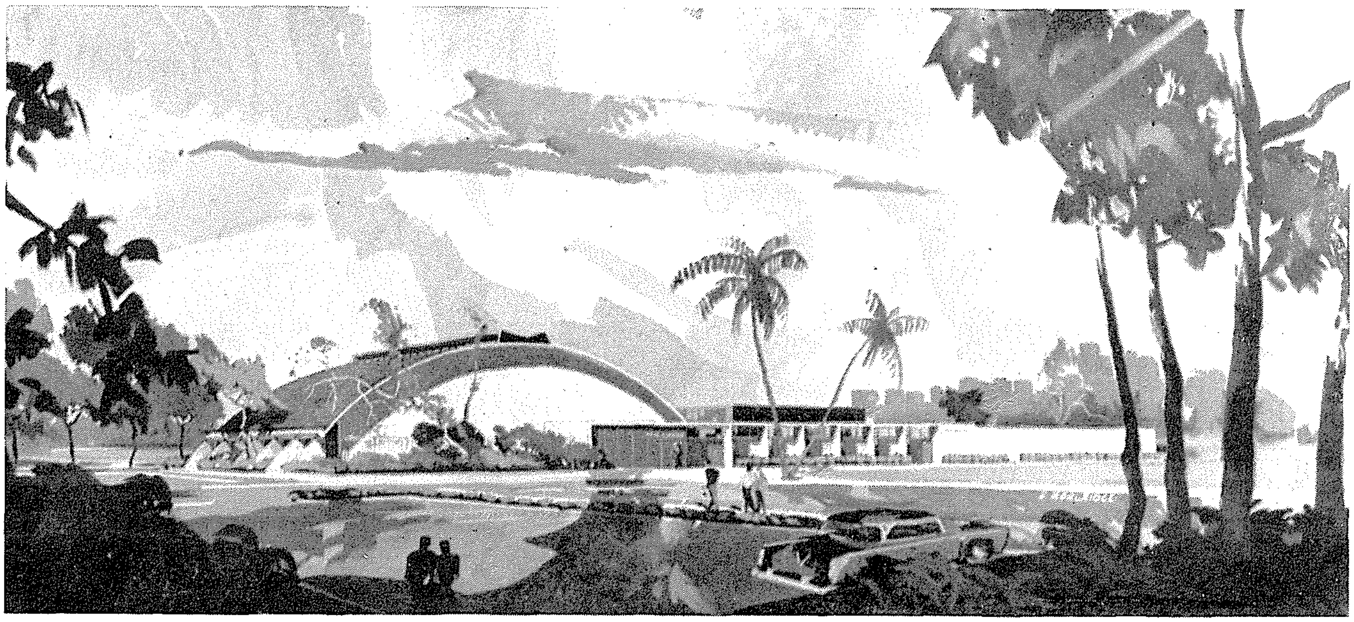
In the 1952 earthquakes in Kern County faulting began at a point near Wheeler Ridge at a depth of about 12 miles. The slipping reached the surface in something like three seconds, and moved northeastward along the fault for a distance of approximately 36 miles to the vicinity of Caliente in a matter of about 16 seconds.

Every earthquake of any size is followed by a number of after-shocks, which we believe are produced by elastic after-working in the rock. If a straight piece of wood or metal is bent and held fast for an instant and then released, it will fling back most of the way quickly, but there will be a small part of the recovery which takes place slowly. Rocks behave in this same manner. The principal shock is thus produced by the quick elastic recovery and the after-shocks represent the remaining slow creep recovery. Aftershocks may be distributed over a wide area as they have been in Kern County. It was one of these aftershocks, with a magnitude of only 5½, which occurred close enough to Bakersfield to cause greater damage than that produced by the principal shock.

There have been some instances where aftershock activity ceased in a matter of two or three days, and others where it ran as long as three years. Unless a new segment of the White Wolf fault should slip, the present tapering off of aftershock activity in Kern County indicates that the sequence is nearly at an end.



The San Andreas, which produced the 1906 San Francisco earthquake, is the principal fault of California. However, the Owens Valley, San Jacinto, Inglewood and White Wolf faults have also produced destructive quakes.



Architect's drawing of the new Caltech gymnasium and swimming pool

THE MONTH AT CALTECH

Gym and Pool

PRELIMINARY PLANS for the new gymnasium and swimming pool on the campus have now been completed and contract drawings for bids are being prepared. Construction should get under way soon after the first of the year, and the unit will be ready for use by the beginning of the next school year.

Construction details of the Alumni Swimming Pool were first announced last spring (*E&S*—March, 1953) when contributions to the Caltech Alumni Fund approached the $150,000 goal. Soon after this announcement, however, a $400,000 fund, made available through a bequest of the late Scott Brown, was allocated by the Institute Board of Trustees to the construction of a new gymnasium. Plans were then reformulated for a gym-swimming pool combination.

The new buildings will go up at the south end of the Tournament Park parking lot. The gym will be on the east, athletic offices and locker rooms in the center, and the pool on the west.

The gym will be approximately 132 ft.x96 ft., with a floor 114 ft.x94 ft. Seating capacity for varsity basketball games will be 1,000. With bleachers folded, two 44 ft.x80 ft. courts will be available for practice.

The pool, as originally planned, will be L-shaped, with a relatively shallow 75 ft.x42 ft. section for racing and a deeper 40 ft.x60 ft. section for diving and water polo. The pool will be heated and lighted for night swimming, and will be open to the air, with a fenced windbreak.

There will be a locker room for students, with 650 lockers and shower facilities. Visiting teams, faculty and graduate students, and coaches will each have separate locker rooms. Other rooms include seven offices, a lecture room, a stock room, two large equipment rooms and two smaller ones for pool and field equipment, a drying room and a medical room.

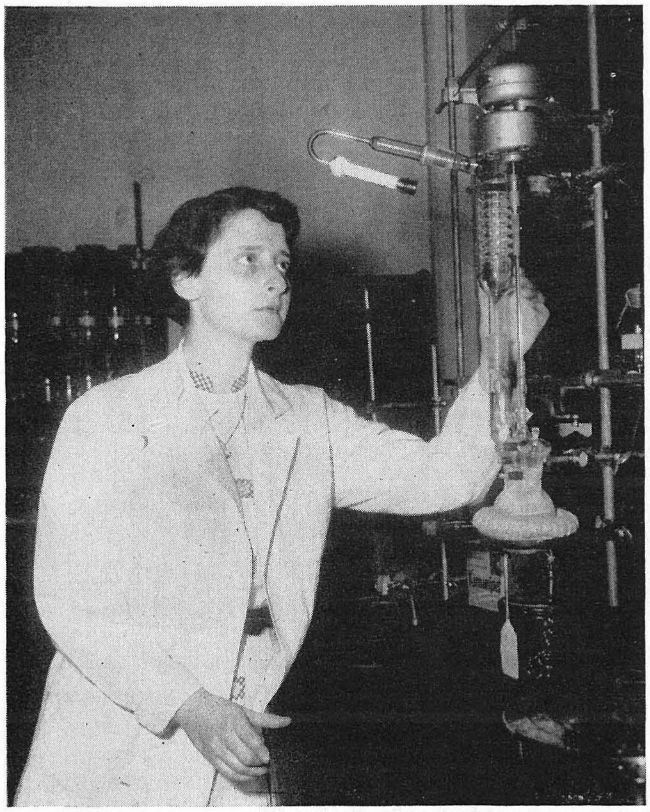
Pioneer

CALTECH QUIETLY ACCEPTED its first woman graduate student this fall when Miss Dorothy Ann Semenow signed in to work here toward a Ph.D. degree in chemistry.

Miss Semenow owes her presence on the campus to a recent action of the Caltech faculty and the Board of Trustees, admitting women to graduate study at the Institute. This gallant action is not, however, an open invitation to the ladies. It applies only to "women of exceptional ability who give promise of great scientific contributions." And, before she can enroll, a woman must get the approval of the academic division in which she intends to work, as well as that of the Committee on Graduate Study.

With such hurdles as these, it is hardly likely that the campus will ever be swarming with female students. Most admissions of women, in fact, will probably involve the use of unique or outstanding research facilities here.

The Institute, founded in 1891 as Throop University and later named Throop Polytechnic Institute, was coeducational in its early years. It offered secondary and



Dorothy Semenow, graduate student in chemistry, is the first woman candidate for a Caltech degree.

college-level training in vocational arts, and had a department of domestic science as well as a normal school for teacher training. After the school moved to the present campus in 1910 most of these courses were discontinued, and engineering and science became the core of a college curriculum limited to men.

Miss Semenow is the first woman candidate for a degree since that time. She was graduated *summa cum laude* from Mount Holyoke College in Massachusetts in 1951. She received an American Chemical Society Student Membership Award in 1950 and in 1951 she was elected to Phi Beta Kappa.

After graduation she continued her work in chemistry as a teaching assistant at Mount Holyoke, and in 1952 became a graduate student and teaching assistant at MIT. She worked there under the direction of Professor John D. Roberts, who was appointed Professor of Organic Chemistry at Caltech this fall.

As a matter of fact the Roberts appointment here is directly responsible for the Institute's ruling admitting women graduate students. When Dr. Roberts accepted his Caltech position, Miss Semenow asked to be transferred here with him to continue her research. It took a change in Institute policy to grant her request.

She is at Caltech on a Skinner Fellowship in Chemistry, sponsored by Mount Holyoke College. Her present research is in the field of theoretical organic chemistry.

Time was when women students were no rarity on the campus—as witness this picture of frantic activity in the cooking room of the old Throop Polytechnic Institute, sometime early in the century.

MIT Conference

PRESIDENT DUBRIDGE and twelve Institute staff members met with members of the Academic Council of the Massachusetts Institute of Technology in Cambridge, Mass., last month, from October 12 to 14, to discuss mutual educational problems.

The meeting was a continuation of a highly successful three-day conference held at Caltech last March, when the MIT group visited here. The Cambridge discussions covered such things as general educational philosophy and objectives, improvement of undergraduate education, admission problems, sponsored research, and graduate study and research.

These meetings have occasioned a good deal of interest in academic circles, since this seems to be the first time two rival institutions have made a cooperative effort to work on common problems.

Knight Commander

CHARLES C. LAURITSEN, Professor of Physics, has been made a Knight Commander of the Danish Order of Dannebrog, one of the oldest in the world.

The honor was conferred by King Frederik IX of Denmark for Dr. Lauritsen's wartime services with the National Defense Research Committee and the Office of Scientific Research and Development in Washington and at Caltech, where he was technical director of the Caltech rocket project. Dr. Lauritsen's war work had previously been recognized with the U. S. Medal for Merit as well as certificates of appreciation from the U. S. Navy Bureau of Ordnance and the U. S. Army.

The Order of Dannebrog was created in 1219, during the crusade of King Valdemar, when the Danes defeated the Russians in a critical battle at Riga. The decoration is conferred on persons who perform meritorious services for Denmark or on native Danes living abroad who have made outstanding contributions in diplomacy or science or in the armed services.

Professor Lauritsen, whose major field of investigation in nuclear physics has been the energy levels of light nuclei, has been a member of the Caltech faculty since 1930. A native of Denmark, where he received his undergraduate education, he was awarded the Ph.D. degree at Caltech in 1929.

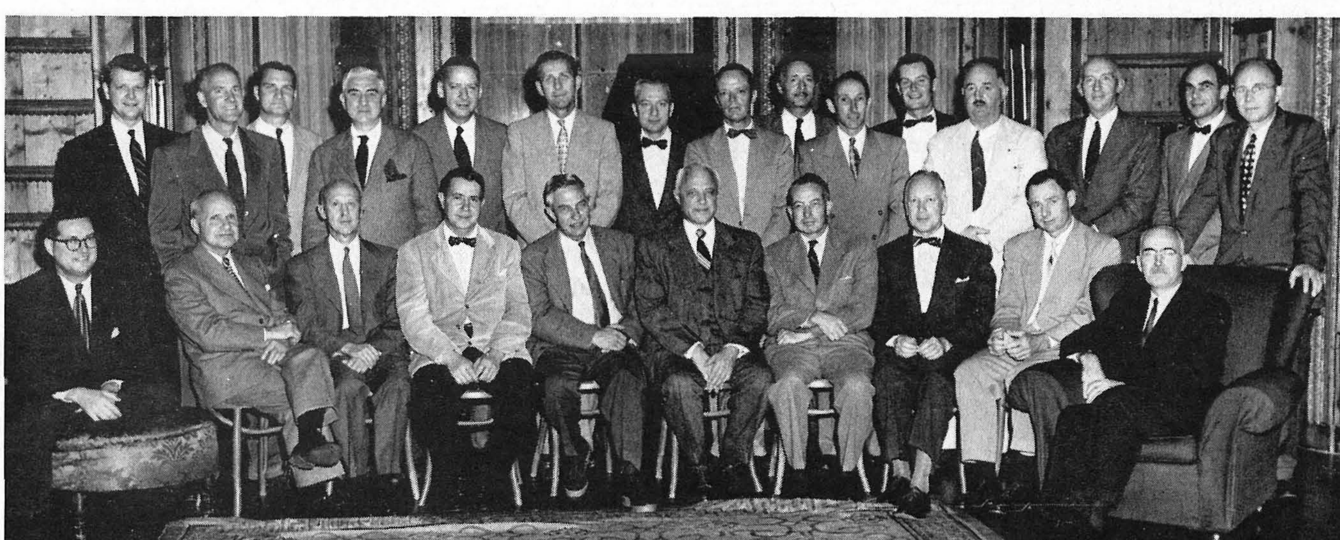
DeMille Lecturer

DR. DONALD S. CLARK, Professor of Mechanical Engineering at the Institute, delivered the Edward DeMille Campbell Memorial Lecture before the national congress of the American Society for Metals in Cleveland, Ohio, on October 21.

