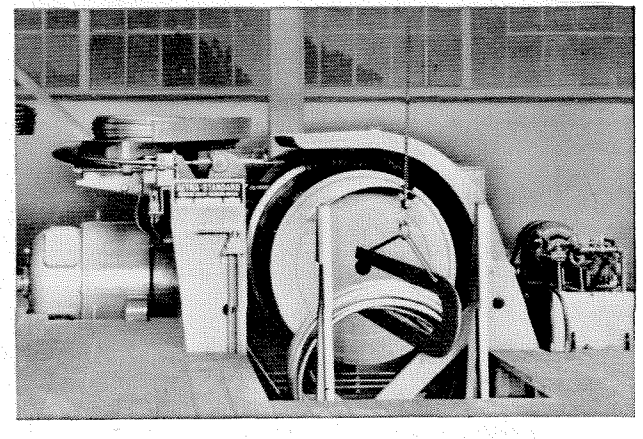
ENGINEERING | AND | SCIENCE

APRIL/1952

Faculty Portrait . . . page 21

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Another page for **YOUR BEARING NOTEBOOK**

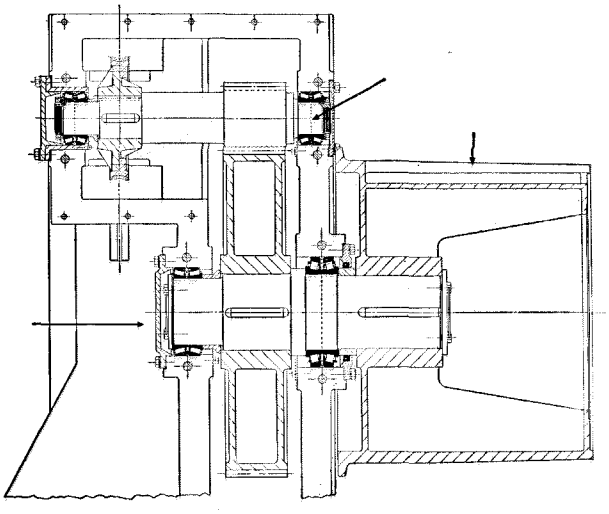


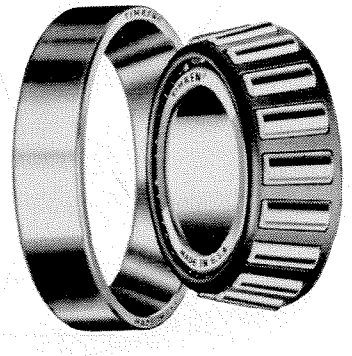
How TIMKEN® bearings help a drum stay fit as a fiddle

This horizontal bull block draws tubing at 150 to 600 feet per minute. The overhung drum on which the tubing is coiled exerts a 20,000 pound pull. To carry this heavy load, design engineers mount the drum shaft on Timken® tapered roller bearings. Due to line contact between rollers and races, Timken bearings provide extra load-carrying capacity. Their tapered construction enables them to carry radial and thrust loads in any combination. Shafts are held in rigid alignment. Wear is reduced, long life assured.

Mounting shafts on TIMKEN bearings

Power input shaft and drum shaft of the horizontal bull block are mounted on two-row, non-adjustable Timken bearings. The left-hand bearing on each shaft is fixed while the bearing on the opposite end of the shaft is free to float. The fixed bearing cup in the power input shaft is mounted in a cartridge to provide an adjustment for the worm wheel. Lubricant is carried to the bearings by means of a circulating oil system.





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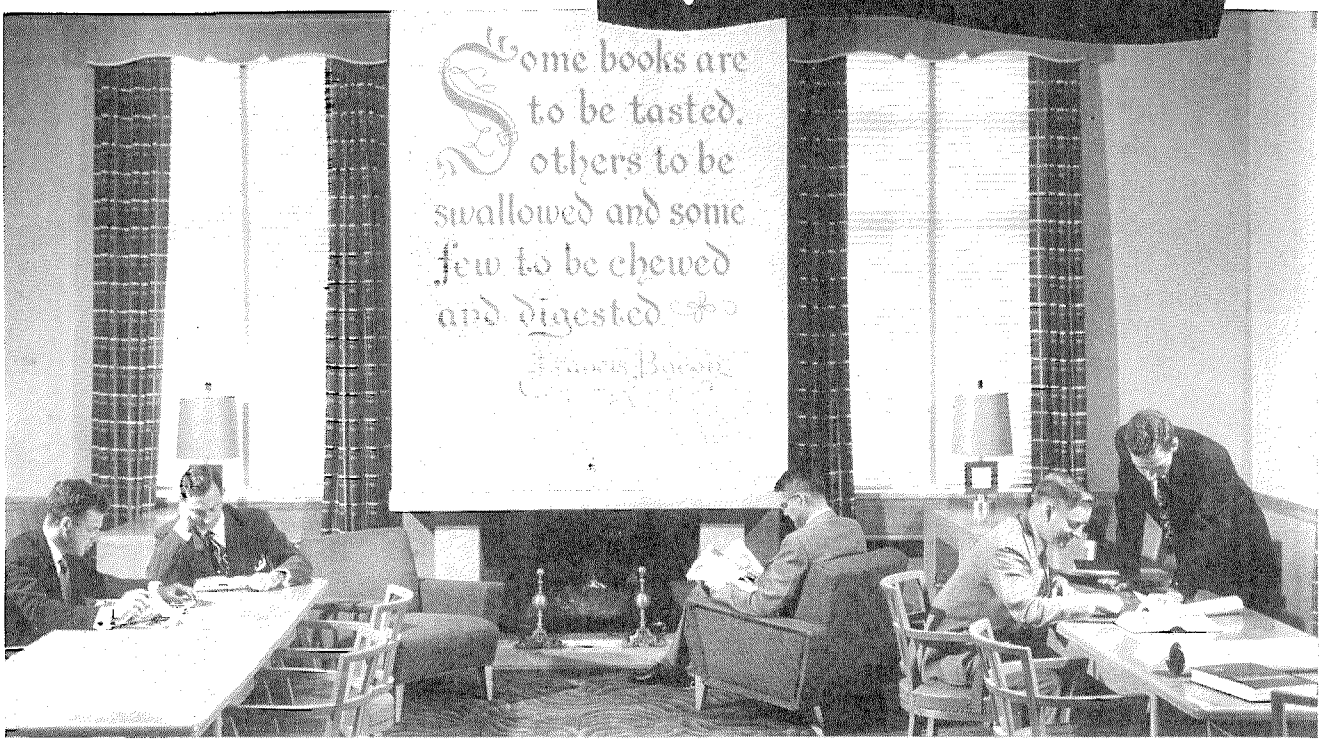
. . . to help you Achieve Success



To get a quick start on the road to success, engineering graduates who join Westinghouse start with an orientation and training program at the new Educational Center. The reading room shown above is one of the many facilities available at the new Center. To aid in carrying out the program, there are also modern classrooms, auditorium, cafeteria, hobby rooms and recreation areas.

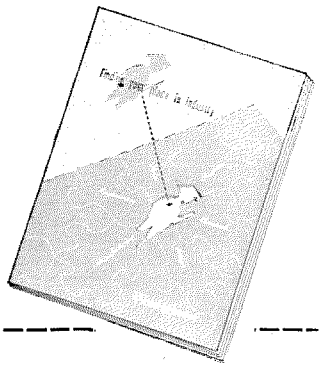
Regardless of the type of career you wish to follow in industry, the Westinghouse Plan will be of value in helping you achieve success.

A major part of the Plan is the Graduate Student Training Program. It has been carefully developed through 50 years to enable top men, selected in leading colleges, to choose their careers wisely from the wide variety of opportunities available at Westinghouse. This method enables you to become a responsible factor, quickly, in one of America's great industrial organizations.

Getting men started right is so important to Westinghouse that millions of dollars have been spent to develop this Plan, provide the facilities and assemble and maintain a staff for this job.

Experience shows that from this Training Program come most of the key personnel, in research, engineering, manufacturing and sales throughout the Company.

For detailed information about the Westinghouse Plan send for a copy of —"Finding Your Place in Industry". G-10173



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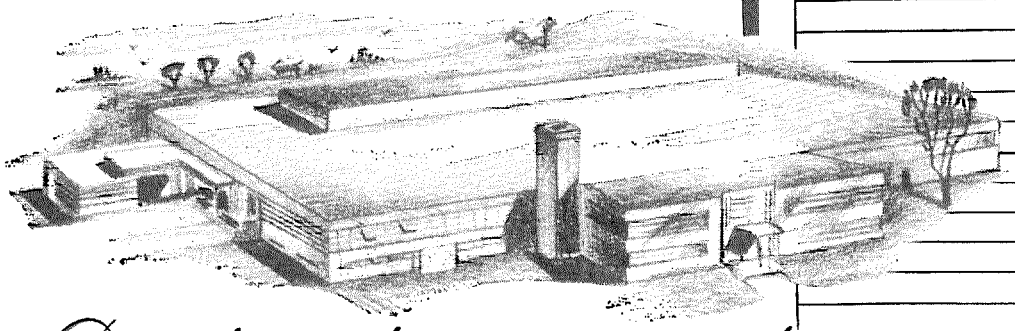

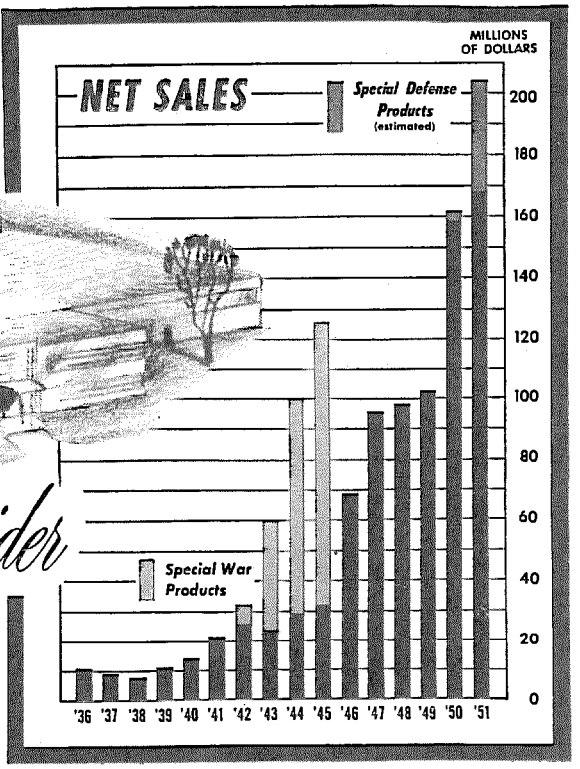

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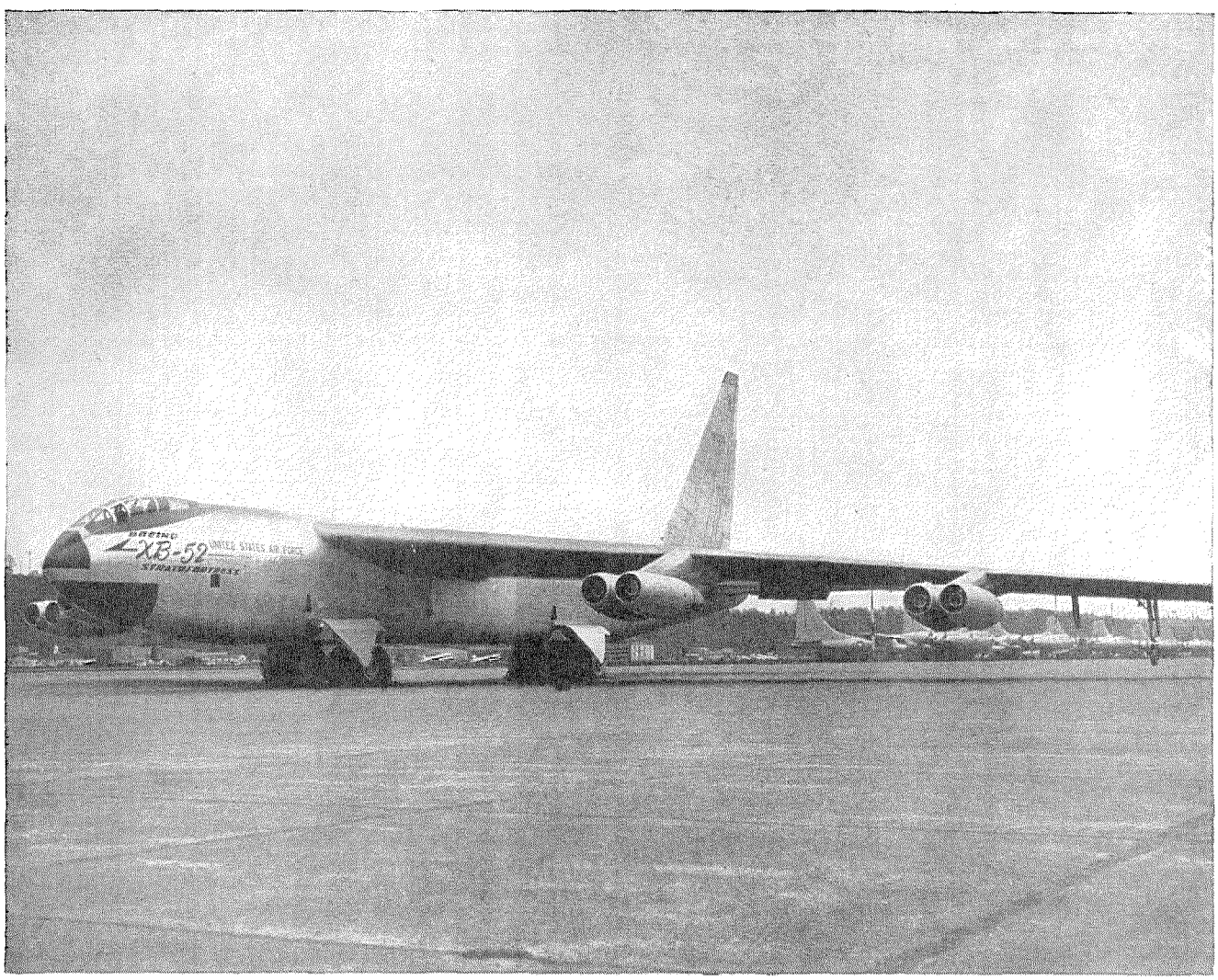

Engineering secrets are under her skin

This is the first official photo of the giant Boeing eight-jet XB-52. It's America's new all-jet heavy bomber, and another trail-blazing product of Boeing engineering leadership. Still highly classified, Boeing's most revolutionary developments are out of sight, under the XB-52's gleaming skin.

The B-52, vital to America's defense plans, is just one of the challenging projects Boeing engineers are at work on. Others include guided missiles, supersonic research, and the B-52's team-mate, the six-jet B-47 medium bomber, now in quantity production.

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BOOKS

THEY WENT TO COLLEGE
The College Graduate in America
by Ernest Havemann and
Patricia Salter West
Harcourt, Brace, New York $4.00

This book began as a reader survey for *Time* Magazine in 1947. But, like a similar survey started by *Time* in 1940, it grew into a full-fledged book. It is based on a questionnaire sent out to college graduates (from the class of 1884 all the way up to the class of 1947), which brought replies from 9,064 graduates of 1,000 colleges.

Of the two authors of *They Went to College*, Patricia Salter West is responsible for the statistical breakdown—a job that took her two years and became her doctor's thesis at Columbia University—and Ernest Havemann, a *Life* editor, for making the statistics as palatable as possible. Between them they have turned out a book which can serve as a kind of model of how to make statistics both interesting and understandable. Even the charts (and there are 52 of them) are readable.

If these college graduates had it to do over again 98 percent would go to college again, and 84 percent would go to the same school. Most would repeat the same majors.

Seventy percent thought their college courses had helped them a lot in their present occupation. Those who specialized were more pleased with their choice of courses than those who didn't—and those who didn't specialize in college would exchange at least part of their education for greater vocational training.

In 1947 the median income of all working males in the United States was $2200. Median earnings of these college men were $4689. Doctors earned most, then lawyers, dentists, businessmen, in that order. Earning power of college graduates increases with age.

The Greasy Grind, who makes a string of A's in school and never goes out for any activities, makes more money than his better-rounded classmates.