The lectureship, established in 1925, annually features an outstanding worker in metals research and is one of the highest honors conferred by the Society. Professor Clark, whose major fields of research have been physical metallurgy and the dynamic properties of metals, spoke on "The Behavior of Metals under Dynamic Loading."

He is a former national trustee of the Society and has received the Charles B. Dudley Medal and the Richard L. Templin Award of the American Society for Testing Materials.

Dr. Clark has been a member of the Institute staff since he received the Ph.D. degree in 1934, and is Institute Director of Placements as well as secretary of the Alumni Association. He is the co-author of two books, *Engineering Materials and Processes* and *Physical Metallurgy for Engineers.*



MIT and Caltech conferees in Massachusetts. Standing: Kispert, Beadle, Snyder, Brooks, Farnsworth, Green, Hazen, Smith, Belluschi, Weir, Bowditch, Robertson, Thresher, Hurley, Edgerton. Sitting: Gilliland, Watson, Lacey, Killian, Dubridge, Compton, Bacher, Stratton, Sharp, Harrison. Missing: Jones, Lindvall, Webb.

MRS. ROBERT A. MILLIKAN

A Tribute

by Inga Howard

GRETA BLANCHARD MILLIKAN died on October 10, after a two-year illness, at her home in San Marino. She was 77 years old.

To say that the California Institute of Technology would not be what it is today had it not been for the devotion to its interests of Mrs. Robert A. Millikan would seem like an over-statement to those who did not know her well and were not aware of her activities. Her paramount interest centered in the success of her husband's work as executive head of the Institute. She did not spare herself in her efforts to assist those members of the student body and staff with whom she came into contact—and she had a large number of friends. At the opening of each fall term she entertained the freshmen in small groups on Sunday evenings, and the graduate students were invited to her home for Sunday dinners.

She inspired the confidence of her friends, gave wise counsel, and showed sympathetic interest in the troubles and happiness of others. She was energetic and effective in all her activities. Her real interest in the Institute graduate students is shown by the fact that in her will one-third of her estate was set aside for a fund (to be named in honor of her husband) to assist needy graduate students in Physics.

Dr. and Mrs. Millikan came to Pasadena to take up their duties at the Institute in 1921. There were just three buildings on the campus then—Throop Hall, the first wing of the Gates Chemical Laboratory, and Culbertson Hall. A fourth building was just nearing completion—the Norman Bridge Laboratory of Physics, which Dr. Bridge had agreed to build if Dr. Millikan would accept its direction.

In that first year there were only 26 graduate students and the Institute was practically unknown outside southern California.

Dr. Millikan pulled the struggling school through many lean years and, with the help of the trustees and staff, made of it what it is today—an institution which draws famed scientists and eager students from most of the world. It is a truly impressive achievement—and Mrs. Millikan was a mighty help in attaining it.

Born in Rochester, Pa., she was graduated from the University of Chicago in 1900, with a B.A. in Greek. She served as assistant principal and teacher of the eighth grade at the Highland Park (Ill.) Public School for a year. Then, in 1902, she was married to Dr. Millikan.

She was extremely active in civic affairs and musical activities, both in Chicago and here—in addition to her busy life as helpmate to her husband.

Mrs. Millikan is survived by her husband; her sons, Clark, director of the Guggenheim Aeronautical Laboratory at the Institute, and Max, professor of economics at the Massachusetts Institute of Technology; the three children of her son Glenn, a physiologist, who was killed in a Tennessee mountain-climbing accident in 1947; four other grandchildren; and her only sister, Mrs. Harry Leslie Walker of Bronxville, New York.

Memorial services are to be held in December, when her son Max and his wife—now in India—are expected to reach Pasadena.

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GERMANY EMERGES AS A EUROPEAN POWER

by HORACE N. GILBERT

THIS IS A PROGRESS REPORT on Germany: progress since the spring of 1951 when *Engineering and Science* printed my "Report on Germany." The purpose is to attempt to convey the significance of the forces that are operating, and to project one man's prophecy of the role Western Germany may play in the months to come.

The conclusion of the earlier report was as follows:

> "Western Germany has made a remarkable economic recovery, aided in an important way by Marshall Plan funds. She has also made good progress with the establishment of democratic government. With peace and access to world markets there is a strong basis for believing that Germany will be able to support herself well as a friendly member of the community of nations."

Then, as now, the immediate problem was the defense against possible Russian aggression.

The conclusion of *this* progress report is that Germany's national stature has improved significantly. Her occupied status has not been officially ended, but for many practical purposes she has been encouraged to behave as a sovereign state. Under Chancellor Adenauer's pro-western leadership, not only is Western Germany emerging as an equal member of the Western European community of nations, but she is demonstrating the ability to take care of her own national interests and even to return to her historic position as a bulwark against the east.

For the United States, I regard this development as entirely favorable; for Russia, I believe it means the defeat of immediate Communist objectives in Western Europe.

Continued economic recovery

The fact of continuing economic recovery is one of the most notable factors in Western Germany's emerging position of national strength and influence. From a distressingly low beginning in the summer of 1948, the index of industrial production has risen to equal the best record in Western Europe. This statistical index, furthermore, does not reflect adequately the favorable economic tempo: labor is working hard, business men are active as enterprisers, people are saving, and consumers are demanding the essentials of a better standard of living—especially housing. The problem of unemployment, created principally by the great influx of ethnic German expellees from the east, has been declining, and is not of alarming proportion.

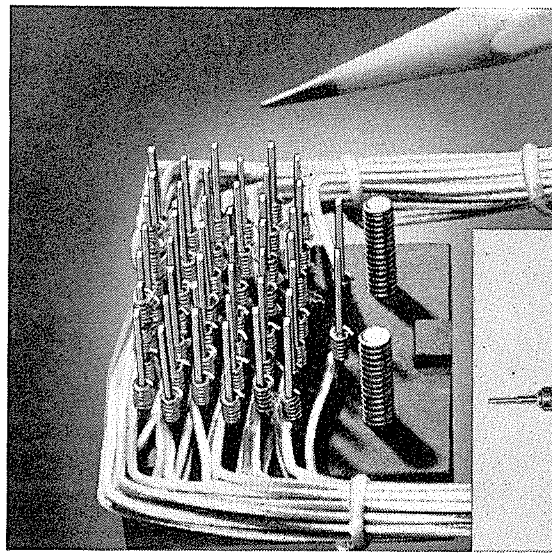
In addition to the internal evidences of economic recovery, Western Germany has attained a favorable position with respect to her international economic position. She has been running a surplus for many months in the European Payments Union, consisting of the former Marshall Plan countries, and more recently she has been building up a surplus in relation to dollar countries. In these respects she is the envy of many Western European countries. France, in particular, has been unable to stop deficits in the Payments Union and in dollars.

It is clearly premature, however, to say that Western Germany has solved her economic problem in so far as exports and imports are concerned. The plain fact is that the world is upset because of the East-West conflict, and there is no normal flow in international trade.

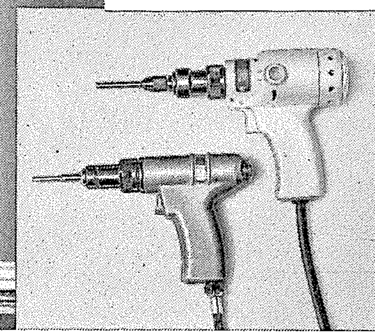
After World War I Germany made a courageous effort to reestablish her economic viability, and for a short period in the later twenties a good showing was made. The wave of economic nationalism that swept over the world in connection with the great depression destroyed Germany's hopes.

World thinking on this point today is better than when the U. S. passed the Smoot-Hawley tariff and Britain adopted its Empire Preference program. But it is too early to say that Western Germany can assuredly make a comeback in world markets. The need for such a

Good Connections
...electrically speaking



New solderless method permits the making of very closely spaced connections, as shown on this experimental terminal block.



Electrically powered "wire wrap" tool (above) and compressed air tool (below) for making wrapped solderless connections.

GOOD CONNECTIONS are mighty important to us for, you see, we make more than a billion electrical connections each year. It takes that many to manufacture and install complex telephone equipment in the Bell System.

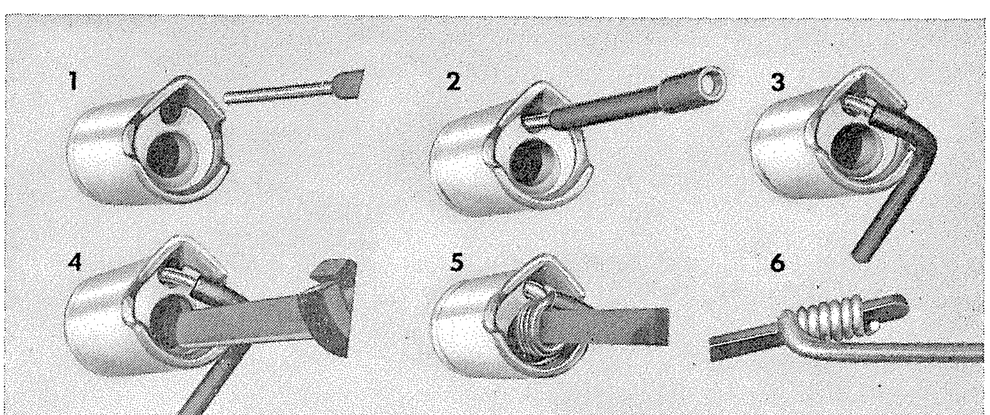
That's why the revolutionary new method of making electrical connections *without solder*—a method created by Western Electric engineers together with their teammates at Bell Telephone Laboratories—is indeed one of the significant engineering achievements of recent years.

Like most really creative engineering jobs, the development of a tool to make solderless connections grew out of a problem. We had to find a way to connect our newly designed wire spring relay to other components in giant bays of switching equipment. This new relay—something of an engineering achievement itself—can have as many as 36 terminals in an area only 1-3/8" by 11/16". Obviously, the conventional method of hand-wrapping and soldering wires onto the terminals is extremely difficult in such a small area.

After more than five years of research and experimentation, the engineers came up with a pistol-like power tool capable of making mechanically sound solderless connections. Shown above are two tools now used at Western Electric manufacturing locations. They literally shoot wire onto terminals . . . and do it surer, faster and less expensively than conventional methods using solder. That's not all. The new "wire wrap" tool keeps equipment free from solder splashes, wire clippings and reduces bent and distorted terminals. Electrically, the "wire wrap" tool gives a far better connection than can be made manually . . . the high pressure contacts are stronger, cleaner, more compact and more uniform.

In keeping with the Bell System policy of sharing technical know-how with all of industry, Western Electric will make this tool commercially available to electrical manufacturing companies, such as radio, television and communications producers, through licensed tool manufacturers.

You're right if you think we're more than a little pleased with our accomplishment. And as we have been many times before, we're proud of the engineers in all fields—electronics, mechanical, electrical, metallurgical, chemical, industrial—who uphold our reputation for leadership in fundamental manufacturing techniques.



How a solderless connection is made: (1) Skinned wire approaches the small flared opening in the tool tip. (2) Wire is inserted in hole. (3) Wire is bent and anchored by means of notch in side of gun tip. (4) Gun tip is slipped over rectangular wire terminal. (5) Spindle of gun tip rotates to wrap wire around terminal. (6) Six wire wraps around terminal complete electrically sound joint without soldering.

Western Electric

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Manufacturing plants in Chicago, Ill. • Kearny, N. J. • Baltimore, Md. • Indianapolis, Ind. • Allentown, Pa. • Winston-Salem, N. C. Buffalo, N. Y. • Haverhill, Mass. • Lawrence, Mass. • Lincoln, Neb. • St. Paul, Minn. • Duluth, Minn. Distributing Centers in 29 cities and Installation headquarters in 15 cities. Company headquarters, 195 Broadway, New York City.

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comeback is even greater today than before World War II because of the impaired structure of the German national economy resulting from the loss of the eastern areas.

It is possible to project a good guess as to Western Germany's probable competitive position in Western European and world markets. It appears clear that German costs in many industries are low, that her products are good, and that her selling methods will become increasingly effective. Her labor costs are rising, as they should in order to have workers share in their favorable productivity. The opportunities for cost reduction on account of modernization of many industrial operations, however, are great. In the steel industry, it must be remembered, the best plants were carefully selected for dismantlement. The task of modernizing German industry is a slow and expensive one, but it is inevitable that it will be done, and the results can be most favorable to her competitive position.

A good deal has been said about the emphasis placed on free enterprise by Chancellor Adenauer's government. Dr. Erhard, Minister of Economics, is a man of conviction on this point. There is little doubt but that the favorable environment created by this policy has been well-suited to the particular problem of economic recovery in postwar Germany. It has encouraged the release of maximum energies by business men and industrialists. The success of this policy has caused other Western European countries to take note, especially those inclined to rely upon socialistic methods.