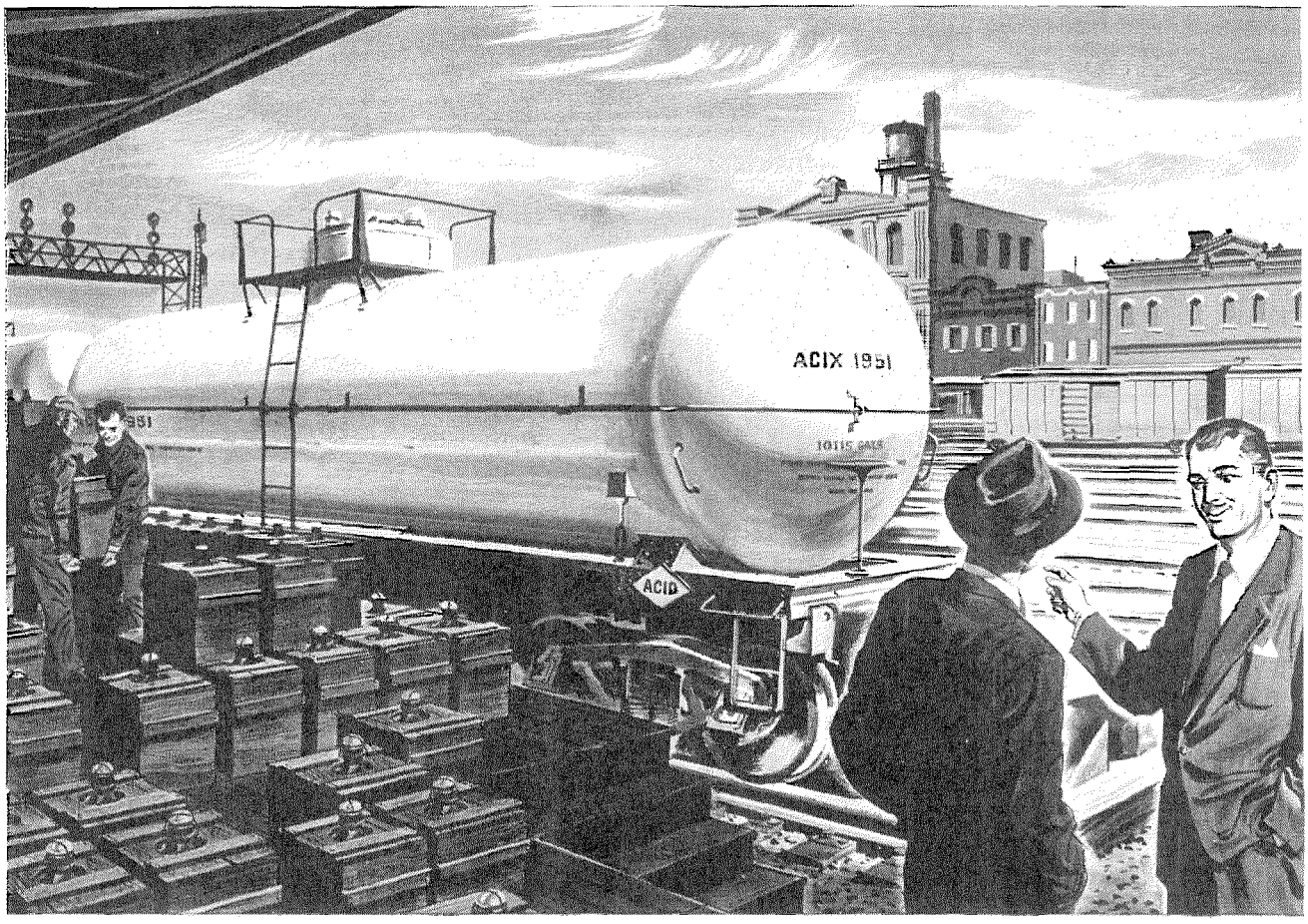
Graduates who had to earn part or all of their college expenses (71 percent of the group, by the way), have lower incomes than those who had their way all paid for them.

Students who went to the wealthiest schools—those with the highest endowments—make the best incomes.

Among men, there are practically as many graduates in engineering and the physical sciences as there are in the humanities. Of the humanities graduates only about four out of ten men actually went into the careers they had planned on, and the majority of them had a harder time getting started than the science and engineering men did.

The majority of science and engineering men leave their home grounds after graduation, though only about 44 percent of all college graduates do this.

This small dose of statistics is a sample of the kind that make up *They Went to College;* a lot of them are just what you'd expect, but there are enough surprises to keep you reading all the way through. For example, to quote one more, college graduates are far from being radical; they are, in fact, depressingly conservative. Sixty-four percent of those surveyed were anti-New Deal, and the large majority voted just exactly the way their fathers did before them.



This car replaced 615 "Bottles"

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Together with tank car builders, we have developed improved riveted and welded car designs, which are now "standard." Today there are over 1,300 aluminum tank cars carrying the fussy compounds that formerly traveled only in small containers.

This is typical of the development jobs we do at Alcoa. Others are under way now and more are waiting for mechanical, metallurgical, electrical, chemical and industrial engineers having the imagineering skill to tackle them. Perhaps you may be one of those men. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pa.

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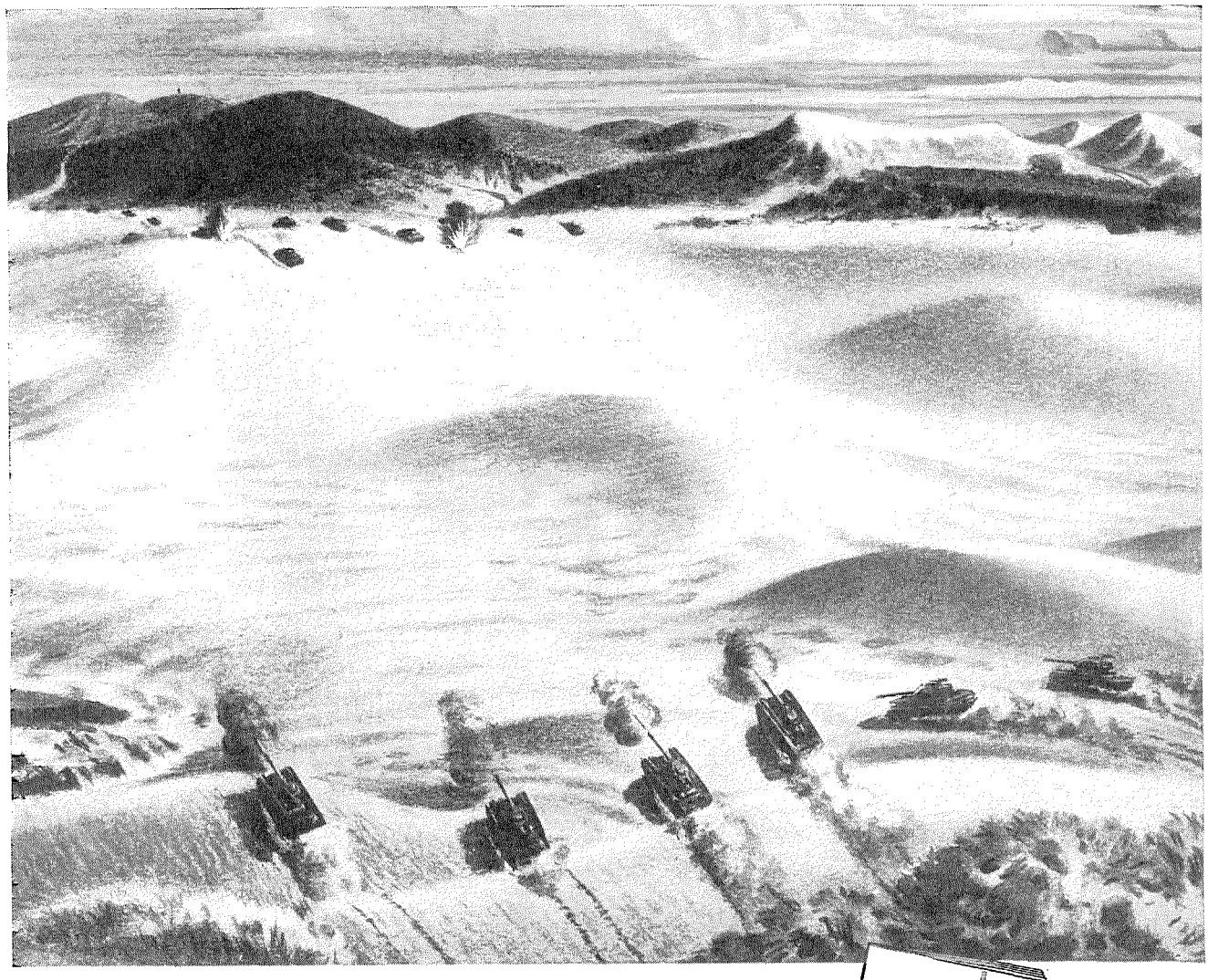
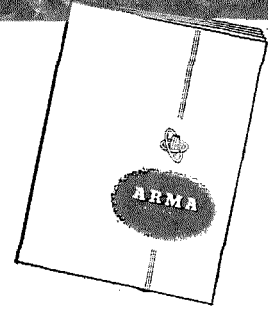


Hitting modern military targets poses ever-new engineering problems



This booklet — "Engineering at Arma" — describes in detail the challenges of an engineering career at Arma. It can open new horizons to you. Write today for your copy to Engineering Division, Arma Corporation, 254 36th Street, Brooklyn 32, N. Y.

Increasing emphasis in speed and mobility in modern warfare intensifies the problem of destroying the target — takes it out of the reach of manual ability and into the realm of electronics. Electrical and mechanical engineering — of the highest skill and ingenuity — are required.

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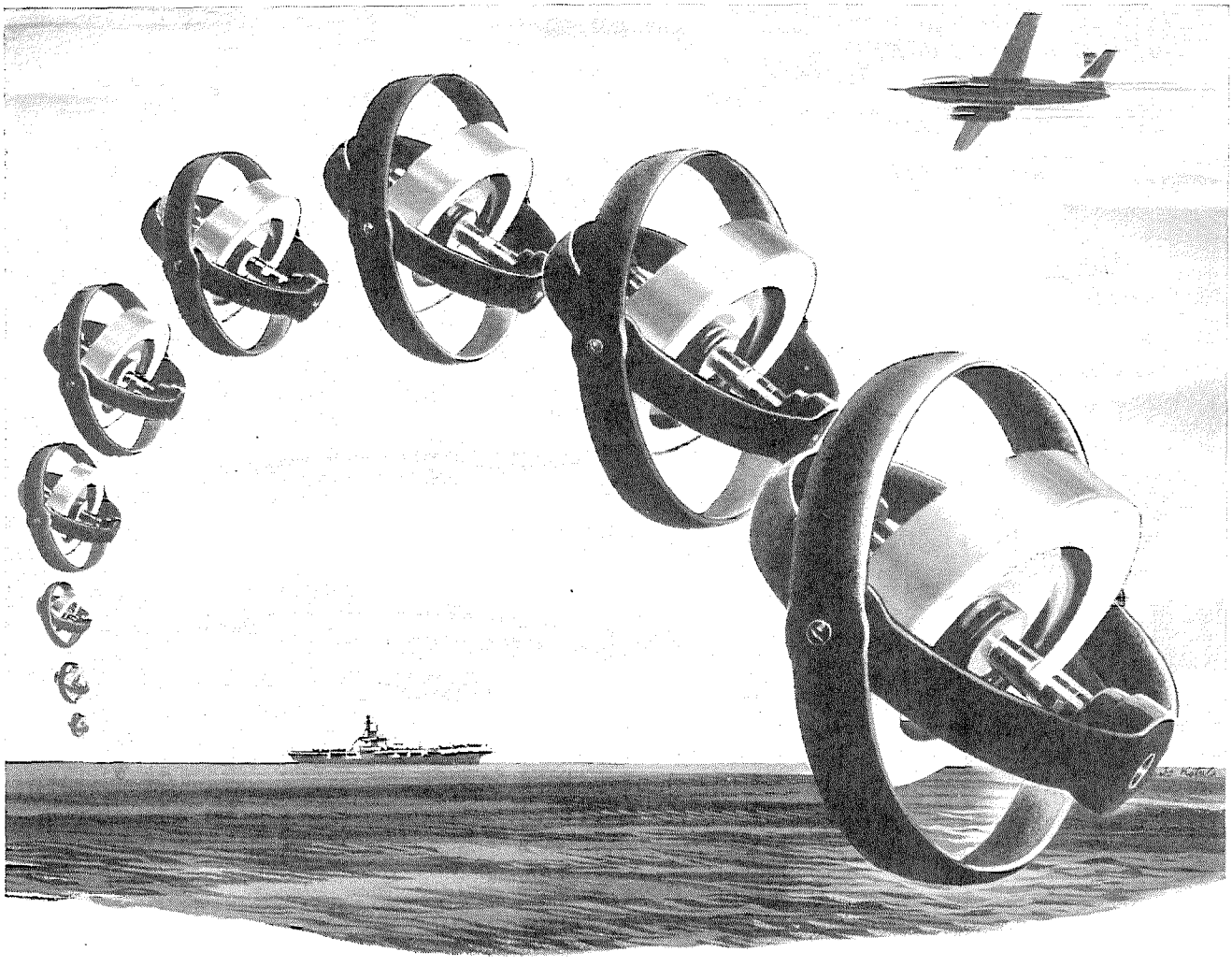

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Sperry sponsored the development of the klystron tube — the first practical source of microwave energy. From Sperry pioneering have come a complete line of Microline* instruments for precision measurement in the entire microwave field.

We want more men like those who have built up this fine record for Sperry — men who can think and work creatively, and get a thrill out of tackling and solving tough problems. It will pay men with such qualifications to write . . .

Employment Section 1 A 5

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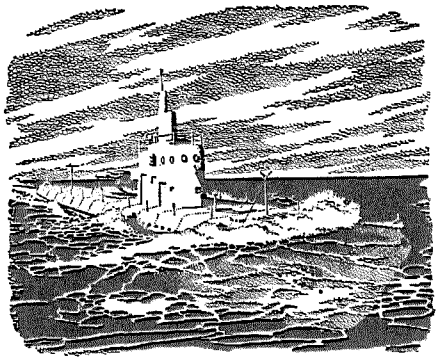
How Honeywell Engineers help make it possible for a sub to dive swiftly and safely



It's a tense moment aboard a U. S. Navy submarine when the signal for diving stations electrifies the crew.

And to make sure all preparations have been *properly* made for a swift, safe descent—submarines are equipped with a panel of colored lights like the one shown below aboard the *U.S.S. Silversides*. Submariners call it the "Christmas Tree," because when all valves and hatches are closed the whole panel glows green.

Important to the "Christmas Tree" are tiny switches—that *must never fail*.

That's why, in choosing the hundreds of precision switches found in every submarine, the Navy selects dependable, proven MICRO Precision Switches, produced by Honeywell.

And this is only one of many vital functions Honeywell devices perform in the fields of marine controls, aviation, guided missiles and atomic energy.

Today, fabulous new controls for many fields are being developed by the men in our expanding engineering and research sections, who find their work often calls for fascinating study in the realm of pure science.

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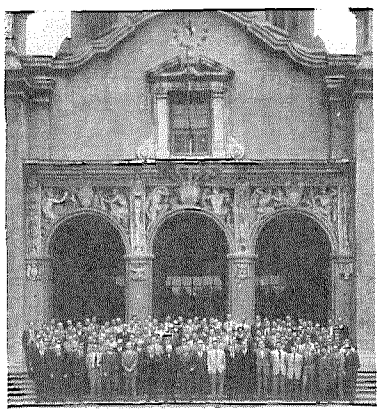
IN THIS ISSUE



This month's cover shows the Caltech faculty assembled on the steps of Throop Hall. If it isn't the *entire* faculty (and it isn't) it is probably as many of the members of the teaching staff as will ever be corralled for a group portrait. The occasion? A shot for the Caltech movie, "Choose Your Future." There's some further information on that, along with a closer view of the assembled faculty, on page 21.

Dr. Findlay Russell, who wrote "Poisonous Fishes" on page 11 of this issue, is a Research Fellow in Biology at the Institute, working in the department of physiology. He is also associated with the School of Tropical and Preventive Medicine at Loma Linda, California—and is a practicing physician in Alhambra.

You've probably heard of the impressive results that have been obtained from adding fluorides to public water supplies—in cutting down on tooth decay in children. In his article in this issue, Prof. McKee, Associate Professor of Sanitary Engineering at the Institute, proposes a plan which sounds as though it would have even *more* impressive results. "Fluorides" is on page 15.

On page 18, Jack L. Alford, Research Fellow in Applied Mechanics at the Institute reports on recent work here on structural effects of earthquakes.

PICTURE CREDITS

Cover	James W. McClanahan
p. 18	William V. Wright
p. 21	James W. McClanahan William V. Wright
p. 26	Art Streib Studio

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The new 14-building research center of the Union Oil Company of California is unique in many features of design. Here, a research staff of 250 will have every modern facility for developing products that will shape the company's future progress.

The same future-minded attitude was maintained toward plant operating costs by the architects and engineers who specified equipment. To insure lasting efficiency and maintenance economy, they chose Jenkins Valves for more than 3,000 control points on the miles of steam, water, sanitation, fire-control, and other pipelines essential to operations.

Like so many of the nation's top-flight building specialists, these men have confidence in the *extra measure* of efficiency and endurance built into Jenkins Valves.

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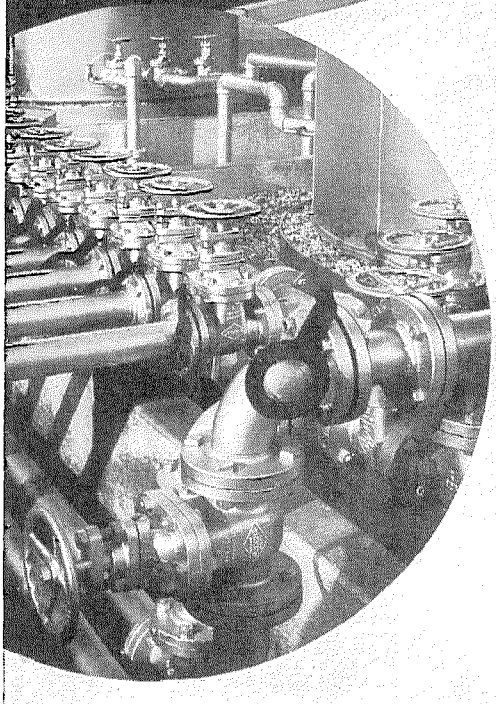

SOME OF THE 3000 JENKINS VALVES *installed at the new research center. Many structural innovations, designed to simplify maintenance, are unique in this plant. Tunnels between buildings carry all pipelines; make them readily accessible. Air-conditioning system supplies 100% fresh air to laboratories at all times. The administration building, shown above, is one of 14 major buildings on a 100 acre site.*

JENKINS
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Native fishermen gather specimens of poisonous fishes for Caltech investigators on Canton Island, in the South Pacific. Specimens are collected by fishing, netting, diving and spearing, poisoning the water, and sometimes even by blasting.

POISONOUS FISHES

In recent years fish poisoning has taken on world-wide medical significance. It's a problem that embraces important military, economic and investigative problems too.

by FINDLAY RUSSELL

FISH POISONING, or—to give it its technical name—ichthyotoxism, implies poisoning due to the ingestion of fish, quite exclusive of bacterial contamination. Of the hundreds of families of fishes about 15 are poisonous to man; by species, about 400. Not all the fishes of these 400 species are poisonous, however. Nor are all poisonous fishes toxic at the same time—or even in the same place at the same time. Toxicity may differ not only from species to species, but also from fish to fish, in the same virulent group. A species of fish that was edible five years ago may be toxic today. In some species only the gonads may prove to be poisonous, while in another —or even in the same species—the entire fish may be toxic.

Constantly confusing, the problem of fish poisoning embraces a number of important medical, military, economic and investigative problems. It has *been* a problem for centuries. In ancient Japan, for instance, it was known that one kind of tetraodon (commonly known as the puffer) was "absolutely mortal . . . no washing or cleansing will take the poison off . . . it is therefore never asked for but by those who intend to make away with themselves."

Fish poisoning is not always fatal, of course. In 1774 Captain James Cook, quite by mistake, ate a tetraodon liver and roe while off New Caledonia, and recorded his symptoms as follows:

"About 3 o'clock in the morning we found ourselves seized with an extraordinary weakness and numbness all over our limbs. I had almost lost the sense of feeling, nor could I distinguish between light and heavy bodies —a quart pot full of water, and a feather, being the same in my hand. We each of us took an emetic and after that a sweat which gave us much relief. In the morning one of the pigs which had eaten the entrails was found dead, he being swollen up to an unusual size."

A world-wide problem

By the beginning of this century and with the advent of modern communications the problem of fish poisoning had taken on world-wide medical significance. Over 500 deaths a year were being reported, and another 500 victims probably died undiagnosed. From 1913 to 1923 in Japan alone 6137 cases of fish poisoning were recorded. Of these, 906 were due to the tetraodon, with over a 64 percent fatality rate. Today less than 100 people die of fish poisoning each year, though it is safe to assume that there are as many as 2,000 or 3,000 non-fatal cases.

During the past five years the fisheries resources in the Central and South Pacific have expanded enormously. With this expansion has come a greater need for a more thorough study of where and when the commercial fisherman may take his haul. The danger of depleting some fishing grounds while leaving others relatively untouched because of a lack of ecological information on poisonous fishes has become a very real problem.

Military situation

During the war in the Pacific several occurrences of fish poisoning hindered the successful completion of military missions. In one report a 30-man crew of a Navy landing craft, after eating a 50-pound poisonous barracuda, became so ill that it was necessary for a relief crew to man their vessel. In another incident eight members of a U. S. Army ship were put to port and hospitalized after eating a poisonous snapper. Small wonder, then, that in the last three years the military has become one of the principal supporters of the research activity directed toward solving the more clinical aspects of the problem.

Lessons learned from the Japanese during the last war point to the importance of using fish as a basic food for combat units. Downed air men must often depend to a certain extent on fish if they are to survive. Some smaller naval units of the Japanese fleet are known to have increased their range from home base by almost a third by utilizing fish in place of stored foods. Isolated units, especially in the South Pacific, must often depend entirely on the sea for their source of fresh meat.

A daily problem

To the many island races that depend upon the oceans for fresh meat, poisonous fishes present a daily problem. These islanders have all kinds of ways of detecting which fish are poisonous and which are not. They range from studying the effects of moon rays on the skin of the fish, to the feeding of the suspected catch to another animal. As you might expect, the number of cases of poisoning is highest where the superstitions are greatest —though sometimes the islanders' superstitions are sufficient to protect them from a possibly toxic fish.

On the whole, poisonous fishes are not as tasty as non-poisonous ones. Often their smell or consistency is such that they are readily discarded on being caught. The most suitable information we have on how the islanders tell when a fish is poisonous is that which has been passed down through the decades, based an actual poisonings. Though this method has its limitations—since toxicity may change—it offers an adequate basis on which the islander may select his fish with a reasonable degree of safety.

In those areas where there is an abundance of rodents, the fish is often fed to these animals to determine the toxicity. Some islanders feel that they are able to identify a poisonous fish by the color of the palatine structures, or by the direction of the gill rakers. Others determine the toxicity by placing a silver coin on the skin of the fish and watching to see if the coin will turn black. Still others will throw a piece of the fish onto an anthill. If the ants refuse it, they do the same.

Of these varied methods, none are entirely satisfactory either for the individual or the commercial fisherman.

Identification

Thus the first barrier for the investigator is to determine which fish are poisonous and which are not. Oddly enough this is relatively a new problem and most of the attention directed towards solving it is being supplied by governments and industries interested in the economic productivity of the seas.

The job of identifying and classifying the hundreds of poisonous fishes is, of course, extremely complicated, but enough information has been collected during the past ten years to make present progress more rapid.

Fish poisoning is often designated, probably somewhat ambiguously, by area groupings of fishes causing the poisoning. There are three main groups. The Caribbean type of poisoning—which is the least virulent, incidentally—is most commonly caused by the giant barracuda, and the amberjack.

Dr. Findlay Russell examines and classifies various poisonous fishes before grinding them up and extracting toxins.

The second grouping is the Pacific type, often caused by the giant barracuda, trigger fish and snapper.

The third type is tetraodon poisoning, caused by the puffer or balloon fish. Puffers—not all of which are poisonous—are found in most of the warm seas of the world, but are most common about the isles of Japan.

A matter of taste

If, for example, one were to eat an ounce of the flesh of *Tetraodon hispidus*, a small puffer known to be highly poisonous, what could he expect to experience?

The immediate symptoms would be confined generally to complaints of perverted sensory function about the mouth—though several victims of tetraodon poisoning are known to have expired in less than twenty minutes after eating one of these fish. Within a period of three hours, complaints of nausea, abdominal pain, severe headache and difficulty in swallowing and articulating would be in evidence. There would be a marked weakness of the extremities, coupled with severe pain and tingling of the hands and feet.

Deep reflexes would probably be absent, as would the pupillary response. Difficulty would be experienced in co-ordinating walking movements, and symptoms of shock would probably develop. Within four or five hours after the onset of symptoms, death would result. Not all victims lapse into shock, however; some die in respiratory paralysis or from secondary complications.

If one were to eat of another unpleasant little creature of the snapper family, *Lutjanus gibbus*, he would probably become violently ill, though not a fatality. Again the symptoms of perverted sensory function about the oral cavity would appear, followed by vomiting and diarrhea. Severe pain in the extremities and an itchiness over the body would put the patient to bed, where all movement would be avoided. The chief complaint would concern an altered sensory function, which the patient might interpret as being an inability to perceive cold objects and to identify pain correctly. For several weeks the victim might complain of indisposition, weakness, loss of appetite, paresthesia and occasional dizziness. Complete recovery in most cases requires from two to six weeks, although some symptoms have been said to persist for as long as three months.

Treatment

As the exact nature of the poisonous substances is unknown, treatment tends to be symptomatic. Such measures as gastric lavage, intubation and oxygen administration and the combatting of secondary infections which often develop, are indicated. Combatting shock with intravenous solutions and appropriate medications as well as allaying the pain with calcium gluconate and Demerol is often necessary.

Why fish poisoning occurs

A good deal of speculation has gone into explaining why fish poisoning occurs. The Carribbean type of poisoning has been attributed to the eating of the poisonous manchineel berry which grows on a plant along the shorelines in that area. The seed is said to fall into the

water, where it is eaten by certain fishes which then become poisonous.

But the manchineel berry, rather locally distributed in the Caribbean, is certainly not responsible for the poison found in the tetraodons off Japan. It is not even certain that it is responsible for the poison in the fishes of the Caribbean. The berry has never been found in the stomachs of these poisonous Caribbean fishes—nor have the stomach contents of the poisonous and non-poisonous Caribbean fishes revealed any remarkable differences.

The proof or rejection of the theory would of course lie in a controlled feeding experiment, which, unfortunately, has never been undertaken. It can be noted too that the giant barracuda which is poisonous in the Caribbean is not a berry eater and, in an aquarium, cannot be induced to eat the suspected seed. In the case of the barracuda, at least, it seems likely that the maturity of the fish has more to do with the presence of the toxin than the diet.

Report from Fanning Island

A second theory frequently proposed and more recently discussed by S. G. Ross can be better substantiated. Ross was employed as the medical officer on Fanning Island in the Central Pacific from 1946 to 1948. According to him, there was a negligible number of fish poisoning cases on the island previous to 1945. In October of 1945 the allied governments dumped huge amounts of tank mines, ammunition, copper wire and other metals not far from the island. Four months later there were ten cases of fish poisoning within a thirty-day period. From February, 1946 to April, 1947, there were 95 cases in all. Ross reported these findings in November, 1947. Although no accurate records were kept, the number of cases of fish poisoning on Fanning Island gradually decreased after Ross's departure at that time.

Natural—or man-made?

There is no doubt that certain edible fish became inedible within the course of a few months in the vicinity of Fanning Island. This change *could* be accounted for by a natural unpredictable fluctuation. If it was due to the dumping of war materials, it is not at all clear whether it was caused specifically by copper, titanium or some other metal.

Unfortunately, there is no record as to whether or not large numbers of fish were killed in the dumping operation near Fanning Island. Nor are there any reports from other areas where similar war supplies were scuttled.

Another possibility

Still another theory concerning fish poisoning is that fish which feed largely on coral life become poisonous. This hypothesis would have to exclude a large number of poisonous fishes whose denticular anatomy is such that coral feeding would be impossible or at least highly improbable. There are, however, some poisonous species which feed almost entirely on coral animals, and in turn these animals have been found abundantly in their stomachs.

Of course, only controlled feeding experiments will indicate the importance of this theory. Many of the suspected molluscs on which some species of poisonous fish are known to feed have not proven poisonous to man. Coral itself has never been found to possess elements that are poisonous in their natural combination in the coral.

Food-chain relationship

The theory held in best repute among the remaining ichthyologists seems to be that the toxin is derived from a poisonous seaweed, alga or echinoderm, on which the fish feeds. As yet these suspected agents have not been identified, although several investigations at the present time seem to indicate that this food-chain relationship may play an important part in the etiology of the poisoning.

In spite of obvious criticisms to these presentations, they may all contribute significantly to the causation fact or factors. It is possible to divide these theories into two assumptions:

1. That toxicity is produced through factors of environment.
2. That toxicity is produced through food ingested by the fish.

Another influence which may prove to be more important than either of the above is related to the role of certain genetic factors. The alteration of several metabolic functions related to hormone production in certain poisonous fishes may play an important part in the production of these toxins.

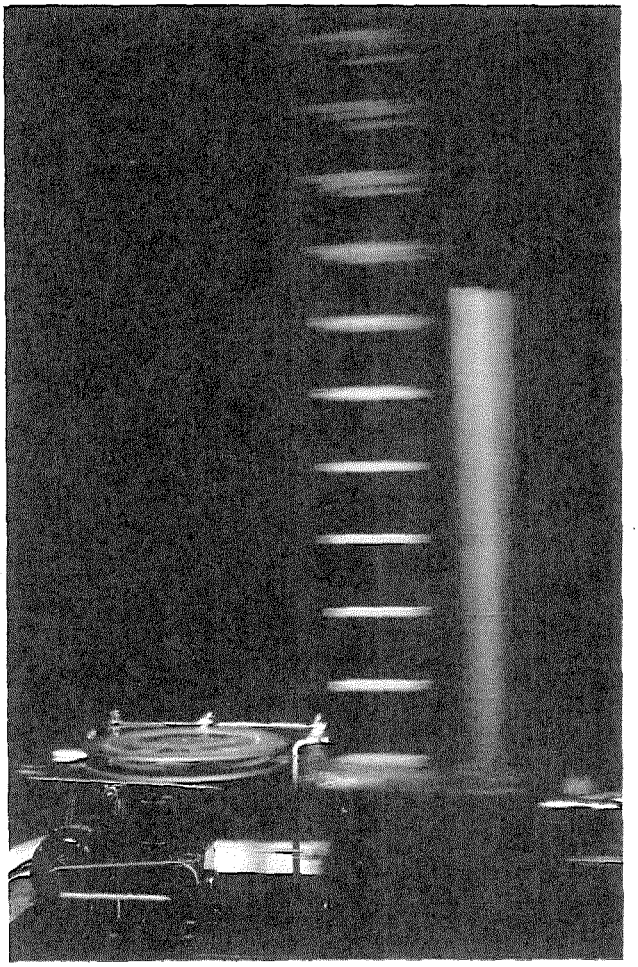
Current investigations

Investigations pertaining to the poisonous fish problem are being conducted in several institutions at the present time. At the School of Tropical Medicine in Loma Linda, California, a very detailed study is being made into the taxonomy and ecology of these poisonous fishes. The work at Caltech is concerned principally with the physiological and pharmacological activity of these poisonous extracts. Studies will also be made into certain hormonal and enzymatic influences, as well as several genotype peculiarities in these fishes.

In retrospect, the significance of the problem can readily be seen. The questions that confront the investigator are numerous and perplex not only to the scientist but to the fisherman, the packer, the soldier, the doctor and the housewife. Within the next five years sufficient progress should be made towards solving the conflict in our existing data and perhaps establishing a firmer insight into the fish poisoning problems.

STRUCTURAL EFFECTS OF EARTHQUAKES

by JACK L. ALFORD



Shaking-table performance of a model building provides a qualitative demonstration of earthquake effects.

AT IRREGULAR INTERVALS public attention is captured by reports of loss of life and damage to property sustained during catastrophic earthquakes, such as those which occurred at San Francisco in 1906, at Tokyo in 1923, and at Long Beach in 1933.

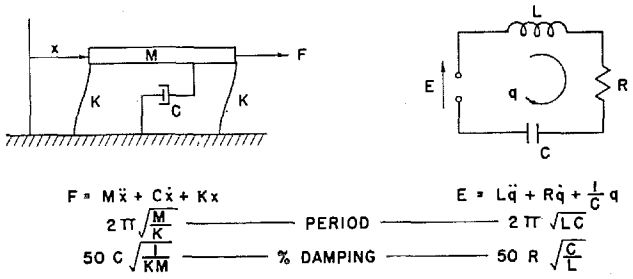
This attention, although intense, is short-lived and, during the period between catastrophic shocks, interest in earthquakes is confined to a relatively small group of scientists and engineers. These men, while interested in the same natural phenomenon, actually study different aspects of it. One way of describing this difference of viewpoint would be to say that the scientist, or seismologist, is interested in the earthquake for itself and for what it tells him about the structure of the earth; the engineer, on the other hand, is primarily interested in the effects of the earthquake upon engineering structures.

The first group has long been ably represented at the Institute by Professor Gutenberg and his associates in the Division of Geological Sciences and at the Seismological Laboratory. It is perhaps less generally known that a small but active program in engineering seismology has been conducted for many years under the leadership of Professor R. R. Martel, and (in recent years) of Professor G. W. Housner.

The central question of engineering seismology is: "How shall structures be designed to withstand the dynamic stresses developed during an earthquake?" The main features of the problem are well understood; structures resting upon the ground are subjected to vibratory excitation during an earthquake and their response depends upon their size, shape, mass, rigidity, damping characteristics, and the properties of the soil upon which they stand.

If our knowledge of all these factors were complete, structures could be designed in accordance with the principles of mechanics so that allowable stresses in the building materials would never be exceeded. Unfortunately, our knowledge of these factors is *not* complete; it is not possible to predict the intensity of an earthquake and it is questionable whether all of the dynamic properties of a building can be determined before it is erected.

The development of design procedures, therefore, cannot be wholly analytical. Some features must be decided on the basis of experience, judgment, and standard practice. Concerning some features of design, information is sufficient for general agreement among engineers; concerning others there is disagreement, as



An idealized structure and its electric circuit analog. The identical form of the differential equations for the two systems is the basis of a quantitative analogy.

a critical comparison of the seismic force requirements of the various building codes will show. The purpose of research in engineering seismology is to reduce this area of disagreement.

Attack on the problem of earthquake-resistant design has used three principal approaches. The first of these has been the study of buildings damaged during actual earthquakes; such a study was made by Professor Martel in Long Beach following the earthquake of March 10, 1933.

The second approach has been to subject scale models of structures to simulated earthquakes in the laboratory. This method has not been employed at Caltech, except in a qualitative way, because of the difficulty of simulating satisfactorily in the laboratory either the earthquake accelerations or the building properties.