Toward national sovereignty

Even before Korea the Allies had sketched a timetable leading to the eventual goal of a peace treaty and the restoration of German sovereignty. Korea added an element of urgency to this plan. The obvious steps were taken: agreement among the occupying powers on the details of the treaty, negotiating with Chancellor Adenauer's government, initialing of the draft by representatives of the occupying powers and the Federal Republic of Germany, and ratification by Parliament, the Chamber of Deputies, the Bundestag, and our Senate.

All of these steps were accomplished, beginning in 1951, except for ratification by the French. Western Germany, today, therefore, is officially still under the Occupation Statute of 1949. In many practical matters, however, the U. S. and Britain are dealing with Dr. Adenauer as if he were Chancellor of a near-sovereign state. We have changed the designation of Dr. Conant, for example, from High Commissioner to Ambassador.

During 1951, while the new status for Western Germany was being worked out, the form in which she was to contribute to the military defense of Western Europe presented a special problem. The German government agreed to the principle, and to a tentative amount. Various proposals for the detailed integration of German manpower and economic support were considered; the one that was eventually adopted was essentially the Pleven Plan, which had been suggested by France.

Because German participation in Western defense was quite separate from the formulation of a peace treaty closing World War II, it was decided to take care of the matter in a separate document, called the European Defense Community Treaty. This has been ratified by the British, German, and U. S. governments, but not by France. The EDC contemplates the pooling of the military efforts of six countries: Benelux, France, Italy, and Western Germany. It supplements the older and larger North Atlantic Treaty Organization, and offers a convenient, strictly continental grouping with which to work for the defense of Western Europe.

Occupation problems

The prolongation of the official occupation because of the failure of France to go along with Britain and the United States presents a serious problem. From the military viewpoint it is preventing the full participation by Germany in the defense of Western Europe, especially the raising of German divisions. It has not prevented, however, the carrying on of important mobilization planning by an officer in Chancellor Adenauer's administration (Dr. Blank), who, in effect, is a defense minister. This activity will save much time when a way out of the present stalemate is found.

From the political point of view, German public opinion is becoming restive at the prolongation of the occupation status, and the fact that France alone is to blame makes the situation especially delicate. The astonishing fact is that the irritation is not greater.

Part of the explanation probably is the fact that both Britain and the U.S. have been treating Western Germany much as if the treaties were in effect. A good deal of the credit belongs, however, to Chancellor Adenauer's sympathetic handling of French problems. His relations with some of France's most important political leaders are good. He appears to be treating the Saar problem with great tact. It is most encouraging that there is so little popular criticism of France in the West German press. But it is generally realized that a way to end the present situation must be found.

Public opinion within Western Germany is not strongly nationalistic. The overwhelming popular vote on September 6 for Chancellor Adenauer's pro-western policies reflected the desire to emphasize cooperation, not national pride. In fact, there appears still to be no enthusiasm in Western Germany for rearmament along old-fashioned lines. German youth groups have been explicit in calling for armed forces only under some plan of European union which carries assurance that the horror of World War II shall not be repeated. There is widespread popular acceptance of, and even demand for, continuing presence of United States and British forces. So long as the East-West tension is critical, the formal ending of the occupation is largely an academic matter.

Back of German attitudes regarding the reestablishment of national sovereignty is the realization expressed

in the following statement which a statesmanlike German industrialist made to me in 1950: "The Dutch hate us; they have reason to hate us. They need us. We shall show them by our conduct that we can be trusted, and we shall prosper together."

Democracy in government

After Hitler's totalitarian dictatorship, many people feared lest postwar Germany would have difficulty returning to democratic processes. During both the military and civilian occupations, the Western Allies were preoccupied about this danger, and specific programs were undertaken to "reorient" the German people, and to "educate" them for democracy. By hindsight some of these activities have come to look increasingly ridiculous, but they probably did no harm.

Democratic ideas have prevailed in the reestablishment of city, state and federal governments. Aided by the explicit directive of the Allied Powers that former Nazis be disqualified from holding government positions, a selective process began which gradually brought forward new leaders. These people quite generally represented the true democratic tradition in German history, only temporarily eclipsed by Hitler.

Some of the new leaders I met impressed me as being more sophisticated with regard to the real meaning of democracy in the European setting, than were those on the High Commission staff who were conducting the reorientation programs. Many of us Americans have come by our "democracy" too easily to know what it really is.

At all government levels, city, state, and federal, the "Nazi" problem was handled successfully. The Occupying Powers tried to be literal in disqualifying all former Nazis. The Germans favored realism, and were firm only when the record was black. There is no serious threat of resurgent Nazism today. Germany's present leaders know better than anyone the tragedy it brought their country, and there is an active will to oppose it, whether by Chancellor Adenaeur or by a village burgermeister.

The Communist threat within Germany is scarcely a threat at all. The Party is very small, and has lost support in recent elections. The German people are some of the best informed in the world regarding Soviet Communism; they know its police state methods. Many have seen the poverty of the exploited Russian people. Every fifth person in Western Germany is an expellee, and bears personal resentment toward Soviet Communism.

Politically, Western Germany has approached a two-party status: the coalition of conservative parties led by Dr. Adenauer, which corresponds to our Republican Party; and the Social Democratic Party, which resembles the British Labor Party, except that the German labor unions organizationally are not a part of it. The victory of the Adenauer group in both the 1949 and 1953 Federal elections is significant in that it indicates the pro-western leanings of the German people. It does not necessarily mean that the traditionally strong Social Democratic Party is becoming weak; as a matter of fact, in many of the states and cities this party is in power.

The essential thought I wish to convey is that the right forces, both political and economic, are still working strongly in Western Germany today. It appears that they will continue to work, so far as internal considerations are concerned.

The problem becomes, then, one of judging the international scene to determine whether a favorable environment will exist in which Germany can make a successful comeback. The basic needs are access to raw materials and to export markets, and reunification of Western Germany and the Soviet Zone.

Thus far in the postwar period, the balance of thinking in the western world has favored increased trade. This was a principal objective of the Marshall Plan, and the beneficiary countries, through their own Organization for European Economic Cooperation, have been carrying on a moderately successful program to reduce tariffs. France, in the Schuman Plan, initiated her own idea of how the total economy of Western Europe could be benefited; it is now operating. But the fears of international economic competition still exist, and German industry is most feared.

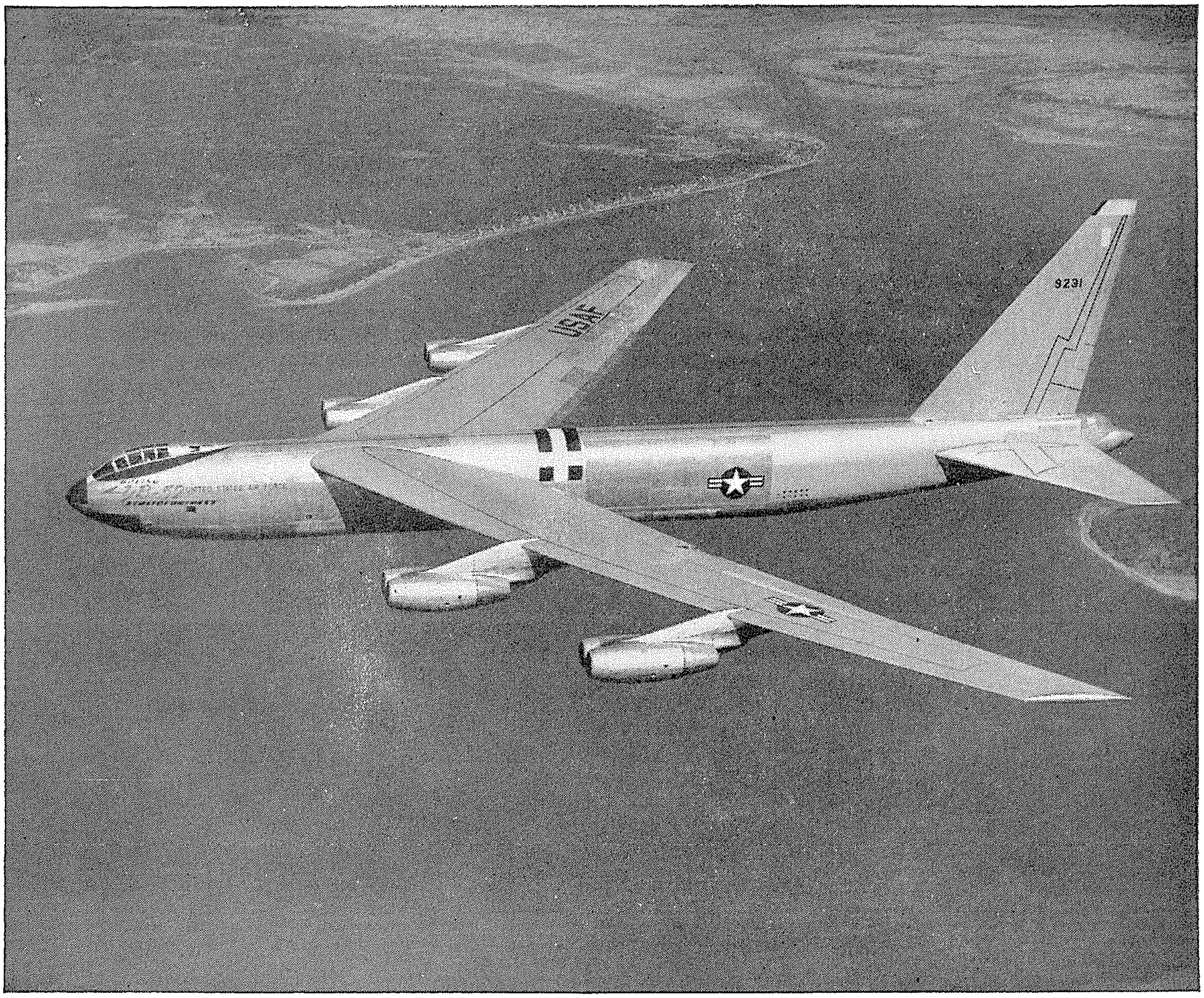
Fortunately, the crisis is still in the future, for world markets are still absorbing the output of the industrial nations in a reasonably satisfactory way. What is needed is an expanding world economy, which will benefit raw material and food producing countries at the same time that the industrial workshops are kept busy.

Prospects for the future

The obvious problem in the international political field is the division of Germany and the loss of eastern territories to Poland. The long-range pressures for unification are tremendous. But it is generally recognized that reunification must wait on free elections in the Soviet Zone. Western Germany does not want reunification if it means inclusion in the Federal Republic of a Communist satellite.

With the emergence of a strong, near-sovereign Western Germany, it can be hoped that a new approach to resolving the East-West conflict, at least with regard to Western Europe, will be tried. Chancellor Adenauer is in a position to negotiate directly with Soviet Russia and her satellites. Western Germany is not a member of the United Nations, so something along the line of a non-aggression pact, in return for the reunification of Germany, would be in order. This is at least a fresh approach.

Germany has had a long experience in dealing with Russia. It is possible that the United States represents so much of what Soviet leaders have successfully represented to the Russian people as irreconcilable, that direct negotiations by the United States are no longer useful. It might please the incomprehensible Russian mind to deal directly with Western Germany. My own opinion is that the interests of the free world are in safe hands, if Chancellor Adenauer attempts such negotiations.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THE CALTECH ALUMNUS

I. His Origin, Background and College Career

by JOHN R. WEIR

This is the first of a series of articles discussing various aspects of the questionnaire survey of alumni which was conducted last year. It deals with the statistics concerning the alumni when they were students at Caltech. Articles to be published in future issues of E&S *will be concerned with political and religious affiliations, opinions and attitudes, income and occupation, and a comparison of science and engineering as occupational fields.*

IN A RECENT BOOK titled *They Went to College,* Ernest Havemann and Patricia West were able to make a good many interesting observations concerning the college graduate in America today. Their conclusions were based on a questionnaire survey of U. S. college graduates conducted by *Time* magazine and analyzed by the Columbia University Bureau of Applied Social Research. The circulation of the same questionnaire to the Caltech alumni now makes it possible to compare the Caltech graduate with this broad sample of college graduates from all over the United States.