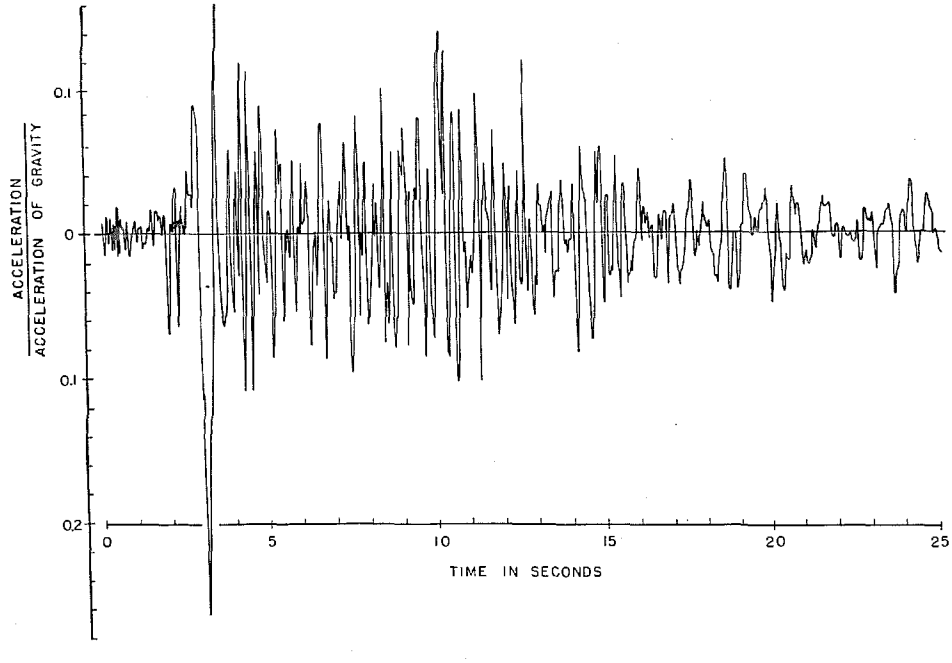
The third principal technique used in engineering seismology investigations has been analysis of the response of structures to transient base accelerations. Recent work at Caltech has been of this type.

In the initial stages of the analytical treatment, only the simplest of structures is studied; in its ideal form it becomes the simple oscillator shown at the left of the diagram above. Acceleration of the base of the ideal structure produces inertia forces and, if the form of the base acceleration is known, the vibration problem thus posed can be solved in a straightforward manner. Such solutions are very tedious by ordinary mathematical techniques, however, as may be appreciated from an inspection of the typical ground acceleration record shown below.

This obstacle has been overcome through the use of the Electric Analog Computer (see *E&S* for April, 1949) in the Institute's Analysis Laboratory. An electric circuit which is the analog of the simple mechanical oscillator, as shown at the right of the diagram above, is subjected to a voltage which has the same form as the earthquake ground acceleration. The ensuing response of the oscillator is then observed by displaying the analogous electrical quantity on the screen of an oscilloscope, whence it can be measured (to an appropriate scale).

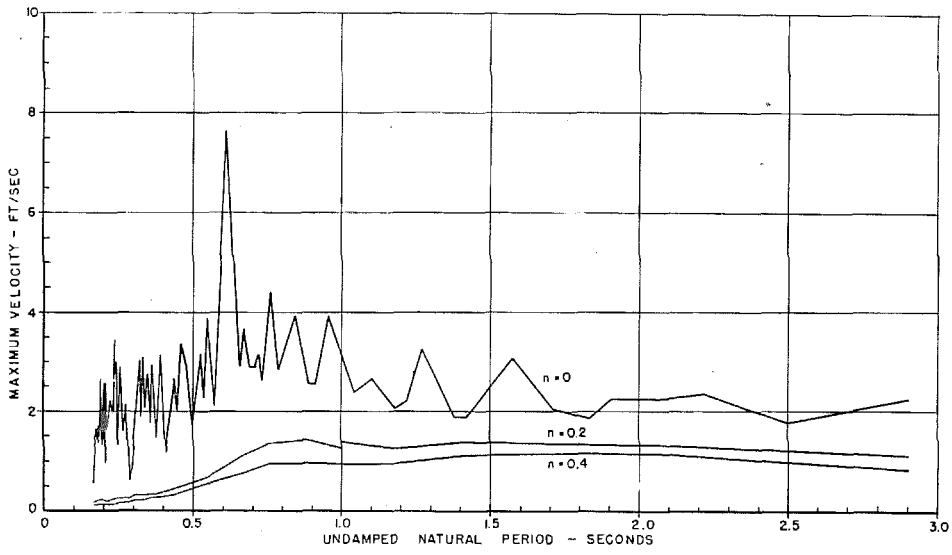
Spectrum of an earthquake

In this manner a graph of the sort shown on page 17 can be constructed; this graph is called the spectrum of the earthquake. The significance of the spectrum is that it separates the characteristics of the earthquake from the characteristics of particular structures. During the past year a study of 88 such spectra was completed at Caltech, covering all of the important strong-motion earthquakes recorded in the United States since 1933. Basic acceleration data for this study were provided by



North-south ground acceleration for El Centro, California, earthquake on December 30, 1934.

Spectrum for the north-south component of the El Centro earthquake whose ground acceleration record appears on page 16.



the U. S. Coast and Geodetic Survey; the program was sponsored by the Office of Naval Research.

Having a large number of earthquake spectra, it is possible to draw some conclusions regarding the general characteristics of past earthquakes. One important conclusion is that the spectra of the strong earthquakes which have been recorded are all similar. This means that, assuming that future earthquakes will have the same characteristics as past earthquakes, simple structures can be designed which are earthquake-resistant in the sense of having equal factors of safety. However, since the intensity of a future earthquake cannot be predicted, an earthquake-proof structure cannot be designed on the basis of present knowledge.

Earthquake-proof structures?

If the analysis which has been outlined were applicable only to the very simple structure that is shown schematically at the top of page 16, it would not hold much practical interest. It is known, however, that the motion of a complicated structure can be regarded as a combination of normal modes, or natural vibrations, and it can be shown that the coefficient of each of these natural vibrations is just the spectrum value described above. Thus, if the vibration characteristics of a structure can be calculated or measured, the means are at hand for calculating its response to the ground accelerations of typical earthquakes. Here again, if it is assumed that future earthquakes will have the same characteristics as past earthquakes, an ideal structure can be designed which will have equal factors of safety at all levels. The earthquake-proof structure remains beyond reach, as in the case of the simple structure.

The spectrum of the earthquake at the top of this page shows several lines, the uppermost of which is called the undamped spectrum, or spectrum for an oscillator which would vibrate indefinitely, once set in motion. Experience tells us that real oscillators come to rest within some finite time and thus that the initial vibration energy is somehow dissipated. As oscillators with more and more energy dissipation, or damping, are treated, it is found that the response to a given base acceleration is reduced. This is the significance of the lower lines, or damped spectra, in the diagram.

Since the damping properties of structures bring about reductions in their responses to base accelerations, it becomes of interest to know how much damping actual structures possess and how much alleviation of earthquake stresses can be expected from this source. In order to obtain such information members of the Caltech group conducted last year a resonant vibration test of a four-story, reinforced-concrete building. This test was made with the cooperation of the Earthquake Engineering Research Institute, a non-profit corporation organized in 1949 for the purpose of promoting research and disseminating knowledge in the field of engineering seismology. The results of the test indicated that the damping of the building's vibration, while not large, was sufficient to ensure a significant reduction of dynamic stresses in the event of an earthquake. Many more tests of this type are necessary before the damping characteristics of typical structures can be established.

Design procedures

Some of the concepts which have been discussed above are embodied in the building code of Los Angeles; however, it must be emphasized that revision of building codes is not advocated on the basis of research results thus far obtained. Any theory which is advanced as a description of natural phenomena must be tested against observation. A peculiar characteristic of engineering seismology is the difficulty of making the necessary observations. Destructive earthquakes (fortunately) occur infrequently, and the time and place of their occurrence cannot be satisfactorily predicted. It may be many years, therefore, before enough reliable data are available to warrant any extensive changes in building codes. Until then prudence requires that design procedures err, if at all, in the direction of conservatism.

FLUORIDES

Added to public water supplies, they cut down on tooth decay in children. But here's a way they might do twice as good a job.

by JACK E. McKEE

THE PRACTICE OF adding fluorides to municipal water supplies, as a prophylactic measure to minimize dental caries, has gained wide acceptance in recent years. Moreover, it is being urged upon many reluctant waterworks authorities by an aroused public. By mid-1951 fluoride was being added to 82 supplies serving a total population of 1,700,000 and approval had been granted for fluoridation of 95 other supplies, to serve nearly 6,000,000 persons. Today, almost every waterworks superintendent in the country is faced with the problem of whether to fluoridate or to try to resist the landslide toward this practice.

The enthusiam for fluoridation of public water supplies is not without reason or merit. Already there are scores of papers in the waterworks and public-health literature that attest to the fact that the presence of natural fluorides up to 1.0 to 1.5 parts per million or the addition of artificial fluorides to water supplies so as to produce concentrations of 0.8 to 1.2 ppm, is associated with 50 to 60 percent reductions in the prevalence of dental caries. Furthermore, it appears to be well established that the presence of 1.0 ppm of fluoride ion in water is not detrimental to the teeth and bone structure of children or adults; nor does it produce unfavorable reactions or effects in industrial process waters used for soft drinks, brewing, food processing, metal plating, chemical industries, etc. Only in the manufacture of ice has fluoride been troublesome, and this effect can be overcome by proper control of the process. Thus, the evidence in favor of fluoridation of public water supplies seems to be so positive and so overwhelming that many people cannot understand why it should not be put into effect immediately at all municipal waterworks.

There are other sides to the question, however, and like the arguments in favor of fluoridation, those in opposition have a certain logic. Natural resistance arises from the waterworks superintendent whose supply originates in numerous wells or surface sources, each of which must be equipped with proportional-feeding fluoridating devices. It has been estimated that the cost of equipment for each source of supply will vary from $1,000 to $15,000, with the higher figures predominating for most municipal sources.

For example, consider the water supply of San Bernardino, California, which originates in 17 separate well fields and surface streams, all of which are pumped directly into the distribution grid with reservoirs floating on the system throughout the city. The initial cost of fluoridating equipment and appurtenances for this city would be at least $200,000, not to mention the problems of servicing and maintaining the equipment.

Such a cost, to be sure, is a small fraction of the total waterworks value and can be readily amortized. On a national basis, the total operating and amortized investment cost of fluoridation has been estimated at from 5 to 15 cents per capita per year, but for San Bernardino the annual cost of amortization alone (at 3 percent interest for 20 years) would be $13,500, or about 20 cents per capita. To this must be added the cost of extra servicing and maintenance as well as chemicals. It is understandable, then, that the complexity and magnitude of such multiple installations cause the public officials to think twice before committing the city to fluoridation.

Perhaps more serious than the cost of fluoridation is the limited supply of fluorides. As more and more cities climb on the bandwagon, the present capacity for production is being approached rapidly by the demand. If several of the large cities should institute the practice, the existing supplies would probably have to be rationed, unless measures are taken to increase production.

An argument against fluoridation of public water supplies arises from the fact that only a small proportion of the water is consumed by children to whom fluoridation will be advantageous. Thus, if a city uses 150 gallons per day per capita, only about 0.3 gpd will be consumed by the average person, or about 0.2 percent of the supply. Assuming that 20 percent of the population consists of children in the ages during which fluoride affects teeth, only about 0.04 percent (four ten-thousandths) of the added fluoride will be serving a useful purpose. Most of the remainder will be flushed or drained into the sewer, or used for garden watering or car washing.

The third and perhaps most vociferous objection comes from Christian Scientists and other religious groups who balk at "mass medication." The same type of opposition

arose several decades ago when proposals were made to add iodine to water supplies in order to counteract tendencies toward goiter. Fortunately, this argument abated with the introduction of iodized salt, the use of which is optional. While many public-health-minded citizens may be exasperated by such opposition of minority religious groups, few of them wish to violate the concepts of religious freedom or to incur the ill will of fellow citizens.

Another reason for urging caution in the hasty adoption of water fluoridation arises from the uncertainties and irregularities of water consumption by children. In his thorough study of food and water requirements of children from one to 12 years old, F. J. McClure states: "Drinking of water is a variable factor, especially among children, whose drinking habits are greatly influenced by muscular activity as well as by atmospheric temperature and humidity. It is likewise true of children's diets especially that the requirement of water is met largely by preformed water in the food or by liquid food, particularly milk. The water deficit made up by drinking water may be a relatively small fraction of the total daily amount of water ingested."

Variation in water consumption

That water consumption varies widely from child to child, and for the same child from day to day and season to season, is evident to all parents. Very few observers of children's habits cite specific data to show the magnitude or the variation of the quantities of water consumed. It is this extreme variation in water consumption that may account, in part, for dental fluorosis in some children while others in the same community have numerous cases of caries.

Granted, then, that the objection to fluoridation of public water supplies have some merit, is there any way that the aforementioned advantages of fluoridation can be achieved without the disadvantages? To answer this question it is necessary to investigate other vehicles, especially pills, tooth-paste, chewing gum, salt, solid foods, and milk.

The first four of these can be ruled out quickly for obvious reasons. Fluoridated pills or tooth-paste, already on the market, reach a very small segment of the population, even when highly advertised. Chewing gum is neither an aesthetic way nor a reliable means to promote prophylaxis. Fluoridated salt would provide fluorides for adults—to whom it would be of no advantage—but very few children like salt on their foods, nor could careful control over the dosage be exercised. The selection narrows, therefore, to food and milk.

The fluoride contents of meats, fish, hen's eggs, cow's milk, citrus fruits, non-citrus fruits, tea, cereals and cereal products, vegetables and tubers, miscellaneous substances and wine have been tabulated by F. J. McClure. With the exception of seafoods and tea, the majority of foods found in the average diet contain from 0.2 to 0.3 ppm or less of fluoride in the food as consumed. Consequently the average diet, exclusive of drinking water, appears to provide 0.2 to 0.3 mg of fluoride daily. Tea was found to contain as high as 398.8 ppm of fluoride in the dry tea, with average values of about 100 ppm, 75 percent or more of which is extracted by boiling water. At 100 ppm, one tea ball alone would provide approximately 0.2 mg of fluoride. Unfortunately, in this respect, children under 8 years of age seldom drink tea. Nor is seafood generally a favorite of the younger set.

Attempts have been made to increase the fluoride content of vegetables, fruits, and grains by adding calcium fluoride to the soil or water in which the plants are grown. The results demonstrate, however, that the fluoride content of the soil or water has little or no influence on the fluoride content of leaves, fruit, or roots. Hence, the possibility of increasing the fluoride content of solid foods, other than by the addition of fluoridated salt, appears to be remote. The search narrows further, then, to liquid foods that are acceptable to and preferred by children; or, in other words, to milk.

The fluoride content of cow's milk, with no unusual fluoride in the cow's ration or drinking water, varies from 0.07 to 0.55 ppm, with a median value of 0.10 to 0.20 ppm, according to McClure. Furthermore, the addition of fluoride to the cow's ration or drinking water has no appreciable influence on the fluoride content of the cow's milk, the added fluoride probably being excreted in feces, urine, and perspiration as it is for humans.

Inasmuch as the natural fluoride content of milk is too low to provide an adequate dietary supplement in the volume normally consumed by children, serious consideration should be given to artificial fluoridation of bottled milk. Such consideration involves questions of assimilation of milk-borne fluoride, quantities and variations of daily consumption, effects of fluoridation on the palatability and nutritive value of milk, universal application, cost, and reception by the public.

Fluorides must be assimilated

To be effective in reducing dental caries, it is apparent that fluorides must be assimilated and carried in the blood stream. Mere contact of the weakly fluoridated liquid with exposed enamel of fully formed teeth seems to have little, if any, prophylactic value—although the topical application of a 2 percent solution of sodium fluoride has been effective in reducing dental caries in 7 to 17-year-old children by 40 percent. For these reasons it is desirable that optimum fluoride intake of water or milk be maintained during the ages from 1 to 10, and that the fluoride be in a form that can be assimilated.

It appears that natural fluorides in food and milk, or artificial fluorides added thereto, are largely available for assimilation. In fact, McClure showed that when no control was exercised over eating and drinking habits, there were no indications of a difference in total assimilation by young rats of water-borne versus food-borne fluorides.

In other tests, McClure, Mitchell, Hamilton, and Kin-

ser, of the U. S. Public Health Service, added 3.50 to 6.00 mg of fluoride per day in the form of sodium fluoride, calcium fluoride, mineral cryolite and bone meal to the food or water of five young men, and measured the fluoride eliminated via feces, urine, and perspiration. The results showed that about 13 to 55 percent of the ingested fluoride remained in the feces and hence was not assimilated. Maximum assimilation (80 to 90 percent) occurred from sodium fluoride in food and water, and from calcium fluoride in water, while less fluoride was assimilated from cryolite and bone meal. Of the assimilated fluoride, about 50 to 80 percent appeared in the urine and 20 to 50 percent in the perspiration, depending upon muscular activity, temperature, and humidity. The total daily intake, even at these high rates of ingestion, appeared to have been eliminated practically 100 percent.

The foregoing tests lead to the assumption that sodium fluoride or calcium fluoride added to milk would be available for assimilation as readily as the fluorides added to drinking water, and that in concentrations of 1.0 to 1.5 ppm almost all assimilated fluorides would be eliminated from the body rather than accumulate in bones or tissues. It has been demonstrated, moreover, that food-borne and water-borne fluorides both have inhibitory effects upon dental caries in rats and both cause mottled enamel when concentrations exceed 1.5 ppm of fluoride. Although sodium fluoride or sodium silicofluoride may form insoluble calcium fluoride with the naturally high calcium content of milk, there appears to be no reason to believe that such fluoride would not be readily assimilable or that it would produce effects different from those of fluorides added to water.

Milk consumption

Milk consumption by children is subject to far less variation, by age, sex, season, or climate, than is water consumption. It is estimated that the average child consumes about 1.5 pints of milk per day. Most children from 2 to 8 years of age drink a glass of milk at each meal and possibly a mid-afternoon or mid-morning glass. Moreover, milk consumption by children does not change much with season, temperature, or humidity, for children tend to vary their water consumption instead. The more-uniform consumption of fluoridated milk than of water should tend to reduce the variations in total fluoride intake from child to child and from season to season and thereby should minimize the probability of dental fluorosis in one child while another in the same community has a deficient fluoride intake.

There are some children, to be sure, who do not drink milk, but they are relatively few in number.* Deliveries of bottled milk in most metropolitan areas cover wider territories than do the municipal water supplies; in fact, many rural areas throughout the nation are well served with bottled milk. In Los Angeles County there are reported to be over 500 municipal and private water companies supplying domestic consumers, with hundreds more in contiguous areas; yet the Los Angeles telephone directories list less than 70 major milk distributors. To reach a high proportion of children through the few dairies would be infinitely more certain than to try to do it through the numerous water supplies. Similar examples can be cited for almost all metropolitan areas.

Detrimental effects?

Any detrimental effects of fluorides upon the palatability and nutritive value of milk remain to be demonstrated. Inquiries of local dairy research staffs and biochemists at local universities have failed to uncover any arguments or proof to show that the addition of 0.8 to 1.0 ppm of sodium fluoride would alter the taste, nutritive value, or enzymes of milk. (I have been adding 0.5 ppm of fluoride in the form of sodium fluoride to the milk used by my family, including three children, and have yet to notice any change in the palatability of the milk, or to receive any complaints from the children.) This is a matter, however, that deserves more thorough consideration and research.

The cost of chemicals for the fluoridation of milk, up to 1.0 ppm, is infinitesimal ($0.000,005 per quart) and the dairies should be willing to absorb the cost as part of routine operations. If it becomes necessary, however, to increase the cost of milk by 1 cent per quart in order to cover added costs of handling, labelling, distributing, and advertising, most parents of small children should be willing to pay the difference, considering the ultimate savings in dental bills.

Finally we come to the question of acceptance of fluoridated milk by the general public. It is sometimes surprising how rapidly the public will accept a new idea and clamor for its adoption in local communities, especially following a few newspaper editorials or advertisements or an article in a national magazine. That the public should oppose the concept of fluoridated milk, especially when its purchase is optional, seems inconceivable. Dairies could advertise the availability of fluoridated milk for families with small children, pointing out that regular milk is still sold for adults or for those who object to fluoridation. This optional feature should appeal to religious groups who now oppose water fluoridation.

This presentation of the possible case for milk rather than water as the optimum vehicle for fluoridation is intended not as a firm endorsement thereof but rather as a stimulant to further thinking and research into the matter. The many arguments in favor of milk as a fluoride carrier are so enticing that some action should be taken by research agencies either to confirm or to discredit them on the basis of sound fundamental data. The author urges such research and welcomes any logical criticism or reasons in opposition to the ideas propounded in this article.

*One of the exceptions was the present writer, who was allergic to milk when young; yet he has had relatively few dental caries. Perhaps his good fortune in this respect is attributable to the fact that he was weaned on tea, which has a high fluoride content.

FACULTY PORTRAIT

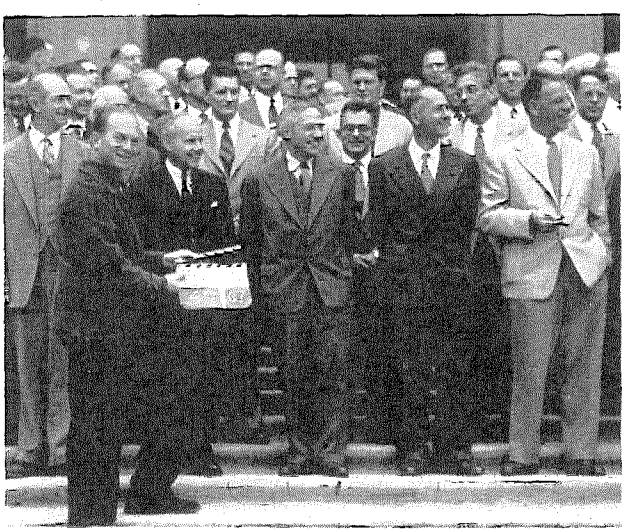
THE GROUP PORTRAIT above—and on this month's cover—is probably the closest the Institute will ever come to getting a picture of its entire teaching staff. There are some notable gaps in the picture (most of the Geology Division, for instance, was off at a meeting in Arizona), but, for the record, this is the Caltech faculty as of April, 1952.

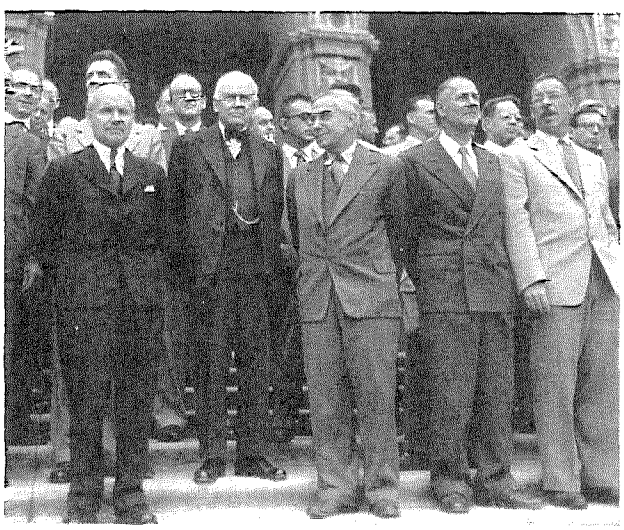
This impressive assemblage will appear in the Caltech movie, "Choose Your Future," now being shot on the campus. The camera crew is shown at the left, with Ed Bernds, director of the picture, setting up the shot of the assembled faculty.

Below, left, as Gil Mandelik, production manager of the picture, sets the scene, and the camera is ready to roll, the faculty's attention is distracted by a straggler.

Below, right, the latecomer has joined the group. Turned out to be R. A. Millikan.

"Choose Your Future," begun a year ago as a silent picture, is now being made with sound. Shooting should be finished this month, and the film will be edited over the summer. The project is under the general supervision of Frank Capra '18.





THE MONTH AT CALTECH

Paul Keenan presents Dean Franklin Thomas with the Construction Industries Achievement Award.

Man of the Year

DR. FRANKLIN THOMAS, Dean of Students and Professor of Civil Engineering, was named "Man of the Year" by more than 1000 representatives of the southern California construction industry at their 17th annual banquet in Los Angeles last month.

Dr. Thomas was presented with the Construction Industries Achievement Award "for having done the most to further the interests of industry and the entire community."

"He has contributed much toward maintaining the industry's greatest collective asset—trained minds of men of broad wisdom," said Paul C. Keenan, chairman of the selection committee, in making the award.

Dr. Thomas was one of the pioneers in the campaign to bring adequate water supplies to southern California. He has been a director of the Metropolitan Water District since its formation in 1928 and was vice-chairman of the board from 1929 to 1947. In 1948 he was elected chairman of the Colorado River Board of California. He served as president of the American Society of Civil Engineers in 1949. He has been professor of Civil Engineering at Caltech since 1915, and has served as consultant on a number of flood control and sanitation projects for the city of Los Angeles and for Los Angeles and Orange Counties.

Scientific Manpower

IN AN INFORMAL ADDRESS before the Los Angeles Section of the Institute of Radio Engineers last month President DuBridge delivered some straight talk on the current and critical shortage of scientific and engineering manpower. We quote:

1. By the most conservative estimates, the present engineering population in this country is about 400,000 — divided 300,000 in industry, 90,000 in government agencies and 10,000 in education.

2. The present *shortage* is about 95,000; i.e., there are 95,000 military and civilian jobs now vacant.

3. Between now and 1955 the country will need about 33,000 new engineers each year. Hence the accumulated need by 1955 will be for an engineering population at that time of nearly 630,000.

4. The number of engineers we may actually have in 1955 can be accurately predicted. It is the number we now have (400,000) plus the number now in engineering schools who will graduate by 1955. Making no allowance whatsoever for losses in the meantime, this adds up to 474,000—156,000 short! What's more, this shortage is increasing at the rate of some 16,000 per year.

By doing a little slip-stick work of my own, I come up with the following picture:

1. If we allow for death, retirement, losses to non-technical military service, calling up of reserves and other diversions to non-technical work, the present rate of *supply* of new engineers is actually *less* than the expected annual losses. In other words, the actual ac-

CONTINUED ON PAGE 26

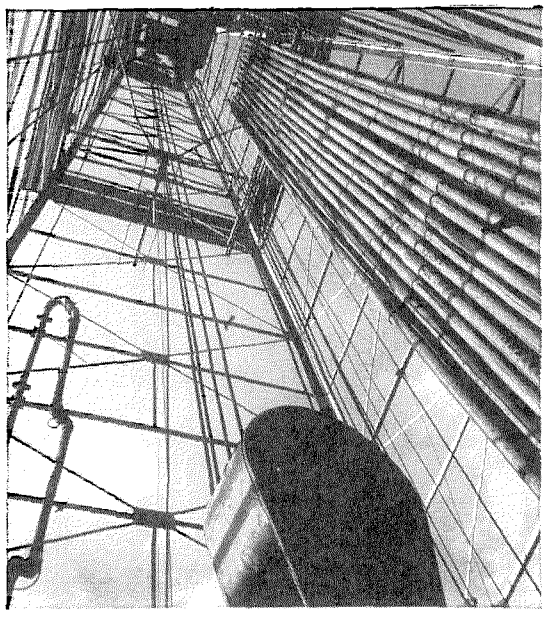
THE FUTURE OF THE YOUNG ENGINEER at Western Electric is limited only by his own ability, by his vision to see what lies ahead and by his capacity to work for the goal he sets himself. Recent developments such as microwave radio relay networks for telephone calls and television programs – operator and customer dialing of long distance calls – automatic message accounting – new secret electronic equipment for the Armed Forces – promise an ever widening field for him.

MANY ENGINEERING TALENTS ARE REQUIRED. Most are used in creating plans, machines and technological methods to convert raw materials into thousands of different precisely manufactured articles. Here at Western, the engineer translates the stream of new designs from Bell Telephone Laboratories into terms of practical production. It is his job – a fascinating and satisfying one – to provide the ways and means of reproducing the laboratory model, as economically as possible, in whatever quantity the Bell Telephone System needs. And even after production is rolling, his efforts are unceasing in the search for improved methods, tools and materials which will result in a better product or a lower unit cost.

Western Electric

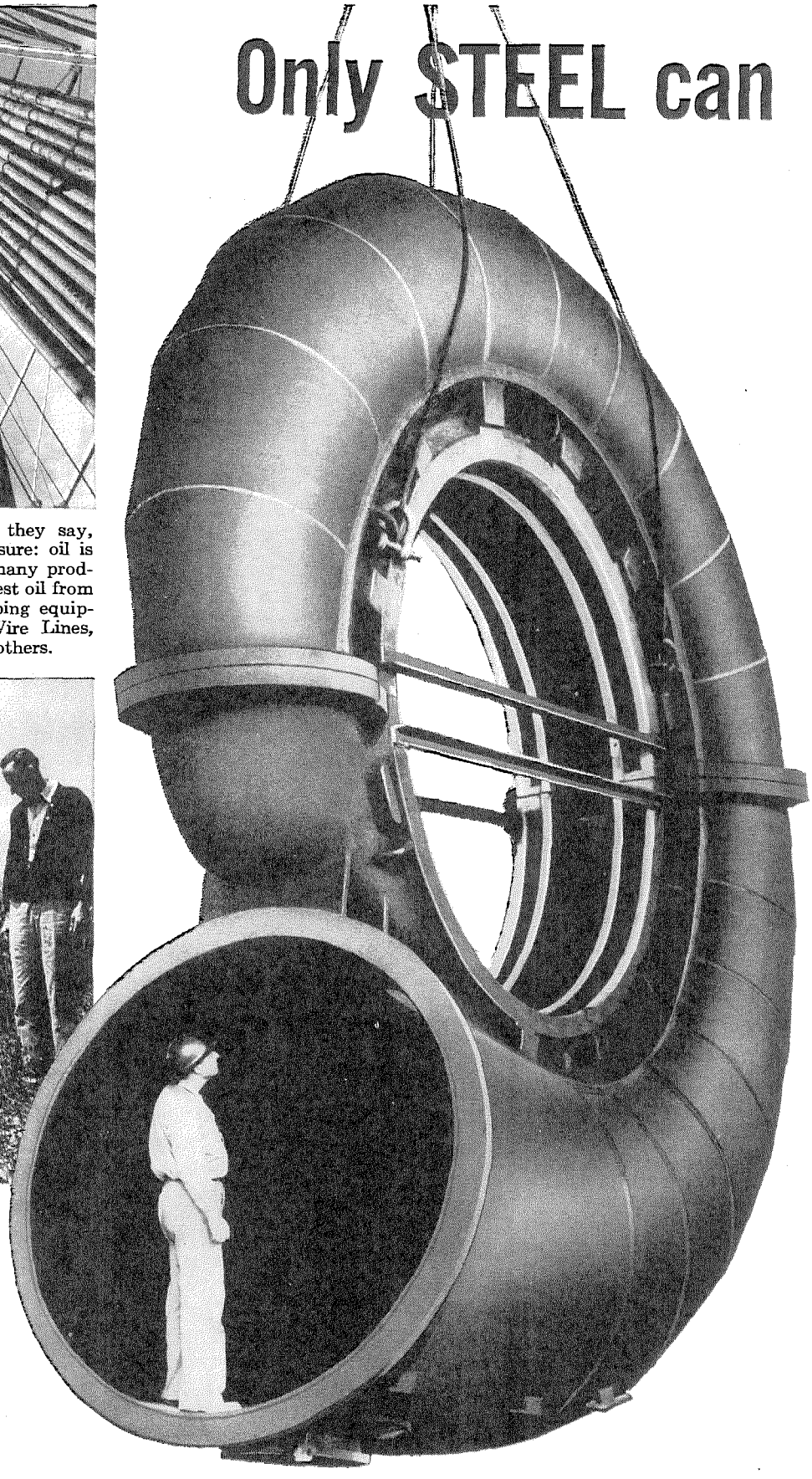
A UNIT OF THE BELL SYSTEM SINCE 1882

Only STEEL can



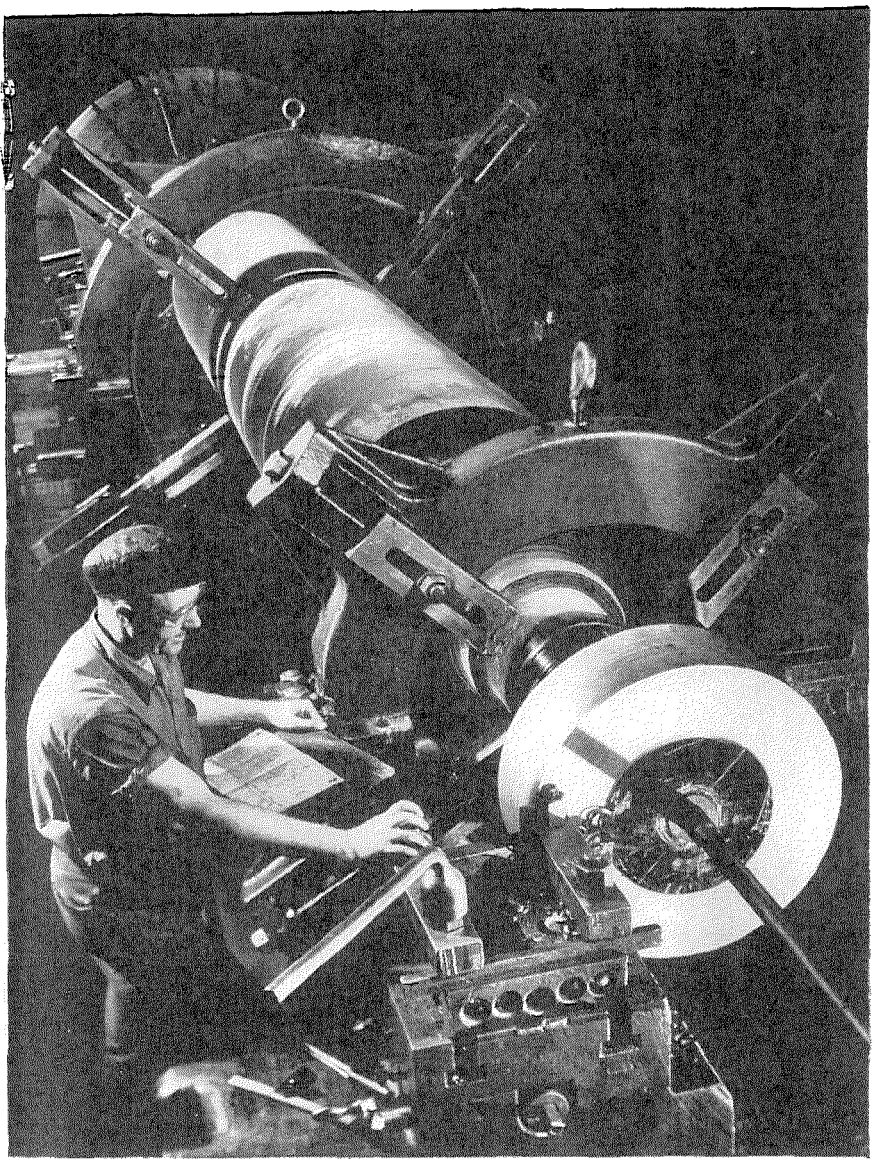
OIL WILL SHAPE THE FUTURE of mankind, they say, which may be true. But one thing is sure: oil is essential to our *present* security. And many products of U.S. Steel are widely used to wrest oil from the earth: "Oilwell" drilling and pumping equipment, National Pipe, Tiger Brand Wire Lines, Universal Atlas Cement, and a host of others.