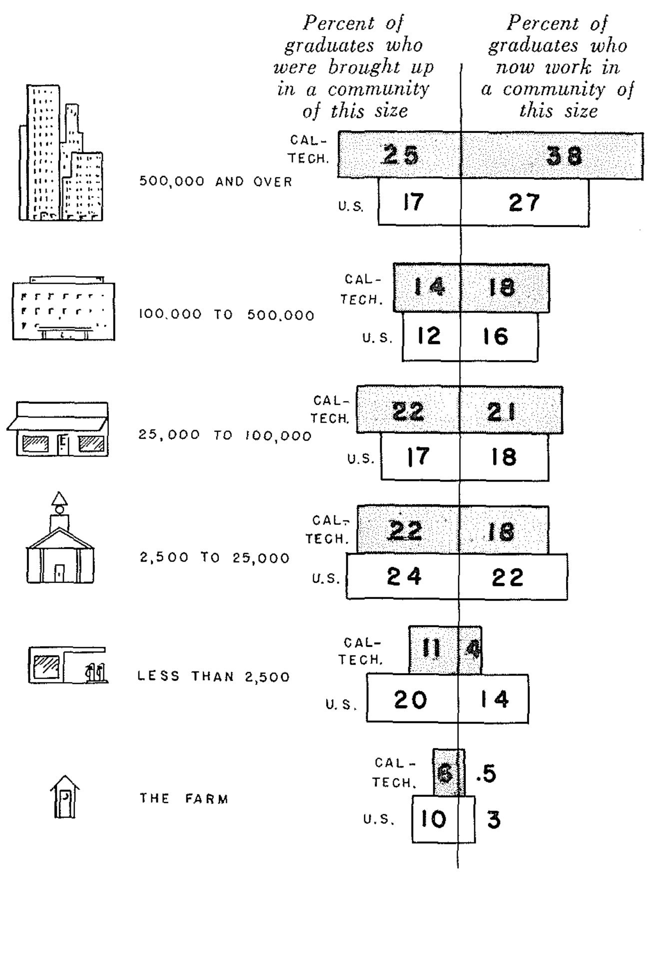
The typical U. S. graduate is distinguished by his youth. Havemann and West found that one-fifth of the living graduates are past fifty, a fifth in their forties, and the majority, three out of five, in their twenties and thirties.

When compared with this group, the Caltech alumni are even more youthful. Less than one-tenth are past fifty, one fifth past forty, and almost three-quarters in their twenties or thirties.

This youthfulness is indicated even more dramatically when the Caltech alumni are grouped according to the year they obtained their degrees. Over half of them have received their bachelor's degree since 1940. Sixty-six percent, or two-thirds, have received their highest degree since 1940. And 50 percent have received their highest degree since the end of World War II!

This remarkable youthfulness is, of course, accounted for by the relatively recent establishment of Caltech as an institute of science and engineering in the early 1920's. The youth of the Caltech alumni should be kept in mind when reading subsequent articles in this series, in which such matters as financial success and occupational satisfaction are considered, and comparisons made with the Havemann and West sample; for the Caltech graduate has not yet had as much time to make his mark in the world as has the typical U. S. graduate. The unusually high occupational incomes of the Caltech alumni,

GETTING A DEGREE
MEANS A MOVE TO THE CITY

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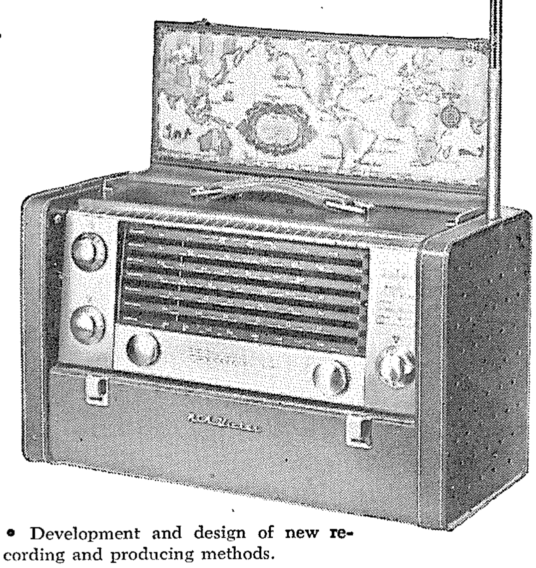


to be reported in future articles, will undoubtedly be even more impressive when these graduates have had another decade or two to realize their maximum potentialities.

Caltech is a western school, and the origins of its alumni reflect this fact very clearly. While 70 percent of U. S. college graduates come from the East and the Midwest, only 23 percent of Caltech graduates do so. Barely 10 percent of U. S. graduates come from the West, but 66 percent of Caltech graduates come from here.

The Caltech grad comes not only from the West, but from the big city. As the chart on page 30 shows, almost two-thirds (61 percent) come from cities of 25,000 or more, compared with 46 percent for U. S. graduates. Furthermore, this tendency to concentrate in the big city is continued after graduation, for nearly 80 percent of the C. I. T. grads are now working in cities of 25,000 or more, compared to 61 percent for the U. S. grads.

It would seem apparent from this that it is the city-reared boy who is most aware of the desirability of obtaining a scientific or technical education. And one might also conclude that being a scientist or engineer means living in a fairly large city.

In addition to this movement toward the large city, there is also a migration to the West, revealed by the fact that 48 percent of our alumni were born in California or west of the Rockies, and 66 percent spent most of their post-college years there.

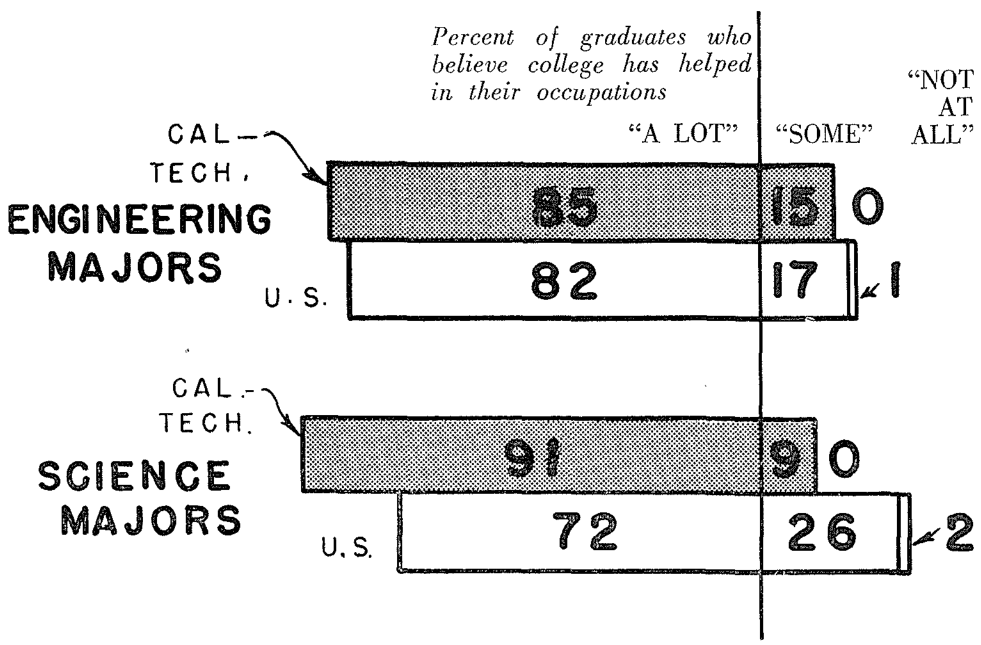
Probably the simplest and most obvious interpretation of these figures would be to consider them a reflection of the tremendous increase in the population of southern California and the Los Angeles area in the last two decades.

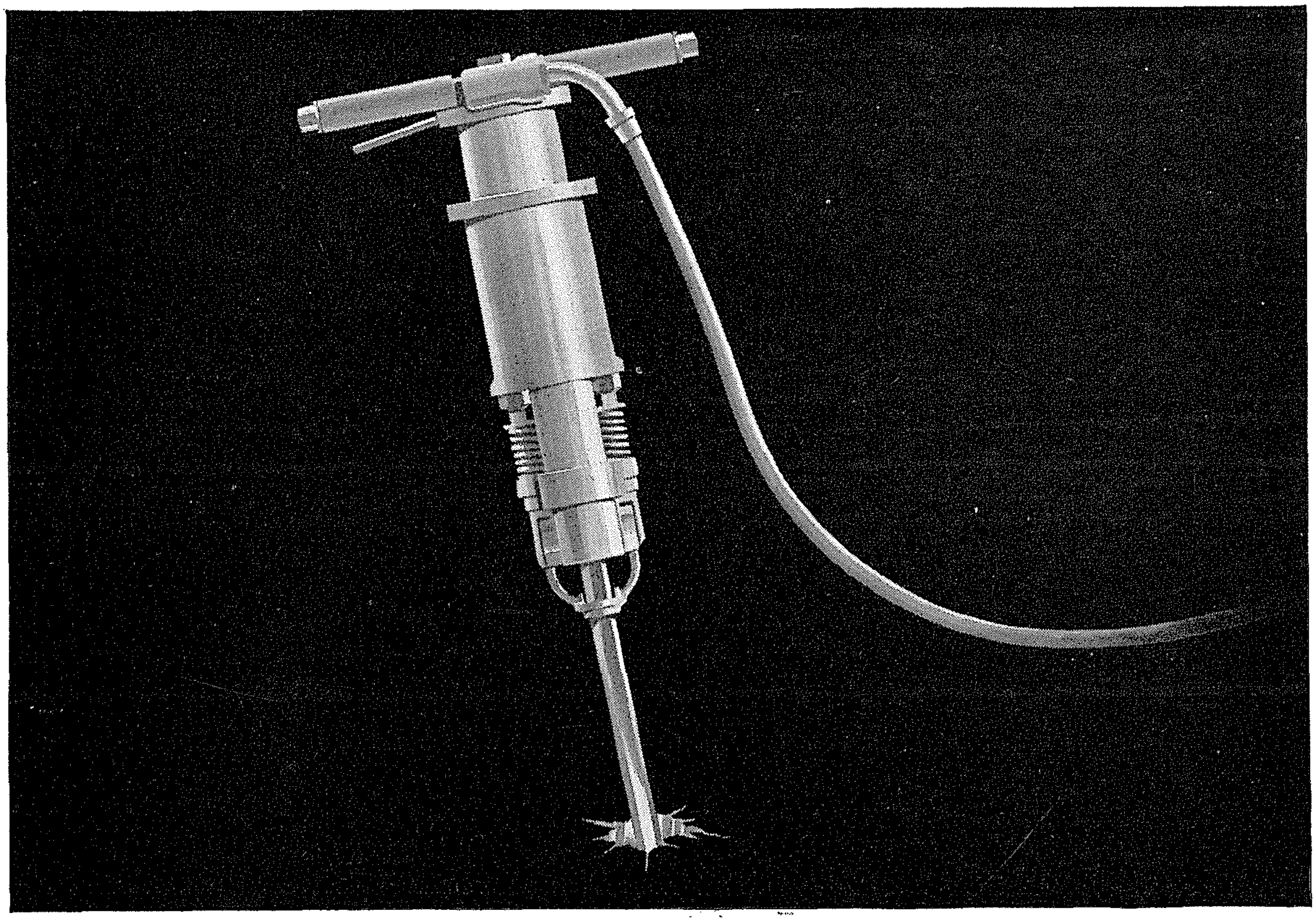
Havemann and West make the point that only about 6 percent of all Americans old enough to have a college degree actually do have one. Moreover, it is generally assumed that college graduates are not the big breeders in our society. So, one would not expect the parents of college graduates to have college degrees themselves. Of the men graduates in the Havemann-West sample, however, 32 percent came from families in which at least one parent had gone to college. At this rate, we might expect that about a third of our Caltech alumni would have at least one parent who had attended college. But surveys contrasting the educational background of the parents of engineering students with those of liberal arts students reveal, almost without exception, that fewer parents of engineering students have obtained college degrees than have those of liberal arts students. Therefore, we should expect that considerably fewer than 32 percent of our alumni will have come from families where at least one parent has attended college.

This is not the case at all. Not fewer, but *more*, of our alumni (50 percent, in fact) report one or more of their parents having attended college. Apparently the college-educated parent is more cognizant than the non-college parent of the benefits of having his son obtain a Caltech degree.

The old myth about college being a pleasant way for a young man to waste four years while his parents support him until he has his degree really *is* a myth. For Havemann and West report that of all the U. S. graduates in their sample, only 29 percent never worked at all during their college career. The remaining 71 percent

COLLEGE IS A HELP IN YOUR OCCUPATION





AIR MUSCLE...

Properly compressed and coupled to this drilling tool, air packs a rock-busting wallop. How different from the days when men slung sledges, and even cracking pavement was a slow, tortuous task . . . as were many other manual jobs in industry.

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worked their way in whole or in part, with more than half of them holding jobs after classroom hours during the school term. As they say, it is the rule rather than the exception for the student to pay at least part of his expenses through his own labor.

This statement is even more true when we look at the Caltech figures. Only 4 percent did not work at some time during their college years. Of the 96 percent who did work, two-thirds had jobs right through the school term. These figures are doubly impressive when one considers Caltech's heavy scholastic requirements and relatively long classroom and study hours.

The Caltech student is apparently highly motivated to get his training here, and is willing to make a considerable sacrifice to do so. That this determination and dedication to purpose is recognized and rewarded by the Caltech faculty is indicated by the fact that 42 percent of our alumni report having received a scholarship some time during their attendance at the Institute.

The most important comments about grades will be made in connection with later articles where occupational success in relation to college grades will be discussed. However, one interesting aspect may be mentioned here. The alumni were asked whether they got mostly As, Bs, Cs or Ds in school. Twenty-two percent reported getting mostly As; 50 percent got mostly Bs, and 28 percent mostly Cs. Only one person reported getting mostly Ds. These percentages indicate that the grade point average for the total Caltech alumni body would be a B. I am sure it is unnecessary to remind alumni of the toil and anguish requisite to the attainment of a B, for it is popularly declared that a B at Caltech is the equivalent of an A elsewhere.