WHAT HAS A STEEL MILL to do with soil conditioning? A lot. For some of the products of steel-making are ideal for agricultural use. For example, many southern farmers use Tennessee Basic Slag to add phosphorus and lime to the soil, stimulate luxurious crops. Look at the picture: at left, test crop of crimson clover and barley grown on badly eroded land conditioned with Basic Slag; at right, result of same planting without Basic Slag.

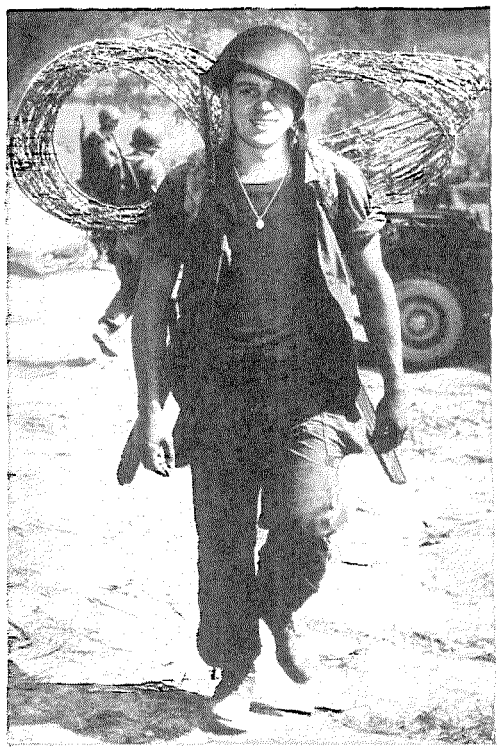


MAN SIZE! When you can step into its mouth and look down its throat like this, you've got a scroll casing for a hydroelectric turbine that's really *big!* This one, of welded steel construction, has a 98-inch inlet, a 132-inch bore. It's made by United States Steel.

do so many jobs so well



WHOPPER. This 96-inch lathe in the Homestead District Works of U.S. Steel can turn and bore a 110-ton piece of steel that's 8 feet in diameter and 66 feet long! But to produce quality forgings, it takes fine steel and skilled craftsmen, as well as modern machines. United States Steel has all three.



THE DEFENSE PROGRAM calls for steel and more steel . . . for weapons, ships, planes, even lowly barbed wire like this. Only steel can do so many jobs so well. And fortunately, United States Steel and the more than 200 other steel companies in America are able to produce enormous quantities of this vital metal . . . more than all the rest of the world put together.

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FACTS YOU SHOULD KNOW ABOUT STEEL. In making the products that are sold under the United States Steel trade-mark, U.S. Steel buys materials from nearly 54,000 other companies ... and over 40% of all money received by U.S. Steel for its products is paid out to these suppliers.

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OIL WELL SUPPLY..TENNESSEE COAL & IRON..UNITED STATES STEEL PRODUCTS..UNITED STATES STEEL SUPPLY..*Divisions of* **UNITED STATES STEEL COMPANY, PITTSBURGH**
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tive engineering population in 1955 will be smaller than what we have today. In fact it will be 20,000 less (380,000 as compared to 400,000). We are thus *losing ground* at the rate of 5,000 per year.

2. But the anticipated needs have also been grossly *underestimated*. The technical requirements of the new 1.5 billion dollar a year program of military development (three times larger than 1950) have only begun to be felt. The military production program is rapidly climbing. The Atomic Energy Commission has been instructed to initiate a vast 5 billion dollar program of expansion. These national security programs alone could easily demand 30,000 more engineers a year for the next four years. Thus it could easily be true that by 1955 the number of engineers actually needed will be nearly 700,000. And we will actually *have* less than 400,000.

It is this potential shortage of 300,000, plus the fact that we are actually losing ground rather than gaining each year, that really represents the true dimensions of our problem, in my opinion.

But the numerical shortage is only a symptom of a deeper ailment. We as a nation have grown dependent on scientists and engineers and we don't know it and refuse to admit it. So, with one hand we appropriate billions of dollars for work that only scientists and engineers can do, and with the other hand we slap them in the face and accuse them of causing all the world's ills—which we then call on them to help cure. As a symptom of all this, the House of Representatives the other day slashed the budget of the National Science Foundation by 77%. This is the one agency of government set up to produce more scientists and engineers and to produce rather than consume basic knowledge.

Are we then wholly helpless to do anything about this crisis? I suggest three things:

1. We *can* expose this nonsense about technology being the cause of the world's ills, about scientists being unconcerned about human welfare. We can let it be known that human welfare is the major goal for all of us and that we as scientists and engineers stand ready to join hands with all men of good will everywhere to advance that goal. And we have been *doing* it!

2. We can carry this same message to high school students—initiate an information campaign to tell high school students and teachers that the field of science and engineering offers great and exciting challenges for the future; that scientists and engineers can be, and for the most part *are*, good citizens too. We can tell them that the best citizen is the useful citizen, the one who is using his talents to their fullest. We can invite these kids to visit our plants and factories and laboratories and show them how exciting science and technology can be.

3. Finally I'd like to suggest something very definite we can do right here in southern California. Let us say that southern California industry is going to need 100 engineers more each year than are now in sight. (I'll choose a modest number to avoid scaring you!) Why shouldn't the engineering societies get together and raise, by industrial contributions, a scholarship fund to send to engineering schools each year 100 boys who can not go without financial help, or for whom a financial incentive would turn the trick. For $200,000 a year one could offer 100 four-year scholarships averaging $2000 each—$500 a year—to the 100 most promising applicants. And my guess is that for each winner about 3 to 5 others would have their interest sufficiently aroused by the contest so that they would find other sources of funds and go to college anyway. If we in southern California started such an enterprise it might be copied in other areas. If properly promoted, such scholarship funds might well help to reverse the tide of declining interest in science and engineering, would make the voice of the scientist and engineer heard again—and eventually help to avert a real national calamity.

Van Maanen Fellowship

THE INSTITUTE last month announced the establishment of a graduate fellowship in astronomy as a permanent memorial to Dr. Adriaan van Maanen, Mount Wilson astronomer from 1912 until his death in 1946. Fellowships will be awarded every other year, on recommendation of the Institute's Observatory Committee.

Dr. van Maanen founded the Students' Fund, Inc. in 1927, as a revolving loan fund to aid promising students. He administered its business almost single-handed until 1940, and solicited subscriptions from prominent citizens in Pasadena and Los Angeles. After his death the directors of the corporation renamed it the Van Maanen Fund, Inc. When the corporation was dissolved recently its assets—amounting to about $15,000—were presented to Caltech, making possible the establishment of the new graduate fellowships.

Clayton Lecture

DR. ROBERT T. KNAPP, Professor of Hydraulic Engineering, is to deliver the annual James Clayton lecture before the Institution of Mechanical Engineers, meeting in London, England, on April 18.

Dr. Knapp will speak on "Cavitation Mechanics and Its Relation to the Design of Hydraulic Equipment," and will repeat the lecture at another Institution meeting in Edinburgh on April 21.

The Institution, founded in 1847 for the advancement of knowledge in mechanical engineering, is similar to the American Society of Mechanical Engineers. It honors distinguished engineers and scientists throughout the world by inviting them to deliver the Clayton lecture.

CONTINUED ON PAGE 28

Power at your finger tip

Nearly everything you do today is done easier, quicker and better—thanks to electricity

If you are an average American worker you use the strength of nine horses each working hour of the day.

WHERE DO YOU GET SUCH POWER—Merely by flicking a switch . . . for by that simple act you are tapping the vast sources of electric energy that are ready to work for all of us in the home and on the job.

Today, the use of electric power has grown to where a single factory uses more electricity than an entire city used a generation ago. And your home—with its electric appliances, lighting and other conveniences—consumes more power than was used in yesterday's factory.

NEW MATERIALS WERE NEEDED—This great progress could not have been achieved without the many new and better materials which make possible today's larger and more efficient power generating equipment.

A JOB FOR ALLOY STEEL—Giant turbines and generators, for example, couldn't stand up under terrific heat, pressure, wear and corrosion if it weren't for steels made tough and enduring by alloying metals.

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FOR MORE POWER—Developing and producing alloys, plastics, carbons and many other better materials for our power industry are but a few of the many ways in which the people of Union Carbide serve all of us.

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Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS. *Ask for booklet A-2.*

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While he's in Great Britain Dr. Knapp will visit the Admiralty hydraulics laboratories and the Universities of Wales and Cambridge—and before he comes back to Caltech he'll tour hydrodynamics laboratories and facilities in Zurich, Madrid, Paris and Grenoble.

Combatting Communism

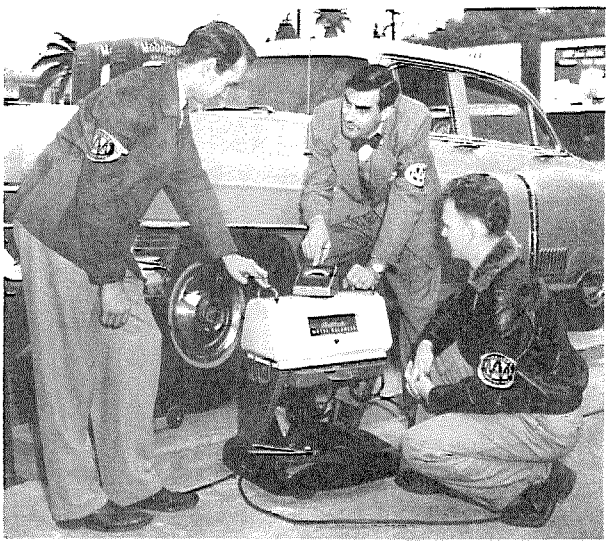
NINE SOUTHERN CALIFORNIA colleges and universities last month instituted a concerted program to combat "Communist infiltration" in their schools. Meeting under the leadership of the State Senate Committee on Un-American Activities, the presidents and other officials of Caltech, the University of California, Claremont, Scripps, Occidental, Redlands, Loyola, Pomona, Whittier, and the University of Southern California, unanimously agreed to appoint one person at each school to serve as a liaison between the school and the committee in ascertaining what Communist activity exists on each campus.

"It is the first time in the United States that such a plan has been attempted," said Senator Hugh M. Burns, chairman of the State Senate Committee on Un-American Activities, who plans soon to call together the presidents of the northern California colleges and universities for a similar purpose.

Economy Run

CALTECH STUDENTS did such a good job on last year's Mobilgas Economy Run that they're going to act as official American Automobile Association observers again on the 1952 run, which starts on April 14.

The Economy Run is a test conducted under the auspices of the AAA to determine the performance and gas consumption of stock autos manufactured in the United States.



Peter Kyropoulos, Assistant Professor of Mechanical Engineering (center), explains operation of electronic wheel balancer which will be used to test cars participating in 1952 Economy Run.

Forty-five Caltech students have been chosen (out of 100 applicants) to go on the 1952 Run. Each student's application has had to be checked and approved by the Dean, because this year's Run will be a long trip to Sun Valley, which will keep students away from classes for a week. For the past month the student-observers have been making trial runs with the test cars to familiarize themselves with their job. At the start of the run each man will be assigned to a particular car, and will be reassigned at each overnight stop.

Because every effort is made to see that the contest reflects the conditions under which the average motorist drives, the observer must watch carefully to see that no special advantages accrue to the driver, who, while a non-professional, is admittedly an expert.

Some 60 different places on each car are sealed and only an AAA official may break one of these seals. Whenever a seal is broken the observer "must not leave the car or take his eyes from the unsealed part until it is resealed," according to the regulations. He must be the last to leave the car and before doing so he must lock all windows, doors, and the trunk compartment and keep the keys on his person.

Ford Fellowship

DR. GEORGE K. TANHAM, Assistant Professor of History, is one of 246 college teachers awarded 1952-53 fellowships by the Ford Foundation's Fund for Advancement of Education. Initiated last year, these faculty fellowships are "based on the belief that a year devoted to study, research, observation or experiment will renew and enrich the intellectual lives of the recipients of the awards and help them to become better teachers of undergraduates."

Dr. Tanham plans to spend his year studying military history at the University of Chicago, the War College in Washington, D. C., and Princeton University—and to spend the remaining time doing general cultural reading at Oxford University in England.

During Dr. Tanham's absence, Dr. John Weir, Associate in Psychology, will serve as acting Master of Student Houses at the Institute.

Government Suit

U. S. ATTORNEY GENERAL J. Howard McGrath brought suit against Caltech last month, alleging that it was, of all things, "hindering national defense."

The Institute, however, was merely one of a number of defendants named in the action, which was aimed at all landowners along the Santa Margarita River in San Diego County, and is intended to adjudicate water rights in the area. Federal officials have apparently sponsored the action so that the future water supply for Camp

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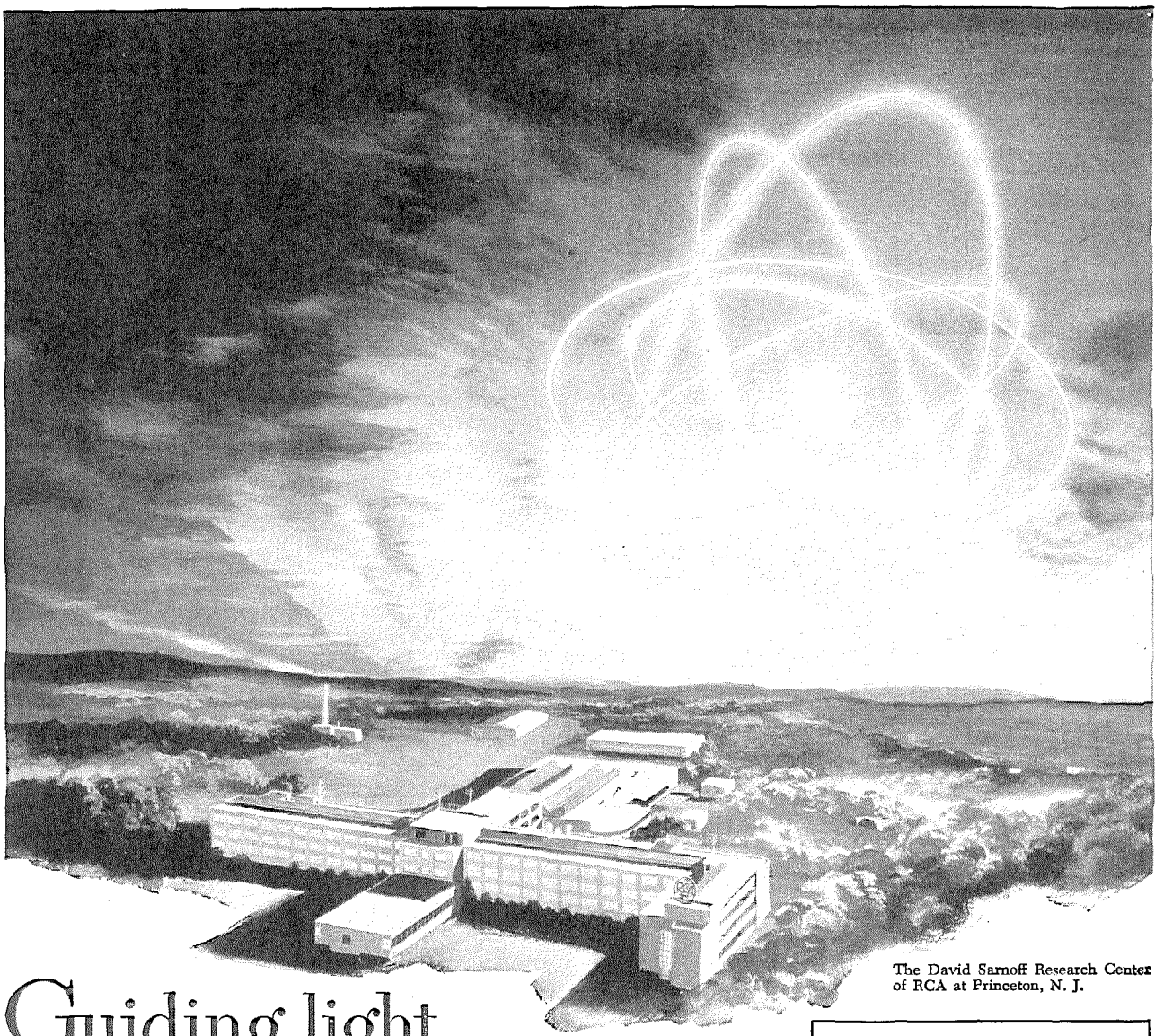

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How useful it can be is seen in the advances already made by RCA scientists—such as the *picture tube* of your television set... the *image orthicon* television camera, used by every studio in the nation . . . the amazing *electron microscope*, which magnifies as much as 200,000 times. RCA scientists now work toward new advances—more powerful television sets . . . all-electronic color television . . . UHF television . . . new electronic systems for industry and our Armed Forces.

To RCA scientists, the challenge of *tomorrow* is more interesting than *yesterday's* success. This pioneering spirit assures you finer quality in every product and service of RCA and RCA Victor.

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- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

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

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COLONEL, RESEARCH AND DEVELOPMENT DIVISION, DEPARTMENT OF THE ARMY: "Full support should be given any sound measure designed to encourage inventors and facilitate consideration and further development of their ideas or inventions. It is difficult to conceive of any action that would accomplish more in this direction than that called for in the Sinclair Plan."

CABINET MEMBER: "It should bring to light some valuable ideas which might otherwise not have been known."