We accept this view, then, that 72 percent of the Caltech alumni got grades that would have made them A students and Phi Beta Kappas anywhere else, or to paraphrase the immodest claim of a well-known women's college: "A bachelor's degree from Caltech is the equivalent of a doctorate anywhere else." (But where did that D fellow come from anyway?)

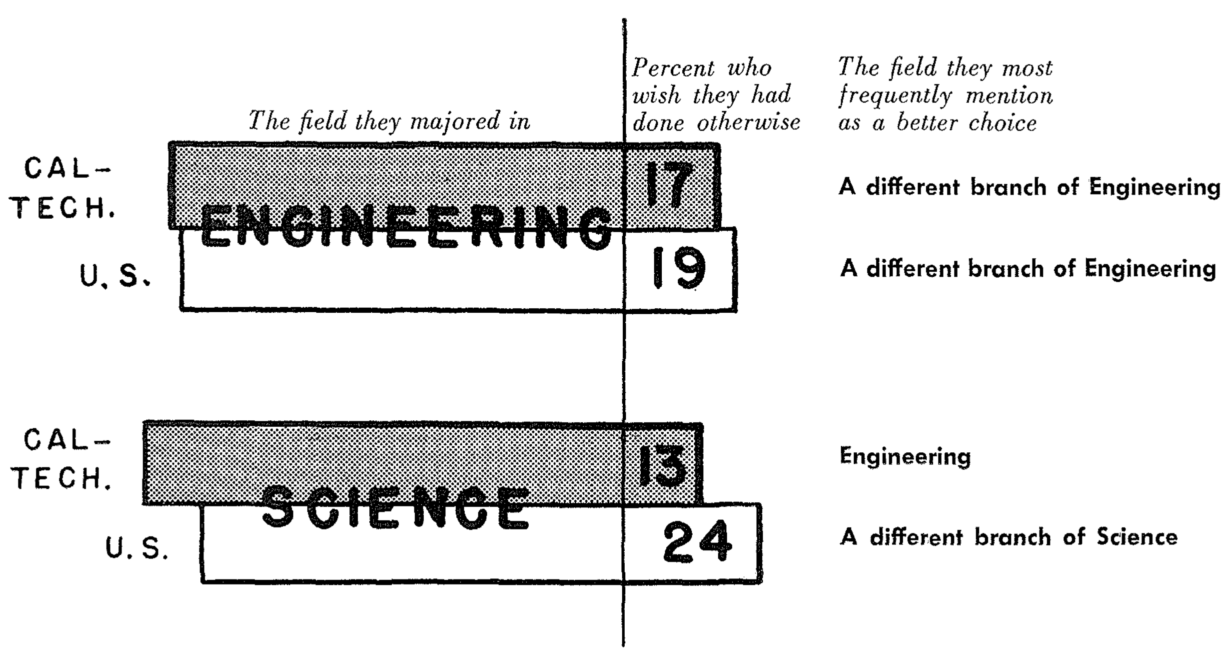
We will also have some interesting things to say about extra-curricular activities when we come to consider occupational success. However, we may comment in passing that, although the Caltech student does work very hard under a heavy scholastic load, and gets very good grades while doing so, he still has time for other activities. In fact, 87 percent of our alumni report having participated in some type of extra-curricular activity, whether it was sports, publications, music, politics, or what-have-you.

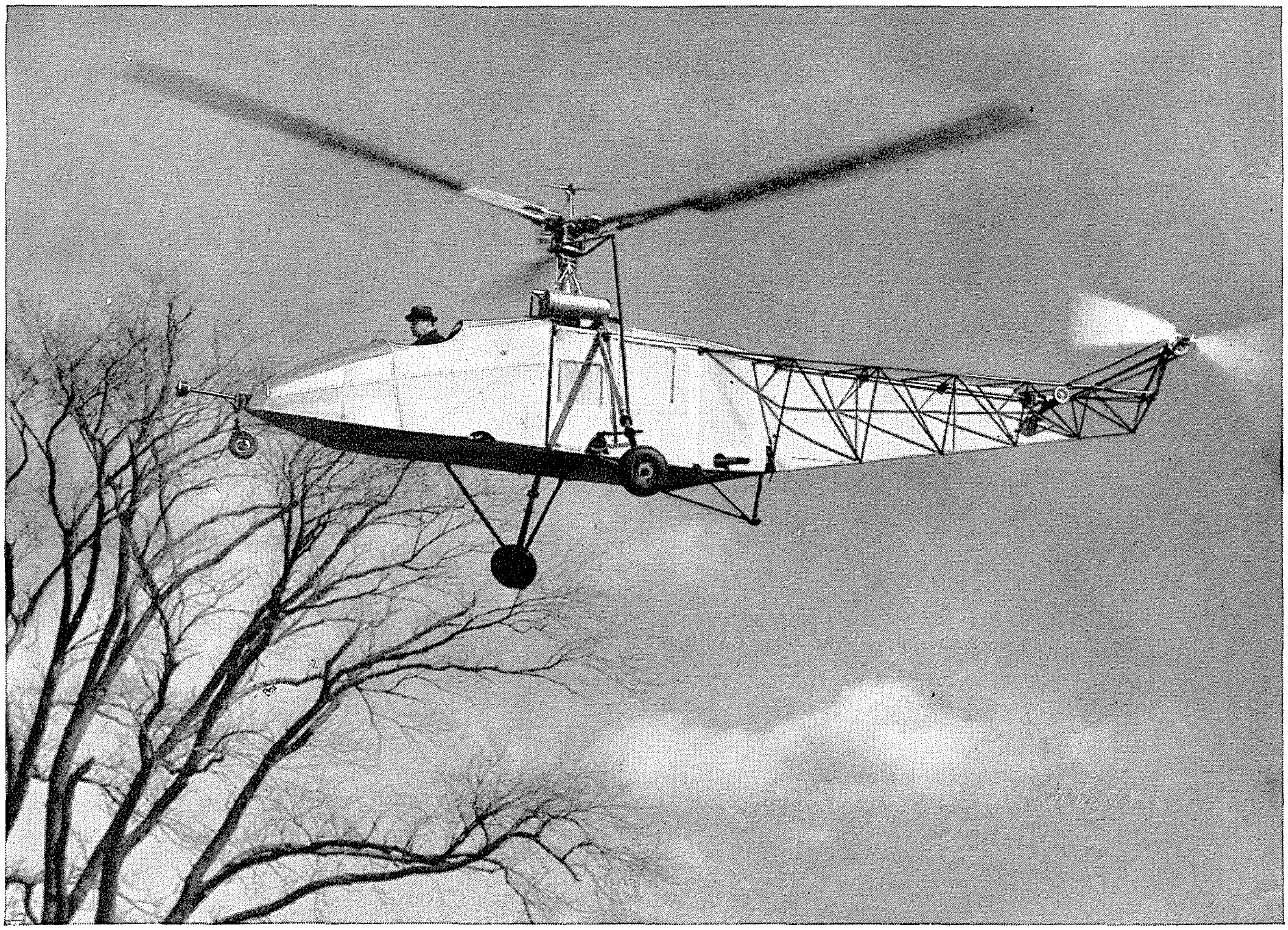
Of this 87 percent who were active, 68 percent concluded that it was of value after college. Of those who did not participate, half said they would if they were to return to college and do it all over again. These figures would indicate that seven out of ten alumni feel that extra-curricular activities in college are worthwhile.

Sixty-eight percent of our alumni majored in engineering and 30 percent majored in science. These figures are in interesting contrast to the U. S. graduate in the Havemann and West survey, where 47 percent of the engineering and science students majored in engineering and 53 percent in science. They also contrast with the current roughly 50-50 distribution of Caltech students between science and engineering.

These contrasts probably reflect a generally increased

ANOTHER MAJOR MIGHT HAVE HELPED EVEN MORE





Simple enough now, this vertical ascent was history-making in 1939.

CALTECH ALUMNUS . . . CONTINUED

interest in science, as well as a tendency for the successes of Caltech science graduates in their own fields to lend prestige and honor to the California Institute—thus attracting more science students.

When we look at the highest degree obtained by our alumni, Caltech emerges as an outstanding center of advanced thought, for the number of alumni who have received advanced degrees (55 percent) is larger than the number who stopped at the bachelor's level (45 percent). Caltech is by no means primarily an undergraduate school. In terms of the degrees of its alumni it might be more accurate to call it a graduate school with a large undergraduate student body.

What does the alumnus think of his education, now that he's had it? Well, 88 percent of Caltech alumni would rather go back to Caltech if they had it to do over again, whereas only 81 percent of technical school graduates in general would return to their alma mater. Eighty-five percent of Caltech alumni are satisfied with their selection of a major subject, compared to 75 percent for the U. S. graduate.

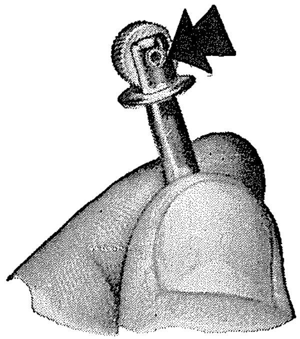
This satisfaction with their education is also reflected in the fact that 84 percent of our alumni have followed the occupation they planned to follow when in college. Eighty-six percent feel that college has helped a lot, and 14 percent feel that it has helped to some extent in their present occupations. So apparently the vast majority of Caltech alumni are satisfied with their major, feel that it helped them materially in reaching their vocational objectives, have spent the time since they have been out of college working in their chosen jobs, and would go back to Caltech if they had to do it over again.

In general

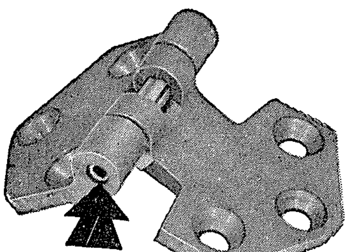
We can now summarize all these statistics with a few broad generalizations. When one compares the Caltech graduate with the average U. S. college graduate, he appears in a very favorable light. He comes from an educated family; he has been sufficiently motivated to help put himself through school, and is most apt to get some financial assistance from the Institute in order to do so.

It is very likely that he will go on for an advanced degree, and will continue to work in the field of his major for the rest of his life. He will be satisfied to do so, will consider himself more successful than the average person, and would go back to the same school to study the same major if he had it to do over again.

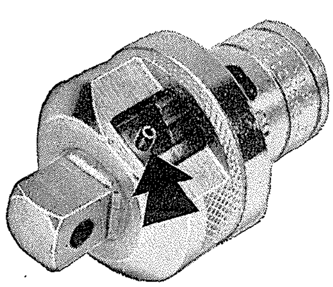
Even in the rare instance when he is dissatisfied, he would only change his major within the fields of science and engineering. Such satisfaction with one's lot in life is not at all common today. Perhaps all the toil and frustration one has to go through to obtain a degree from a school as rigorous and thorough as Caltech is more than compensated for by an extra measure of success and satisfaction in later life.



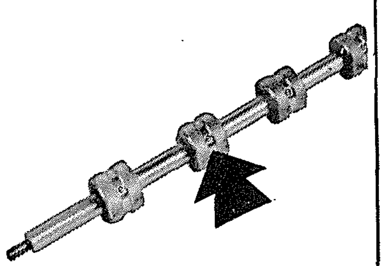
Replacing a rivet



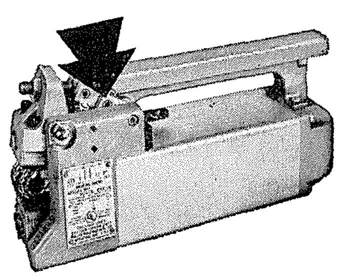
. . . a hinge pin



. . . a stop pin

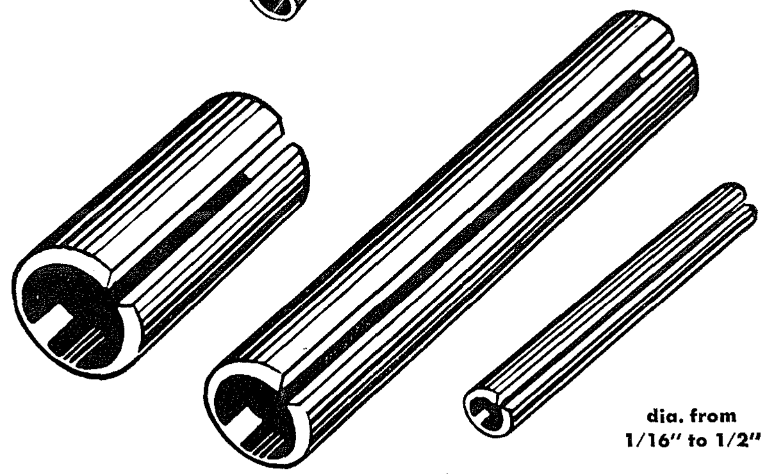


. . . a set screw



. . . a bolt and nut

ROLLPIN



dia. from
1/16" to 1/2"

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Rollpin is a hollow, split, cylindrically formed pin with chamfered ends. It is simply driven into holes drilled to normal production tolerances. Because Rollpin is slightly larger than standard sized holes, it compresses as inserted. It is self-locking—and vibration-proof—because of the constant pressure it exerts against hole walls. Its shear strength exceeds that of a cold rolled pin of the same diameter. Rollpin is readily removed with a drift or pin punch—and can be reused.

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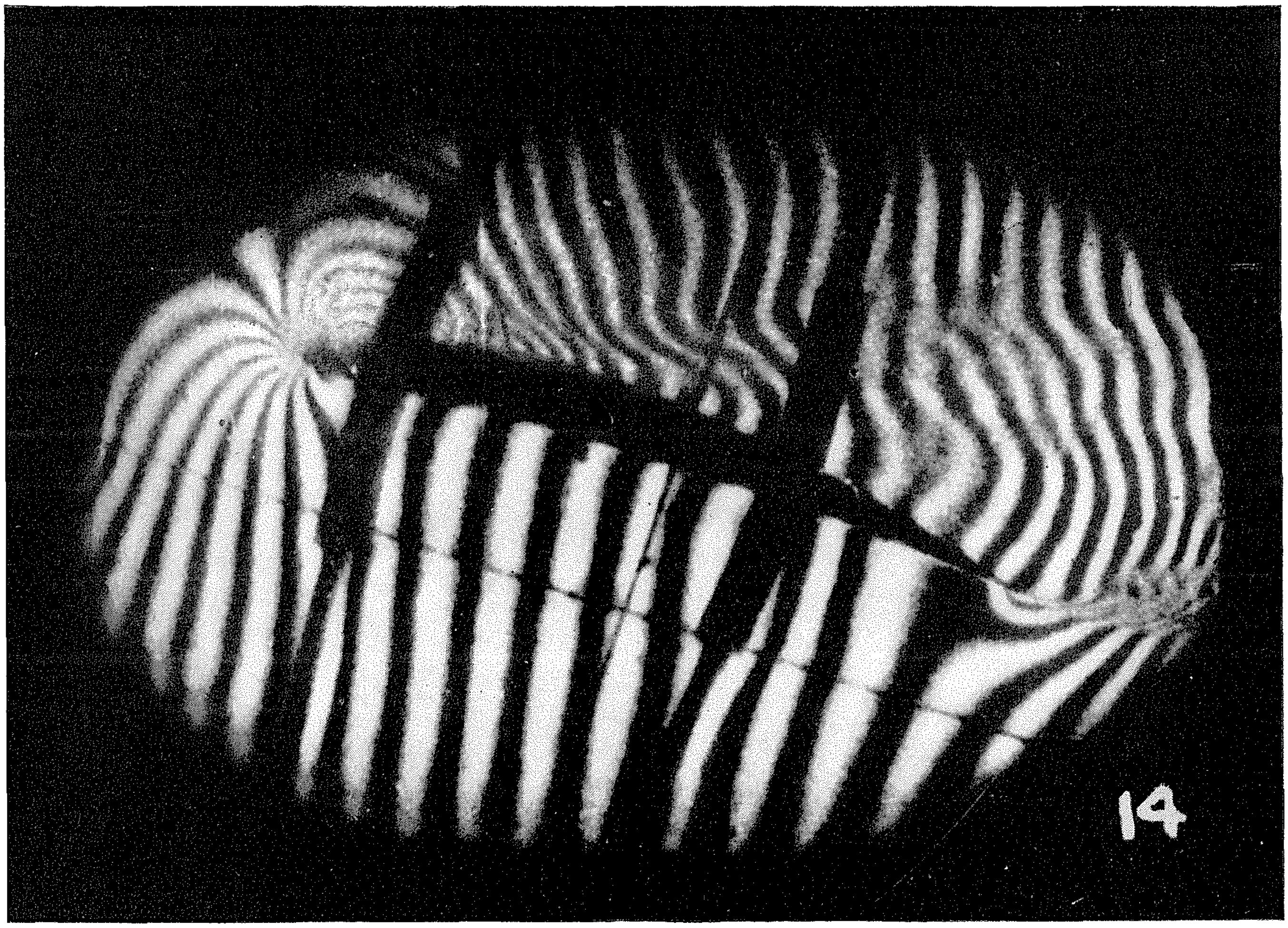
Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA


14

THE PROBLEM OF DRAFTING QUALIFIED GRADUATE STUDENTS BY SELECTIVE SERVICE SYSTEM

by D. S. CLARK

During the past summer, local draft boards, particularly in southern California, have been actively classifying men accepted for graduate school as 1-A. Many of the highly qualified men have not been given adequate consideration for deferment to permit their receiving advanced training. In some localities the effects of this tendency have become very serious.

If the United States is to maintain a proper defense position, it must not only maintain an adequate military force, but also place itself in a strong development position. The Selective Service System was established by the Congress to provide a military force. It may well be questioned if the system that has been set up is as satisfactory as a program of universal military training. However, the problem at the moment is whether or not the present system is interfering with the advanced training of men who are required to carry on developments in order to keep a military force in the most advantageous position among the countries of the world.

The present attitude of the local boards is definitely leading to a situation that will reduce the number of men receiving advanced training. It is probable that the local boards are not cognizant of the seriousness of the situation and have not been properly advised by General Hershey's office.

The number of qualified men who would be deferred is not great. A qualified man can be defined as one who has maintained the academic standing required by the Selective Service System as an undergraduate, and who continues to do outstanding work in graduate school. Under this definition, it is clear that a relatively small number would be able to enter and complete graduate work. Actually in 1952, according to the Engineering Manpower Commission, a total of 529 Ph.D. degrees were granted in all branches of engineering in the U. S.

Certainly there should not be a blanket deferment of students who wish to attend graduate school. Each case must be considered individually, and each local board should determine the qualifications of each registrant and take appropriate action to see to it that those who are qualified are not only allowed, but urged, to obtain the maximum training commensurate with their capacity.

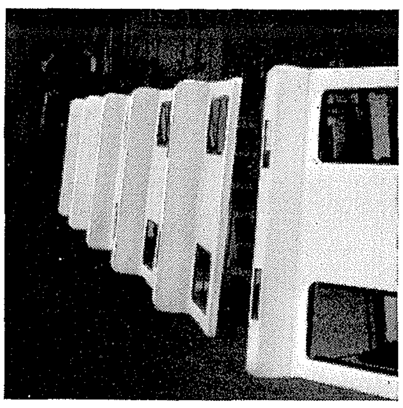
Many boards appear to be taking the attitude that no students should be permitted to go farther than the bachelor's degree (or at most one year of graduate work) before doing their turn in the military services. It does not seem to have been the intention of the Congress or General Hershey to draft all graduate students just because they are graduate students, or to permit no one to enter graduate work directly after receiving a bachelor's degree. The Universal Military Training and Service Act is clear in its purpose, as stated in Sections 1c and 1e, as follows:

> "Section 1c—The Congress further declares that in a free society the obligations and privileges of serving in the armed forces and the reserve components thereof should be shared generally, in accordance with a system of selection which is fair and just, and which is consistent with the maintenance of an effective national economy.
>
> Section 1e—The Congress further declares that adequate provision for national security requires maximum effort in the fields of scientific research and development, and the fullest possible utilization of the Nation's technological, scientific, and other critical manpower resources."

Section 1c indicates that selection is to be consistent with the maintenance of an effective economy. Section 1e specifically points to the necessity of maximum effort in the fields of scientific research and development with the best possible utilization of the nation's manpower resources for national security.

In spite of this stipulation, many cases can be cited in which the top men have been subject to induction even on appeal, and after adequate proof of a man's high standing has been presented to the local board by the educational institution concerned. Such action is not in the best interest of the country.

There is evidence that some boards believe that after one year of graduate work a man is more eligible for draft, and after two years is even more eligible. If a qualified man is allowed to start graduate work, it is important that he be allowed to complete this higher education. It is especially damaging to interrupt this



training while the man's research is in progress.

The members of the local boards, in many instances, fail to realize that, for the good of the country and its defense, men of advanced training must be supplied continuously in order to provide the developments required for advancement in military preparedness. Advancement requires that there be men working on fundamental problems which provide information for others with advanced training to utilize in the development of new materials, new processes, and equipment.

Why has it been possible for the United States to be a leader in these things? It is because in the past, men of capacity have been given advanced training to provide them with the tools for research and development.

It is true that, for many technical positions, four years of basic training are sufficient. But here we are not talking about those men who receive sufficient training for these positions. We are talking about those whose capacity is great enough to warrant training them to the fullest for the greatest benefit of the country.

Research and the services

There is a belief by some that the military service, by the induction of graduate students, will secure men for highly technical work. This is not true, as is proven by the type of duty that is given to such inductees. The research and development that is done by the services is carried on in establishments manned primarily by civilian employees. A man who is drafted is not assigned to such establishments to occupy a position of high research responsibility. So it cannot be claimed that the services particularly seek those qualified for graduate work.

The military services are not in the business of research, but are concerned with the building of a strong defense organization, which must depend for its basic information upon research done in institutions in which the research atmosphere prevails.

We understand that medical students are deferred because of their importance to the health and safety of the country. However, basically the practicing physicians have done little in bringing about the great advance in medicine. The advances are the result of research by men who have had graduate training. Many developments have been accomplished in the universities by permanent staff members assisted by graduate students.

This brings us to the point of considering what men do in graduate school. Their work does not consist solely of attending classes, but involves a participation in the research of the staff that eventually leads to the developments which are of importance to the country as a whole, including the defense effort.

One frequently fails to realize the research of a fundamental character that is required before a jet plane or a gas turbine or other piece of equipment can be designed and built with success. Who are the people that obtain this fundamental information? They are the research people located in the colleges and in some industrial organizations. Among the research people in the colleges are the graduate students, who contribute immeasurably to the solution of the problems undertaken, and who become proficient in their field so that they can carry on further these investigations that will contribute to the advanced position of the country. Therefore, it should be clear that to interfere with this flow of qualified men is detrimental to our success.

The type of men that can be of the greatest technical value to the military services as members of the armed forces includes those who have completed four years of college but are not the type that should enter graduate schools for higher degrees. The total number of men who should continue graduate work is not large in proportion to the total number who become available for service.

Certainly these men can serve the country best by being given advanced training. This is not a question of doing something to avoid service to the country, because the greatest service to the country is done by placing men in positions for which they are best qualified.

The view has been expressed that "the graduate schools can secure their students from those who have completed their military service and that thus the induction of present students will cause no shortage of graduate trained men. This does not seem to work out.

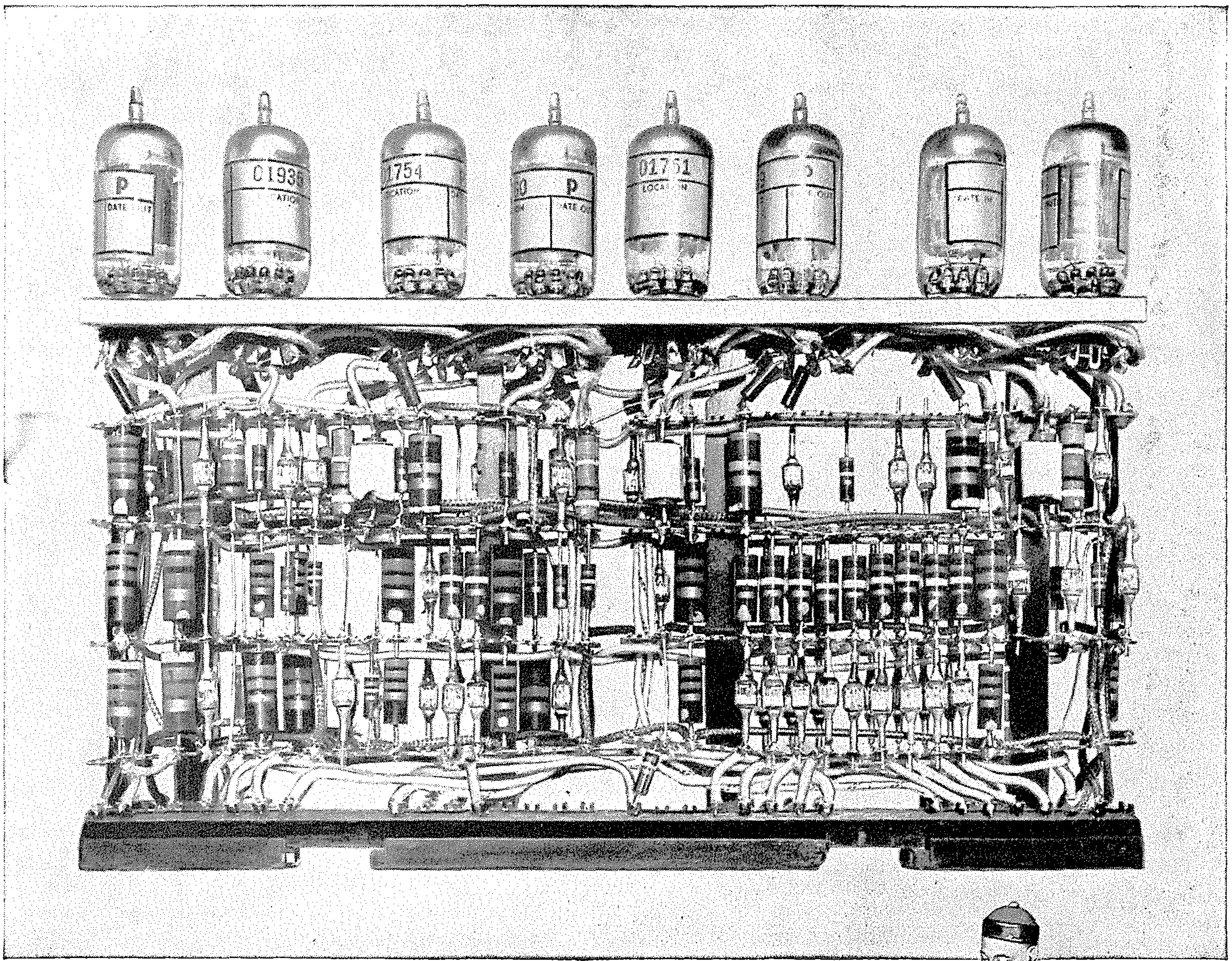
Of the applicants for graduate appointments, only one percent or less have completed service. Why? In the field of engineering, as also in science, the demand by industry for young men even at the bachelor's level is so great, and the financial rewards are so attractive, as compared with the small financial compensation associated with a graduate appointment that only a few of the most serious-minded will turn to graduate work.