AN INVESTMENT COUNSELOR: "I can imagine the great surge of hope now going through the breasts of the young men specializing in this field. 'Here,' they will say, 'is a corporation willing to give us a break.' . . . Its fundamental unselfishness cannot fail to strengthen the faith of those without property. . . . This is opportunity!"

AN AIR FORCE GENERAL: "I have read of your plan for encouraging invention and offering a testing ground for ideas. Such a project seems to me both practical and inspirational!"

Men Who Know the Importance of Independent Invention Encourage You to Use the Sinclair Plan

A CABINET MEMBER: "The provisions regarding patents are unique . . . the compensation for your investment of money, time, and facilities would be limited to nonexclusive, royalty-free shop rights for your company."

PRESIDENT OF A BROADCASTING NETWORK: "To make the magnificent facilities of the Sinclair Research Laboratories available to inventive Americans under what would seem to be a very fair arrangement is a constructive and forward-looking step."

A MEMBER OF THE JOINT CHIEFS OF STAFF: "The Sinclair Oil Corporation is performing another fine public service in opening its research laboratories to the American inventor. I am confident that the nation will derive many benefits from this selfless service."

PRESIDENT OF LARGE MANUFACTURING CORPORATION: "We all think the plan, which opens wide the doors of your great research laboratories, should indeed encourage individual inventors."

AN AIR FORCE GENERAL: "I wholeheartedly agree that there is a need to help the independent inventor because of the complexity of modern technology and the prohibitive cost of these facilities. Your farsighted plan is a great stride in relieving this situation."

PRESIDENT OF A LARGE MANUFACTURING COMPANY: "You have recognized a great need, and have done something objective to overcome it . . . another idea which puts to beneficial use the resources and capacity of a large group."

Advantage of Independent Inventors?

If you have an idea for a new petroleum product— but do not have the facilities needed to develop it— the Sinclair Plan offers you laboratory help.

EIGHT months ago, Sinclair opened up a part of its great research laboratories to independent inventors who had ideas for new or improved petroleum products but who did not have the facilities needed to develop and profit by their ideas.

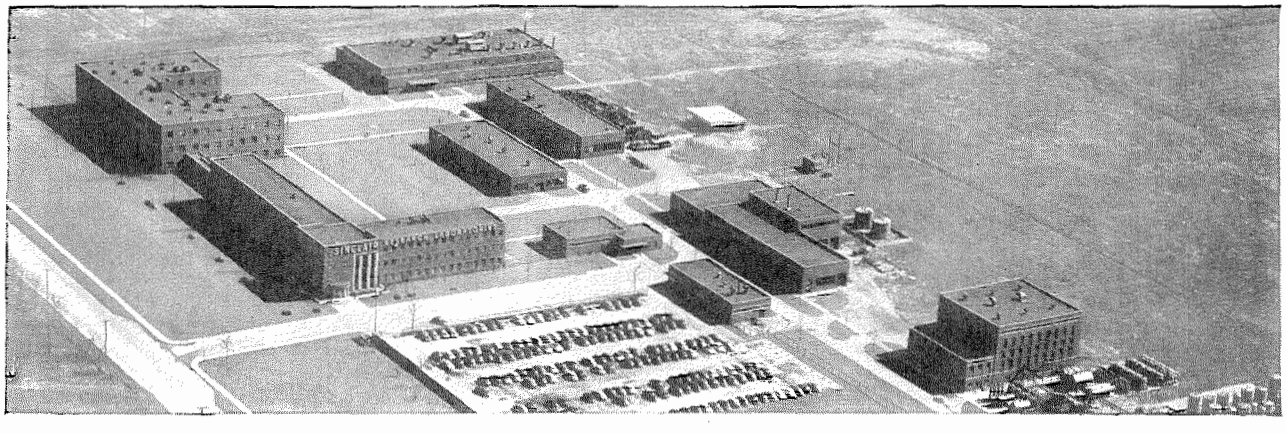
To date nearly 5,000 inventive people have submitted ideas to the laboratories; and the Sinclair Plan has become recognized as a service to inventors, the oil industry and the public. As a result we have made the Plan part and parcel of the long-range operation of our company.

If you have an idea for a new or improved petroleum product or application, you are invited to submit it to the Sinclair Research Laboratories. In your own interest, each idea must first be protected by a patent application or a patent.

If the laboratories select your idea for development, they will make a very simple arrangement with you: In return for the laboratories' work, Sinclair will receive the privilege of using the idea for its own companies, free from royalties. This in no way hinders the inventor from selling his idea to any of the hundreds of other oil companies for whatever he can get. Sinclair has no control over the inventor's sale of his idea to others, and has no participation in any of the inventor's profits through such dealings.

HOW TO PARTICIPATE: Instructions are contained in an Inventor's Booklet. Write to W. M. Flowers, Executive Vice-President, Sinclair Research Laboratories, Inc., 600 Fifth Avenue, New York 20, N. Y.

IMPORTANT: *Please do not send in any ideas until you have sent for and received the instructions.*



Nine buildings of the Sinclair Research Laboratories at Harvey, Ill.

SINCLAIR—for Progress

Pendleton, the big Marine base at Oceanside, Calif., can be settled.

Caltech comes into this picture through its Palomar Observatory. Though this is miles away from the Santa Margarita River it does fall, in part, in the Santa Margarita watershed. The government suit maintains that all water at the Observatory is the rightful property of Camp Pendleton—and, by diverting such water to its own use, the Institute is impeding the war effort.

In reply to the suit, the Institute's lawyers maintain that the only water available at Palomar is "that which falls in the form of rain or snow and that which issues from the ground in springs." They contend that the Institute has every right to use such water—and Camp Pendleton, 40 miles away from the Observatory, could hardly get much material benefit from the water in question.

Honors and Awards

DR. GEORGE W. BEADLE, chairman of the Institute's Biology Division, has been appointed to the National Science Foundation's Divisional Committee for the Biological Sciences. This committee is one of three established by the Foundation to serve it in an advisory capacity on questions concerning its activities in promoting and supporting basic research and education in the sciences.

DR. HARRISON S. BROWN, Professor of Geochemistry, last month received the American Chemical Society's $1,000 award in pure chemistry—one of the highest honors in American chemistry—for outstanding contributions to our knowledge of the composition of meteorites, their significance relative to the age and origin of the solar system and the elements, and particularly for devising new and highly precise methods for determining the abundance of trace elements in these bodies.

ROBERT D. GRAY, director of the Institute's Industrial Relations Section, has been elected first vice-president of the Pasadena Chamber of Commerce and Civic Association.

Special Lectures

AS VISITING PROFESSOR of Astrophysics, Dr. S. Chandrasekhar, of the Yerkes Observatory, will deliver six special lectures at the Institute in April.

A leading mathematical astrophysicist, Dr. Chandrasekhar's fields of interest include the internal constitution of stars, white dwarf stars and stellar atmospheres. He is largely responsible for introducing the aerodynamical theories of turbulence and convection into astronomy.

CONTINUED ON PAGE 34

The name doesn't matter—

only the meaning of Free Enterprise

Some people say we should get a new name for it. Perhaps. But what does the name matter, so long as we preserve the meaning. A good thing, too, to review what it means once in a while:

It means Hope. *Your* boy can start a business or hope to boss the one he's in . . . In countries without free enterprise only the government owns and runs a business.

Free enterprise means Decency . . . In so-called "liberal" countries where "everything is for the people," you can be thrown into a slave labor camp to die, just on the whim of some enemy.

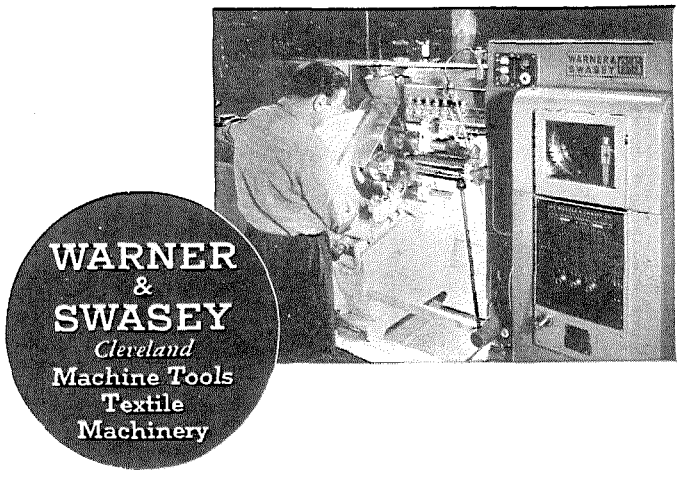
It means Home . . . not two families "assigned" to one room.

It means Courage . . . and no need to cringe at the words "police" or "party member".

It means Dignity . . . not sobbing out a "confession" in a courtroom to avoid more torture.

It means Education. Read what you want . . . not what some official decides for you. (And much of your reading may be made possible, by the way, by a Scotch immigrant boy named Carnegie who made millions under the American free enterprise system, and spent them on free libraries.)

Free enterprise—Americanism—profit-and-loss system . . . the *name* doesn't matter so long as you are on the alert against the people who are trying to change and destroy its *meaning.*



A native of India, he received his Ph.D. in theoretical physics and a Doctor of Science degree in astrophysics at Cambridge University, England, where he was a Fellow of Trinity College. He joined the Yerkes Observatory as a Research Associate in 1936 and was named Distinguished Service Professor in 1946.

Jolly Old Gentleman

DR. SAMUEL T. MCKINNEY, who established the Mary Earl McKinney Essay and Seminar Scholarships for improving English expression among technical students, died in Los Angeles last month at the age of 90. A retired physician and surgeon, Dr. McKinney set up the scholarships in honor of his mother, at Caltech, Rensselaer Polytechnic Institute, U. S. C., Stanford and Pepperdine College. At Caltech the scholarship takes the form of the annual McKinney Prize Contest in English, held regularly since 1946.

In addition, for many years he sent $50 bills to various teachers at Christmas time. He started this practice after he heard an English professor observe that "teachers have plenty of holiday time to travel; too bad they don't ever have any money." So, along with his Christmas gifts, Dr. McKinney would send a note saying, "Here's $50. Take a little trip and have some fun." The notes were always signed: "A Jolly Old Gentleman."

Summer Conference

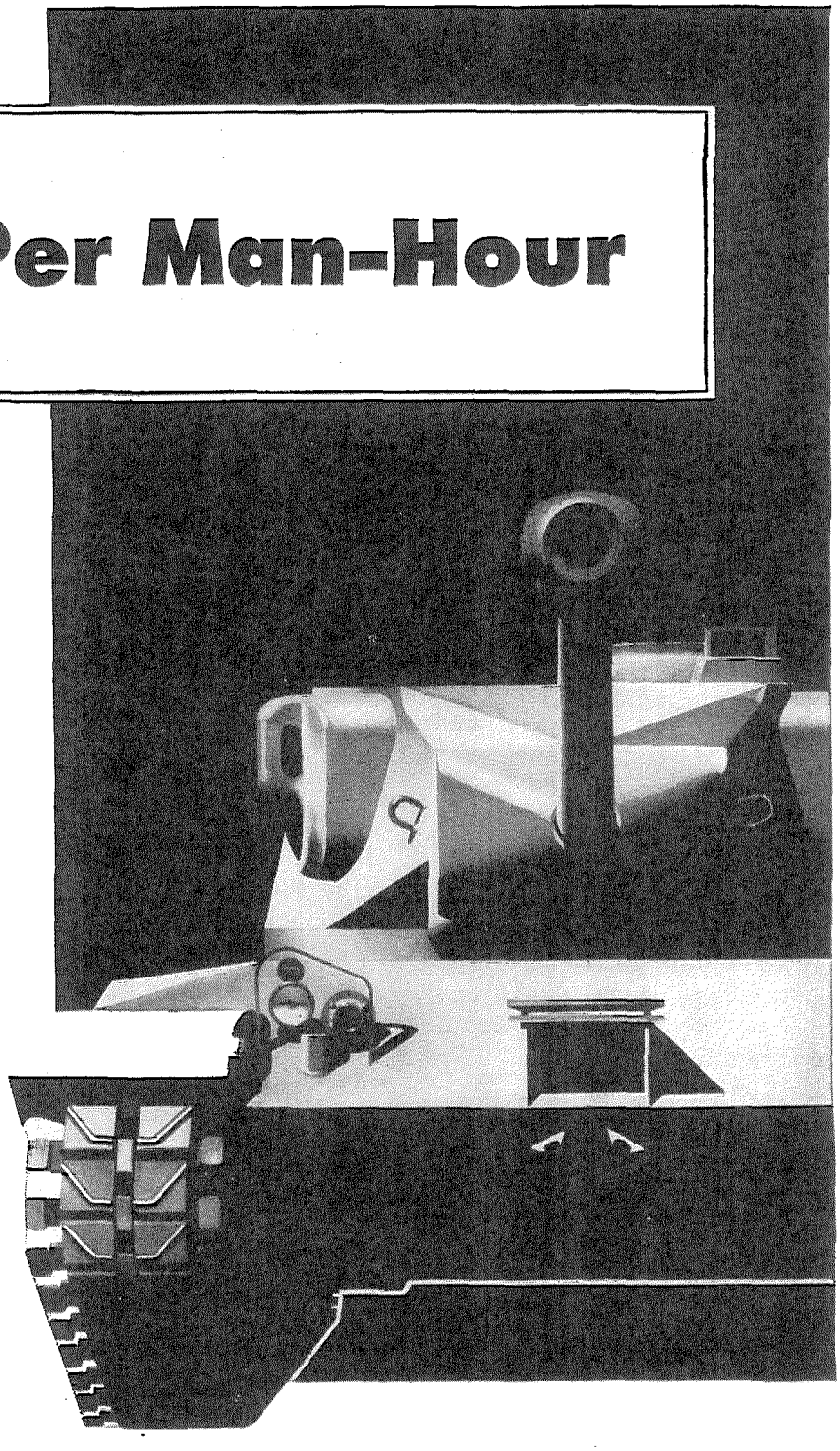
THE INSTITUTE'S Industrial Relations Section has announced its fifth series of summer Management and Personnel Conferences, to be held on the campus from June 15 to 20 and June 22 to 27. Conferences on Wage and Salary Administration, and on Selection and Development of Potential Supervisors will be held from June 15 to 20 and those on Management and Supervision of Office Personnel, and on Executive Development and Organizational Planning will be held from June 22 to 27.

The conferences are open to men and women and include morning, afternoon and evening sessions. Rooms will be made available to registrants in the Student Houses and meals will be provided at the Athenaeum.

Vesper Trophy

THE HOWARD G. VESPER Basketball Trophy for 1952 was awarded this month to Norman E. Gray, 23-year-old senior in Electrical Engineering, for the second successive year. The trophy, which was established in 1950 by Howard Vesper '22, is presented annually to that member of the basketball squad most qualified from the standpoint of sportsmanship, improvement, moral influence, and scholarship.

More Per Man-Hour



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COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

. . . rubber, insecticides, adhesives, soaps, detergents, plastics, paint, varnish, lacquer, textiles, paper, to name a few, use Hercules® synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products and other chemical processing materials. Hercules® explosives serve mining, quarrying, construction, seismograph projects everywhere.

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EC53-4

THE BEAVER

Some Notes on Student Life

Third Term

As students returned to Tech after their short spring vacation, it was quite obvious that this was the third term that was beginning. For one thing, undergrads were not busily running up to each other and asking, "How did you do last term?" No one took the unconstitutional liberty of pulling the little brown envelopes from the mail boxes and holding them up to a strong light to determine the scholastic rank of his colleagues. No one ran around the campus with blue books trying to call a few minor points on his final exams to the attention of his instructors. There was no look of determination on the undergraduates' faces. They had spent all their energy—or rather the Institute had spent it for them—during the first two terms.

The Call to Worship

The mind of the undergrad is often easy to understand—for everyone, that is, except that great part of the faculty which still clings to the heroic myth that the Caltech student is something more than just human.

The undergraduate spends much of his time—certainly more than is necessary or even healthy—thinking about grades. During the first term he is eager to establish good study habits for the year, and makes many sacrifices and genuflections to the Great God G.P.A. He thinks of the grades that will go on his record for the year in terms of the grades he is getting that term. But the undergrad thinks differently in the third term. By then his grades for the year are already two-thirds determined, and his third-term performance thus seems comparatively unimportant.

The Wet Term

Climate is just as important a factor in luring the students from their books during the third term as the psychological factors already mentioned. The combination of Pasadena heat and smog is enough to make the print blur in any textbook. In the vicinity of the student houses, the strain is alleviated by numerous outbreaks of hostilities in the form of water fights. Usually, these are just skirmishes involving no more than a few men. But at times they assume such epic proportions as a conflict between two different houses.

The Sporting Life

As the name implies, this sport involves the production of water, either from a container or a stirrup pump,

CONTINUED ON PAGE 38

"No mud on *our* Pulpit!

"No . . . not in our *little church!*

"But something the Pastor said reminded me of a service I'll never forget. Later, Helen told me I'd said *'Mud!'* out loud. That's why she dug me in the ribs and said *'John, wake up!'*

"I guess I *was* wool-gathering. I was back overseas, listening to a Chaplain who'd found a spot of beauty in a grove of trees for his services . . . right smack in the middle of a war! The green branches made a church-like arch. The sun filtered through the branches like through our church windows.

"The Chaplain's pulpit? Just the hood of a homely Army Jeep . . . *splattered with mud.* No organ music . . . just the booming of big guns far off. No pews, either . . . just mud to sit in. But I felt just as close to God then as I did last Sunday in our Maple Street Church.