A long delay

Furthermore, if the man has had military service, it is unusual for him to be willing to delay the professional career that would await him after a one-to-five-year program of graduate study. To put off the qualified men decreases the number that will complete the advanced training requisite for the highly technical work in this country necessary to defense and advancement.

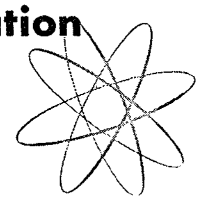
It is not in the national interest that we curtail our educational or research efforts, particularly when countries such as Great Britain and Canada, and even Russia, are giving preferential treatment to those who are qualified for advanced work, such as superior students.

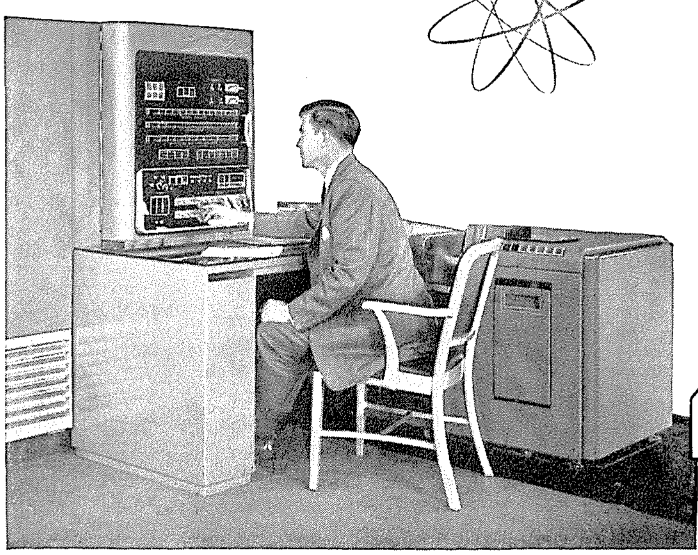
This is a serious problem which goes beyond any individual case. Something must be done to provide information to the local boards so that they may recognize this important problem, and secure information that will permit them to determine the qualifications of the registrant for graduate work—and, when these qualifications indicate graduate work, will *encourage* the added training.



MODERN ABACUS

new tool for lightning-fast calculation





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"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

When you're thinking of a good job, think *high*—think *Worthington.*

3.6

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

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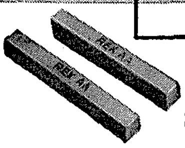
The Sign of Value Around the World

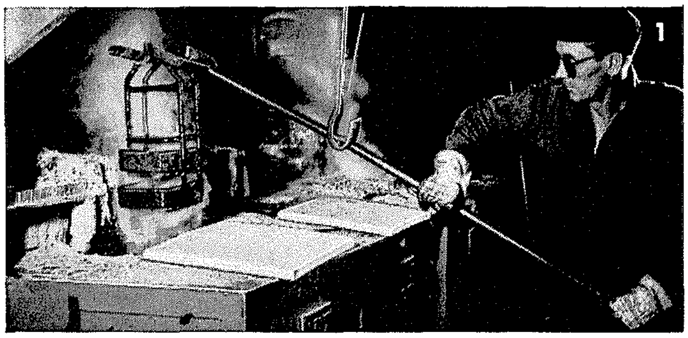
What's Happening at CRUCIBLE

about REX HIGH SPEED tool bits



Many millions of REX High Speed Tool Bits have been produced, in recent years, at Crucible's Sanderson-Halcomb Works, Syracuse, New York. Our Tool Bit Department is actually a manufacturing plant in itself, where production is counted in pieces—in sharp contrast to the larger production units of most other phases of steelmaking.

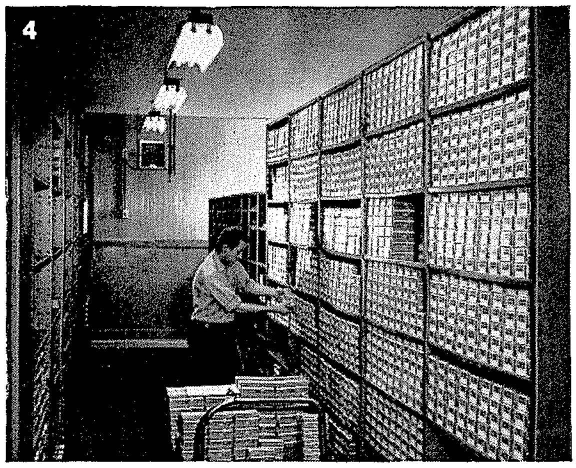
REX High Speed Tool Bits are made from high quality high-speed steel bar stock, produced at Crucible's Sanderson-Halcomb Mill. Bars are cut to tool bit lengths, heat-treated, grit-blasted or ground, and inspected.



HARDENING — Small batches of REX High Speed Tool Bits are hardened in modern salt bath furnaces. The bits are then quenched in either salt or oil.

TEMPERING — Tempering is done in circulating air furnaces. All of the steps illustrated help insure a correct combination of maximum red hardness, toughness and abrasion-resistance necessary for continuous high cutting efficiency.

TUMBLING — Prior to inspection and packaging, REX High Speed Tool Bits are cleaned by tumbling.



STOCKS — REX High Speed Tool Bits are stocked in standard packages in Crucible's warehouses.

Uniformity Each individual REX High Speed Tool Bit possesses the same uniform high quality. Each bit is inspected by the magnetic particle method . . . and representative bits are tested for microstructure and hardness. These tests control quality of the finished product . . . insure that REX bits will give higher production from each grind, and a minimum of "down-time" on your machine.

Crucible Engineering Service Available

Crucible engineers are available to work with you in the selection of the proper REX grade for highest cutting efficiency on your particular job.

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National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

PERSONALS

1917

Paisley B. Harwood is vice-president in charge of engineering with Cutler-Hammer, Inc. in Milwaukee. The third edition of his book, *Control of Electric Motors* was published last December by John Wiley & Sons. The book is an up-to-date description of the design, construction, and application of controllers.

1922

Jay J. DeVoe is now with the Allen T. Archer Company, insurance brokers, in Los Angeles. He was formerly in charge of the engineering department of the Founder's Insurance Company, Los Angeles.

1928

Richard G. Folsom, M.S. '29, Ph.D. '32, has been appointed Director of the Engineering Research Institute at the University of Michigan. Dick was an instructor, then assistant professor, associate professor, and finally chairman of the mechanical engineering department at the University of California at Berkeley until his Michigan appointment on September 1.

1930

John D. Clark has been chief chemist at the U. S. Naval Air Rocket Test Station at Lake Denmark, Dover, New Jersey, since 1949. He says he's possessed of one wife, one dog (Alaskan Malemute) and four cats (assorted). For amusement he raises Malemutes and edits science-fiction anthologies. He also reports having invented a way of making martinis without dilution—and adds that the resulting product may be used for rocket fuel.

Harris K. Mauzy has moved to Sacramento, where he is now Senior Bridge Engineer in the headquarters office of the State Bridge Department. He has also been promoted to Commander in the U. S. Naval Reserve. His third child, a boy, was born last January.

Tom Bernhardi is the newly elected president of the board of trustees of the village of Homewood, Illinois—a job comparable to that of mayor. Homewood has a population of about 11,000 people. Tom is a production engineer with the Swenson Evaporator Company in Harvey, Illinois.

1932

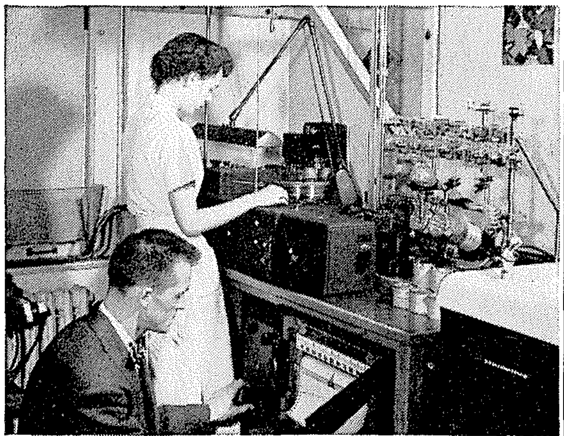
Charles D. Coryell, Ph.D. '35, with his wife and 10-year-old daughter Julie, travelled around Europe from June 15 to September 15 in a Hillman-Minx, before going to Rehovoth, Israel, where Charlie has a Louis Lipsky Fellowship to work for a year at the Weizmann Institute of Science. He's on a year's sabbatical leave from MIT.

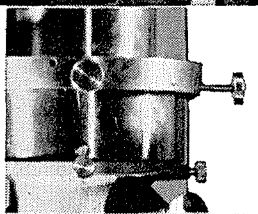
1933

Robert L. Smallman has been named vice-president of the new marketing division at Consolidated Engineering in Pasadena. He heads such departments as sales, technical services, advertising and public relations.

Dean E. Wooldridge, M.S., Ph.D. '36, who, for the past two years has been vice-president in charge of research and development for Hughes Aircraft, is now president of the newly-formed Ramo-Wooldridge Corporation—a Los Angeles electronics firm financed by Thompson Products, Inc. Previous to 1946, when he joined Hughes, Wooldridge served 11 years with the Bell Telephone Labs, and during the war was technical chief of a section dealing with airborne electronics.

A. P. Wilking is president of the St. Mary Hardware Company and the St. Mary Supply Company in Franklin, Louisiana. The Wilkings have three kids—Phil, 12, Myrtle, 10, and Dick, 2.





Making an analysis with the infra-red Spectrophotometer.

Testing action of Perchlorethylene on various metals.

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

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Philip C. Efromson writes from Winchester, Mass., where he is a partner in the Calidyne Company, manufacturing vibration test equipment; and vice-president of the Co-Design Corporation, a subsidiary of Calidyne. The Efromsons' first child, Alan Charles, was born on January 4, 1953.

1934

Nick van Wingen is now a visiting professor at the school of engineering at USC. After getting a master's degree at the University of California in 1938, Nick worked for Shell, Continental and Richfield Oil Corporations. He also taught at the University of Oklahoma and has been a special lecturer for night classes at USC while serving on the board of directors of Petroleum Technologists, Inc. and working as a consulting petroleum engineer. He has just returned from Turkey, where he served as a consultant in oil production for the Turkish government.

1935

Louis T. Rader, M.S., Ph.D. '38, was appointed general manager of General Electric's newly established specialty control department in Schenectady. Louis first joined General Electric on the test course at Schenectady and completed the advanced engineering program a year later. He worked as a design engineer in the control division until 1945 when he left to become head of the electrical engineering department at the Illinois Institute of Technology. Two years later he returned to GE to manage the engineering laboratory of the control division and was appointed manager of engineering in 1951.

1936

Tyler Thompson is now associate professor of philosophy of religion at the Garrett Biblical Institute in Evanston, Illinois. This is the largest of the ten graduate theological schools supported by the Methodist Church. The Thompsons' fourth daughter, Becky, was born last March.

Simon Ramo is vice-president and executive director of the new Ramo-Wooldridge Corporation in Los Angeles. Simon resigned as Hughes Aircraft vice-president for operations to take the new position. He was on the staff of the General Electric Company's laboratory for ten years, and served on the industrial and educational committee for the Army Engineering Devices Center of the Air Force. He is also the author of two well-known text books on electronics.

Rear Admiral Calvin M. Bolster, M.S., is now Chief of Naval Research, Navy Department, Washington, D. C. His daughter, Carolyn, was married in December, 1951, and now has a daughter, Denise. His son, Dennis, is at Duke University, and his youngest daughter, Molly, is at Georgetown Visitation Convent.

Chauncey W. Watt is now a staff engineer in the Visual Computor Lab at M.I.T.

Harry D. Evans, M.S., has been appointed a supervisor of development in the Chemical Engineering Department at the Shell Development Company at Emeryville, Calif.

1940

Gorden B. Weir, M.S., is back on television with a weather show in the Los Angeles area—on KECA TV (Channel 7) Monday, Tuesday, Wednesday, and Friday nights at 6:55 p.m.

1941

Merritt V. Eusey, Jr., is Branch Manager of the Minneapolis Honeywell Regulator Company in Baltimore, Md.

1942

David L. Hill is now on leave from his post as associate professor of physics at Vanderbilt University to serve as consultant in the theoretical physics division of the Los Alamos Scientific Laboratory. He is also now national chairman of the Federation of American Scientists. The Hills have a 17-month-old son, David Albert.

Robert Greenwood, M.S. '43, has accepted a one-year appointment at the Michigan College of Mines in Houghton, Michigan. Until recently, Bob was a director, and chief geologist, for Proberil—a company engaged in production of beryl and other rare minerals in Minas Geraeas, Brazil.

Capt. Sheldon W. Brown, A.E., was transferred on July 1 from Director, Ships Installations Division, Bureau of Aeronautics to the Naval Air Station in Norfolk, Va. as Overhaul and Repair Officer.

Richard W. McCornack has been promoted to chief production engineer by the Elgin National Watch Company in Elgin, Illinois. Dick has been a member of the production engineering department since joining Elgin in 1946.

David H. Brown, Ph.D. '48, is now assistant professor in biological chemistry at Washington University in St. Louis.

1943

Richard E. McWethy writes from Aurora, Illinois, to say that, between keeping his insurance business going and trying to keep his cattle ranch solvent, he's been too busy this year even for golf.

Peter Dehlinger, M.S., Ph.D. '50, resigned as associate consulting geophysicist at the Battelle Memorial Institute last August to accept a position as research associate with the Continental Oil Company in Ponca City, Oklahoma. His job at Continental is to head up the theoretical and interpretive geophysical research for the company. Peter reports that *Leendert de Witte*, M.S. '47, Ph.D. '50, has been with Conoco for about three years, working on well logging methods.

Stanley Swingle, Ph.D., died of cancer on October 5. He was 36 years old. A former teaching fellow, and senior research fellow at Caltech, he had been working since 1949 at the Eli Lilly Research Laboratories in Indianapolis.

Roland Saye is a mechanical engineer with the Soundrive Pump Company in Playa Del Rey. He was formerly with Gordon S. Brown & Associates in Beverly Hills.

1944

Robert M. Weidman is now teaching at Montana State University in the Geology Department. He was married to Eleanor Ruth Young of Modesto, California in 1951.

1942

John D. McKenney, M.S. '48, Engr. '49, has been appointed Section Chief of Industrial Planning at J. P. L. He was formerly Assistant Section Chief.

1946

Kenneth W. Robinson, M.S. '48, has won an RCA Fellowship for the second successive year. Ken is employed at the David Sarnoff Research Center of RCA in Princeton, New Jersey, and will work toward a doctorate at Princeton University.

1947

Dean A. Watkins, M.S., has been appointed associate professor of electrical engineering at Stanford, and will teach graduate courses in applied electromagnetic theory. He has been an acting assistant professor at Stanford since last winter. Prior to this, Dean was connected with the Los Alamos Scientific Laboratory and with the Hughes Aircraft Research and Development Labs.

Harold M. Hipsh is now working for Convair in Ft. Worth, Texas. He reports no new additions to the family, which now consists of 2 dogs and a cat.

1948

Harvey Fraser, M.S. '48, has been named Junior Professor of Mechanics at West Point. This makes him a permanent member of the USMA staff and faculty, and assistant to the head of the department.

Bill Carter, M.S., Ph.D. '49, and his wife now have three daughters. They're still happily settled in Los Alamos.

Arthur N. Cox got his Ph.D. in astronomy at Indiana University and is now on the staff at the Los Alamos Scientific Laboratory. He's planning to go to the spring tests at the Pacific Proving Grounds.

R. J. MacNeill, M.S., formerly assistant chief geologist for the International Nickel Company, is now chief geologist for the Newfoundland and Labrador Corporation. This is a crown (provincial government) backed corporation with mineral concessions of 32,000 square miles in Newfoundland and Labrador. This past summer Jack had a staff of over 60 geologists engaged in making a preliminary survey of this vast region.

Major George J. Newgarden is now assigned to the Los Alamos Scientific Laboratory as U. S. Air Force meteorological consultant.

1949

Vernon Smith was married in 1950, and became the father of twins in 1951—a boy and a girl. He also got his M.A. in economics at the University of Kansas in 1951 and is now studying for his Ph.D. in economics at Harvard, where he has an Earhart Foundation fellowship for 1953-54.

Byron C. Karzas is an engineer in the distribution department of the North Shore Gas Company in Waukegan, Illinois, working on maintenance, distribution, and production. The Karzas have a baby girl, Mary Kay, born on September 28.

Robert Galstan, M.S., is a mechanical supervisor at Procter and Gamble in Chicago, in charge of plant repair and maintenance. The Galstans have a daughter, Deborah Lynn, now 2½ years old.

1950

Robert C. Howard, M.S., has been a member of the technical staff of the Bell Telephone Laboratories, working in New York, since finishing up at Tech last January. The Howards have a new daughter, now about two months old, and they're buying a house in Clifton, New Jersey.

Adam F. Schuch, Ph.D., is an associate group leader at the Los Alamos Scientific Laboratory, New Mexico.

Frederick H. Leinbach, Jr., M.S., is working as a physicist for the Geophysical Institute of the University of Alaska, doing research on Aurora and radio propagation. He has been there since September, 1950.

C. James Blom and Olly Zangerl were married last June in San Marino. Jim has recently returned from Austria where he obtained his Ph.D.

1953

Tom Stockebrand writes that he's in the Army now—and will be until September 27, 1955. Tom's first impression is that the Army has perfected effective ways for making you lazy: "Just give a man a certain time in which to do a job and arrange it so that if he's done early he either does it again or gets more work." Even so, Tom says, "the experience in dealing with people really is valuable."

BOOKS

FOOL'S HAVEN
by C. C. Cawley
House of Edinboro, Boston $2.75

AFTER A SUCCESSFUL engineering career, Clifford Cawley '32, M.S. '33, turned to writing several years ago. His first book, a collection of short stories called *No Trip Like This*, was published in 1951. *Fool's Haven* is his second book, and his first novel.

The fool's haven of Mr. Cawley's title is not, let it be made clear at the beginning, Caltech—though the school, and the city of Pasadena form the background of the story. Faith-healing is what Mr. Cawley here considers a fool's haven from reality.

The story concerns a Caltech junior, in about 1930, who falls in love with the 17-year-old daughter of the house in which he rents a room. The girl's mother, a widow, is a member of a religious sect (never named) which believes in faith-healing. On the eve of her wedding, the girl has an attack of appendicitis. The mother refuses medical attention for her daughter, relying on prayer for a cure. The girl dies.

The mother, and the pastor of her church, are charged with manslaughter. The mother is convicted, the pastor cleared—on the grounds that it was the mother's legal duty to provide reasonable medical care for her daughter, but that the pastor who counseled her had no such duty.

The bitter, angry boy, at the end of the book, has decided to forget engineering and turn to the study of law.

Mr. Cawley's story is based on a legal decision, made in 1895, which is still generally followed in faith-healing deaths today.

It is, indeed, unjust that a parent who denies his child medical aid can be convicted of a crime, while the person who counsels that crime is considered guiltless. Apparently this particular injustice has been galling Mr. Cawley for a long time, for he writes about it with a good deal of heat and passion. If a reader finds it hard to match him in this regard it can only be that we have all become aware of a lot of even greater injustices in recent years.

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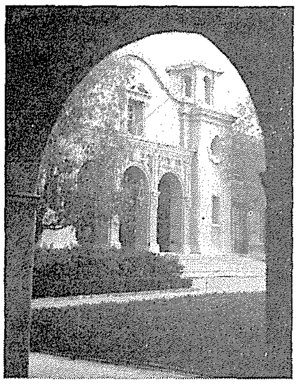
The Editors

CALTECH CALENDAR

November, 1953



ALUMNI ACTIVITIES

November 12, Oxy - Caltech Pre-Game Luncheon—Athenaeum

November 13, Open House Dabney Hall of Humanities

January 13, Dinner Meeting

February 6, Dinner Dance Oakmont Country Club

CALTECH ATHLETIC SCHEDULE

VARSITY FOOTBALL

November 13, 8:00 p.m.
Occidental at the Rose Bowl

VARSITY WATER POLO

November 17, 4:30 p.m.
Oxy at Pasadena CC pool

November 19, 4:00 p.m.
LA State at LA State pool

CROSS COUNTRY

November 20, 4:00 p.m.
Pomona at Caltech

November 24, 4:00 p.m.
Cal Poly, Chapman at Caltech

BASKETBALL

November 21, 8:00 p.m.
LA State at LA State

SOCCER

November 21, 2:00 p.m.
Pomona at Pomona

November 27, 11:00 a.m.
U. of San Francisco at Caltech

December 4, 10:00 a.m.
UCLA at Caltech

DEMONSTRATION LECTURES

Friday Evenings
7:30 p.m—201 Bridge

Nov. 13—"The Strength of Metals," by Professor David S. Wood

Nov. 20—"Earthquakes," by Professor Hugo Benioff

Dec. 4—"New Devices and Modern Concepts in Very High Frequency Electricity," by Professor Lester M. Field

PHOTOGRAPHY AT WORK **No. 5 in a Kodak Series:**

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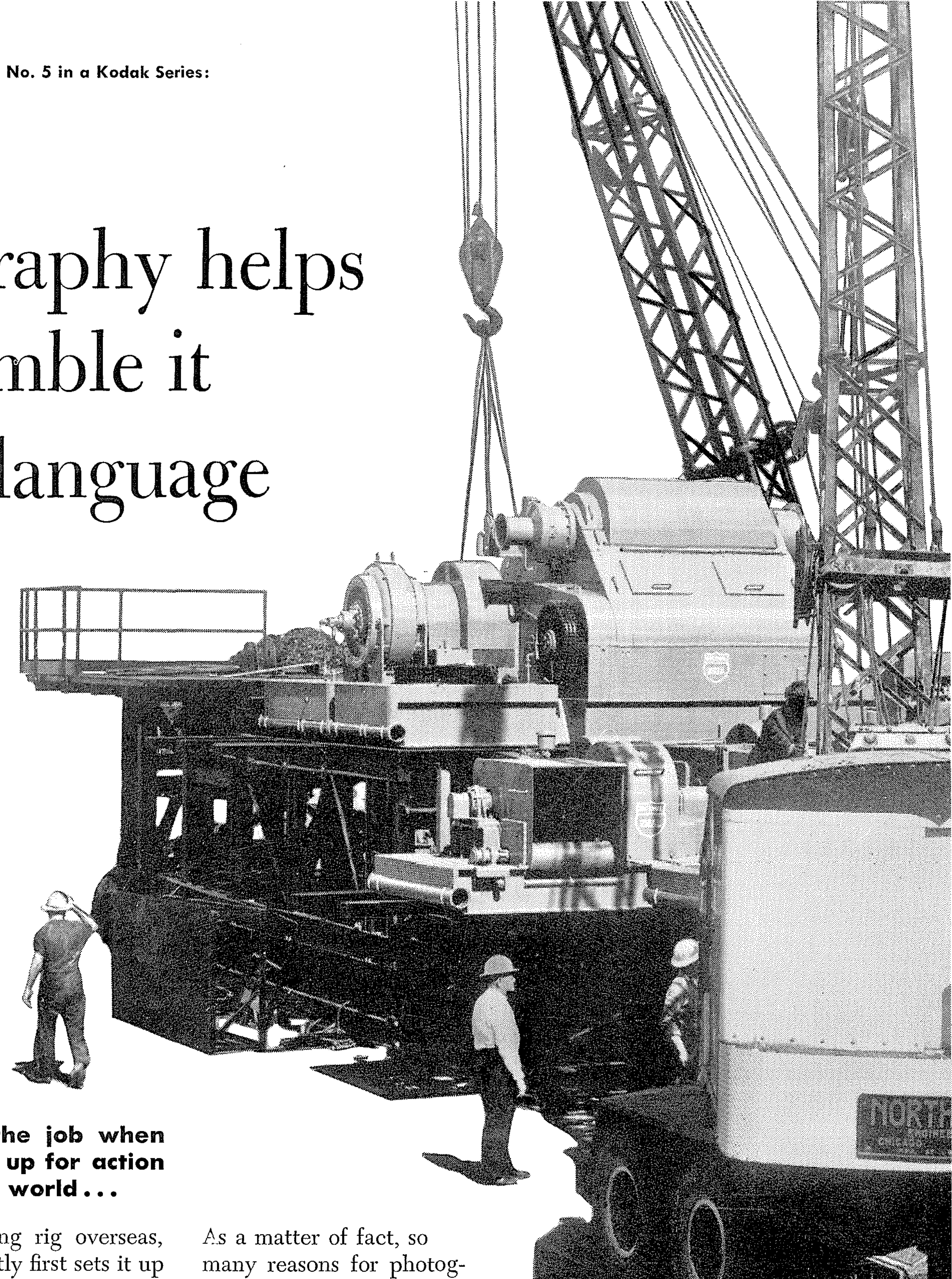

Pictures help boss the job when this drilling rig is set up for action half way around the world . . .

Before shipping a drilling rig overseas, National Supply frequently first sets it up here for tests and paints the complex parts in *coded colors*. Then a color photograph is made.

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National Supply's experience is an example of how photography saves time, cuts cost, reduces error, improves output.

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