"After Helen nudged me awake, I thought of countries where mud *is* slung at pulpits. Where men of the cloth are jailed. Where churches are closed or burned. And where God is disowned. I gave thanks that *here* we respect *all* churches.

"Freedom of worship is *one* of our precious rights. Other Freedoms include our right to vote as we please . . . and without anyone knowing *whom* we vote for. To get rip-roaring mad when we see our taxes wasted by wild spending . . . and when we read about charges of corruption against public officials. To choose our own jobs, like I did when I applied for one at Republic. To own our own homes. To drive our own car across state lines with nobody to push a gate down in our faces.

"I said an *extra* prayer last Sunday: *May our Reverend Johnsons, Father Kellys and Rabbi Cohens always have that sacred Freedom to preach their gospel from unmuddied pulpits. Amen."*

REPUBLIC STEEL

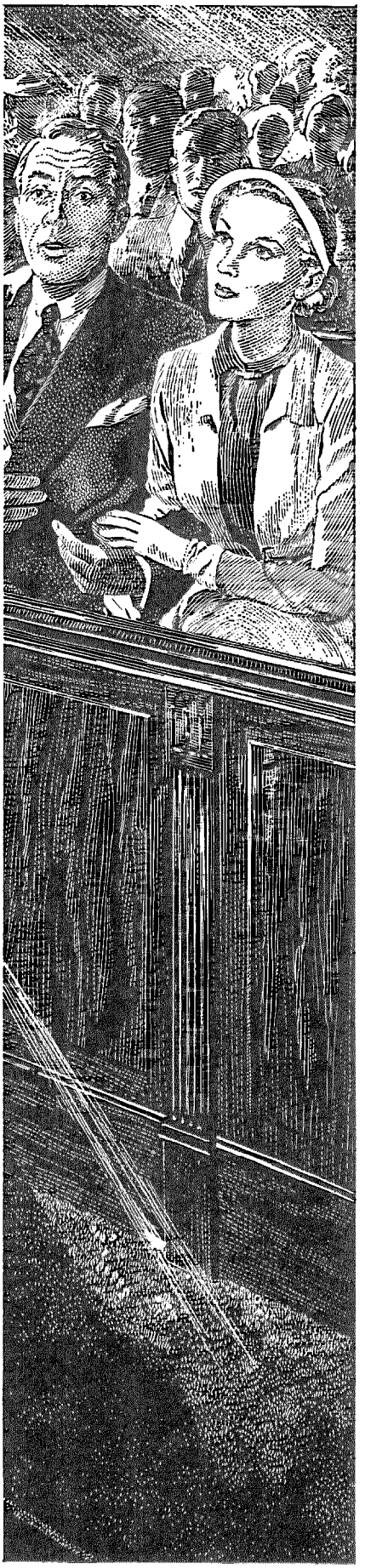
Republic Building • Cleveland 1, Ohio

REPUBLIC STEEL

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . . an America whose aircraft streak to all corners of the free world on missions of commerce, mercy and peace. *Through the Aircraft Industry, too, Republic serves America.* Republic furnaces and mills produce aircraft-quality steels . . . steels for the tools to shape the parts . . . steels for the instruments that guide the way . . . for sheltering hangars . . . for the reinforcing that makes safer runways. Republic is proud of the part it plays in supplying so much of the *ground-based* production power that keeps America powerful *aloft.*

* * *

For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio.



directed by a participant toward any member of the opposition. This form of activity is most popular with the freshmen, but also finds much favor among those sophomores who mature slowly. Because such production of water within the student houses is against the student house rules, ardent enthusiasts of the water fight often exercise much ingenuity to perpetuate their sport.

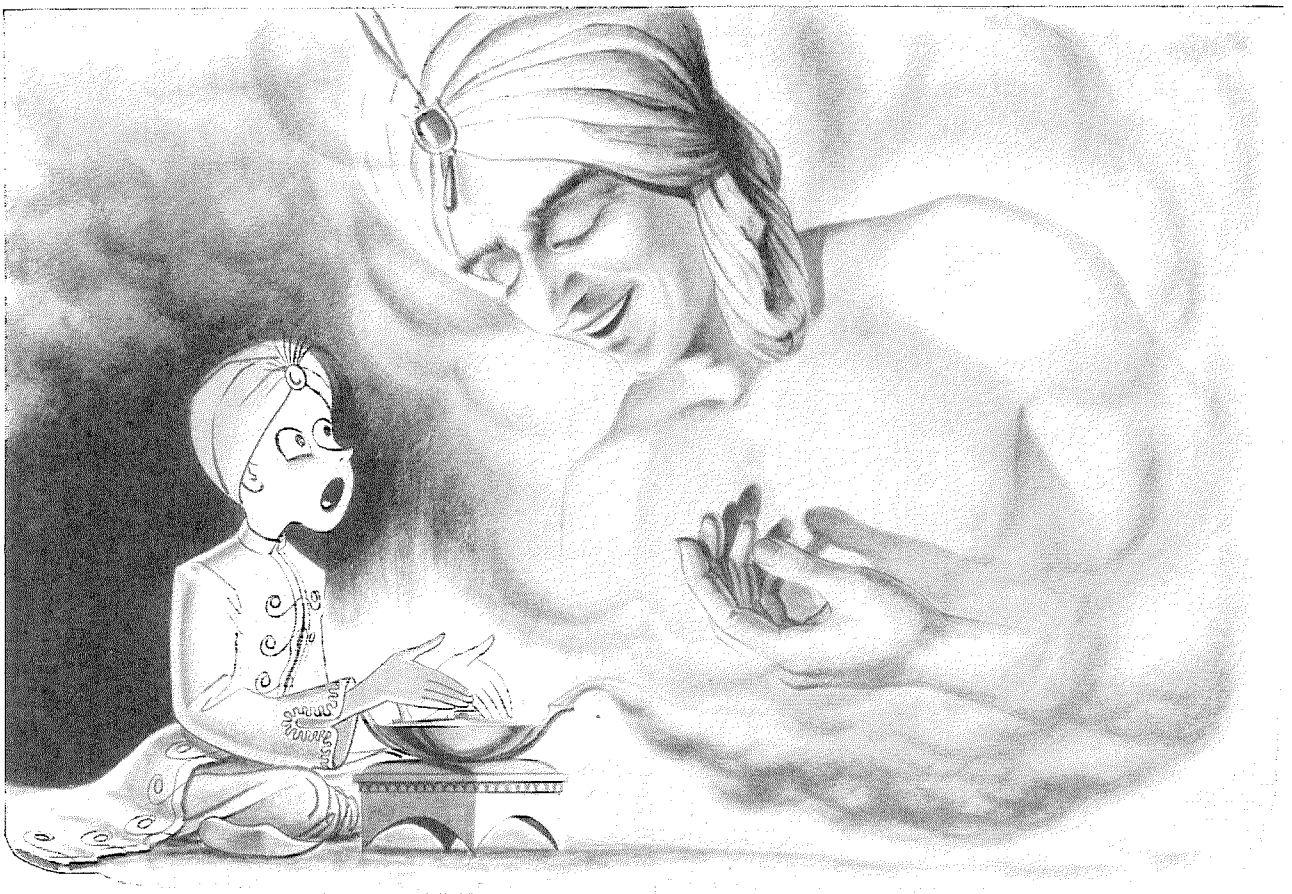
On the Beach

Another distraction is the beach. During the third term it is not uncommon to see Tech men bound for the beach, with a blanket under one arm and a book under the other. The function of the book is not quite clear. One school of thought maintains that it serves as a refreshing memento of the happy excursion when, as it is opened the next Monday, it spills its contents of sand upon the undergrad's desk. Another approach to the problem of why Tech men take books to the beach is more subtle. It assumes that the mere presence of the book soothes a strained conscience, which has not forgotten that nothing but a dimly-lit library is the proper place for a Tech man—even on a bright spring day.

Allegedly, in spring a young man's fancy turns toward the greatest distraction of them all. But Caltech is not the ideal place to observe whether or not this saying is true.

School for Pool-Sharks

During the spring vacation, a truck delivered a shuffle board to 1301 E. California Street. The shuffle board now supplements the ping-pong and pool tables already gracing a section in the basement of the student houses known as the "game room." The game room is kept up financially by a special fund. In other respects, the game room is kept up by the freshmen in the houses. As with any organized and many unorganized activities at Tech, there is a committee which is concerned with just whose turn it is to clean up the game room. As with all school activities which lack an overabundance of glamour, the game room committee has much difficulty prodding people to keep the room in order. Another student committee is now hard at work to assist the game room committee in forming the required subcommittees to keep the room in order. *—Al Haber '53*



Aladdin and the "Al Kali"

You remember the story of Aladdin and his magic lamp. But what never came out in Arabian Nights was the probability that Aladdin might well have used "al kali" to cleanse and polish the old lamp, when he made the discovery of its magic properties.

The origin of soda ash—oldest of the major industrial chemicals—is veiled in antiquity. Its history goes back at least 5,000 years through the civilizations of many peoples. In various parts of the world the ashes of plants were leached to obtain soda. One of the plants so used by the Arabians was kali, and their term for soda, al kali, became our word alkali.

The miracles of modern industrial chemistry of course far surpass the magic of Aladdin's lamp. Many of these industrial processes and products employ alkalies to bring to our civilization a multiplicity of refinements undreamed of even a few short years ago. As one of the nation's leading producers of alkalies and related chemicals, Columbia-Southern salutes the achievements of the industries it serves.

SODA ASH—

a chemical of many uses

Although soda ash was first utilized for its cleansing powers—and soap making continues to be an important usage—other uses have long exceeded the original. Soda ash is a basic ingredient of glass, this being the largest single use; but soda ash is also essential to so many chemical processes that, in the aggregate, this is the largest market. Virtually every industry uses soda ash to some extent and the following are merely indicative of its versatility: water treatment, metals refining, pigments, pulp and paper making, textiles, petroleum refining, ceramics, leather tanning. A complete list of all processes involved would fill a good-sized book!

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ALUMNI NEWS

Ward Foster

WARD D. FOSTER '27, patent lawyer with the firm of Harris, Kiech, Foster & Harris, of Los Angeles, died in Glendale on April 9, at the age of 47. Incapacitated by a severe illness since December 4, 1950, Ward had been confined to his home, which, during recent months, was at 1016 Marion Drive, Glendale.

As an undergraduate, Ward served as Student Body President in his senior year. He was a member of many campus organizations, including the *Big T* staff, the *California Tech* staff, the Debate and Drama Clubs, the Gamma Sigma fraternity, and Tau Beta Pi. He received an honor key in his junior and senior years.

After graduation from Caltech, Ward attended the Law School of the University of Southern California. He was admitted to practice before the State and Federal courts in 1930, and before the Supreme Court of the United States in 1950. He practiced extensively before the Patent Office and the Federal Courts and became well known in California and other states as a brilliant trial lawyer in patent matters.

Ward had been active in the Alumni Association, and served as president in 1937-38.

In 1930 he married Miss Nina Hessenflow of Glendale, who survives him.

Chapter Notes

THE WASHINGTON CHAPTER will hold a dinner meeting on Thursday, May 1, at 7 p.m. at the Iron Gate Inn, 1734 N Street, N. W. This will be during the week of the meetings of the American Physical Society in Washington, and any alumni in the area are invited to attend. Reservations may be made by calling or writing Charles R. Cutler, c/o Kirkland, Fleming, Green, Martin & Ellis, 16th and K Streets, N. W., Washington 6, D. C. The phone number is Sterling 3200.

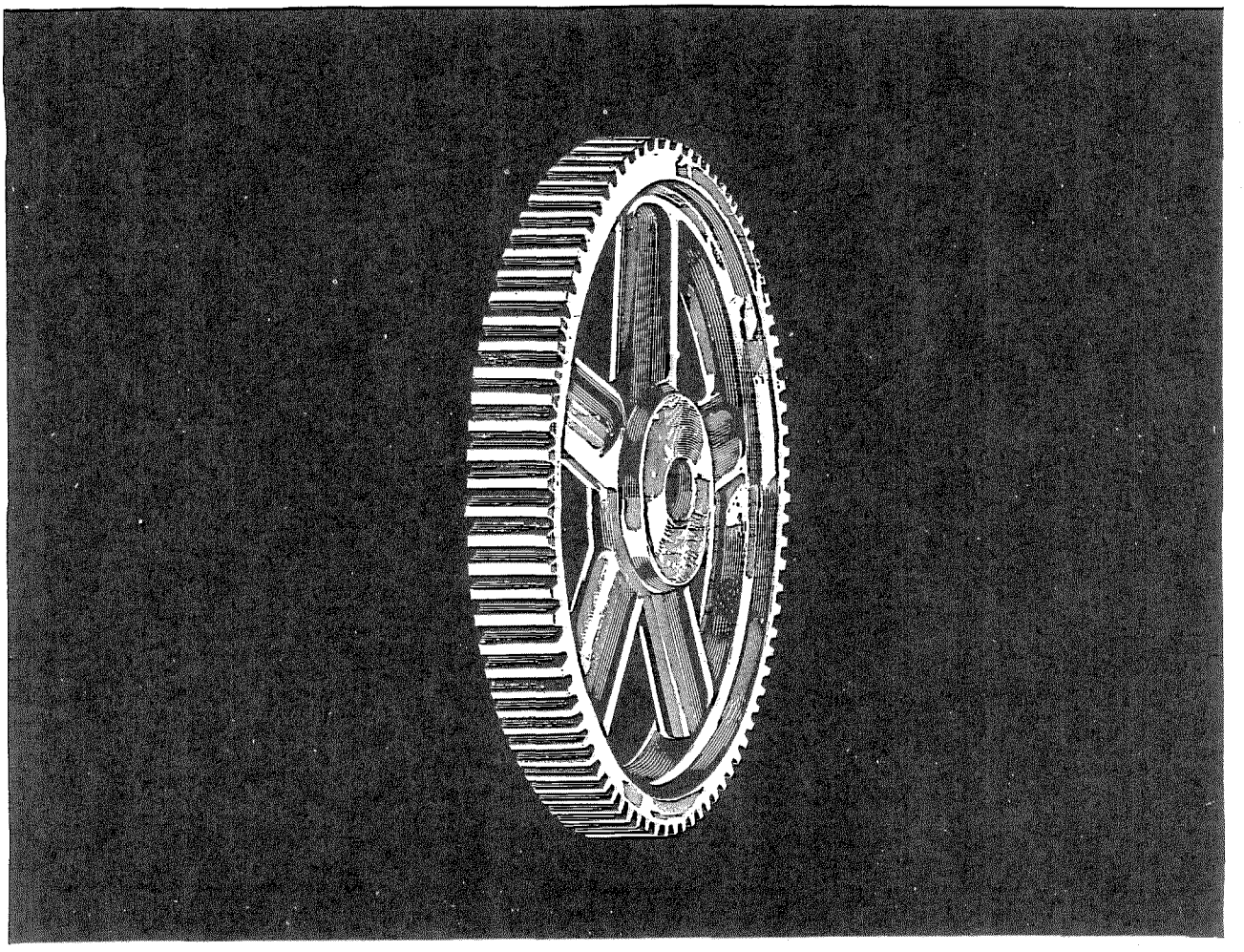
THE SACRAMENTO CHAPTER met on March 15 and elected the following officers for the coming year:

President: W. Layton Stanton '27, Ph.D. '31

Secretary-Treasurer: Edward S. Ida '46

The first organizational meeting of the Sacramento Chapter was held almost exactly a year ago, on March

CONTINUED ON PAGE 42



ANCESTRY UNKNOWN . . .

No one knows who first thought of gears as a means of transmitting power or motion . . . but without them modern civilization could not function.

There would be no clocks, cars or calculators . . . industry would revert to hand production . . . transportation would go back to the horse and buggy . . . household chores would multiply . . . office managers would be seeking mathematical geniuses.

FUTURE UNLIMITED . . .

A gear never works alone. Only when properly meshed can it function efficiently. So, in industry, minds must mesh if progress is to result. Here, in America, engineers, inventors, machinists, toolmakers are geared for great advancement. And their point of contact is America's all-seeing, all-hearing and reporting Inter-Communications System.

THE AMERICAN INTER-COM SYSTEM . . .

Complete communication is the function, the unique contribution of the American business press . . . a great group of specially edited magazines devoted to the specialized work areas of men who want to manage better, design better, manufacture better, research better, sell better.

WHY WE HAPPEN TO KNOW . . .

The McGraw-Hill business publications are a part of this American Inter-Com System.

As publishers, we know the consuming insistence of editors on analyzing, interpreting and reporting worthwhile ideas.

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McGRAW-HILL PUBLISHING COMPANY, INC.

330 WEST 42nd STREET, NEW YORK 36, N. Y.

HEADQUARTERS FOR BUSINESS INFORMATION

30, 1951, and the chapter was officially established by charter on April 17, 1951. During the first year of its existence membership has grown to approximately 30.

Howard G. Vesper '22, president of the California Research Corporation, was guest speaker at last month's meeting. He spoke on the international oil situation.

The Sacramento Chapter extends an invitation to any visiting alumni to attend its regular monthly luncheon at the University Club, held on the first Friday of each month. No advance notice or reservations are necessary.

Fleming Reunion

FLEMING HOUSE will hold the first of what it hopes will be an annual series of reunions on Sunday, May 18. This will be a get-together of all alumni and present members of the house.

Sunday lunch will be served in the Fleming Dining Room, and extra tables will be set up in the court. The afternoon will feature a softball game in Tournament Park between the present members of the house and a team composed of its alumni.

The remainder of the activities will be devoted to swapping stories, past and present, of college days. Wives and girl friends will be invited—though there will be a limit of one to a customer.

DuBridge Letter

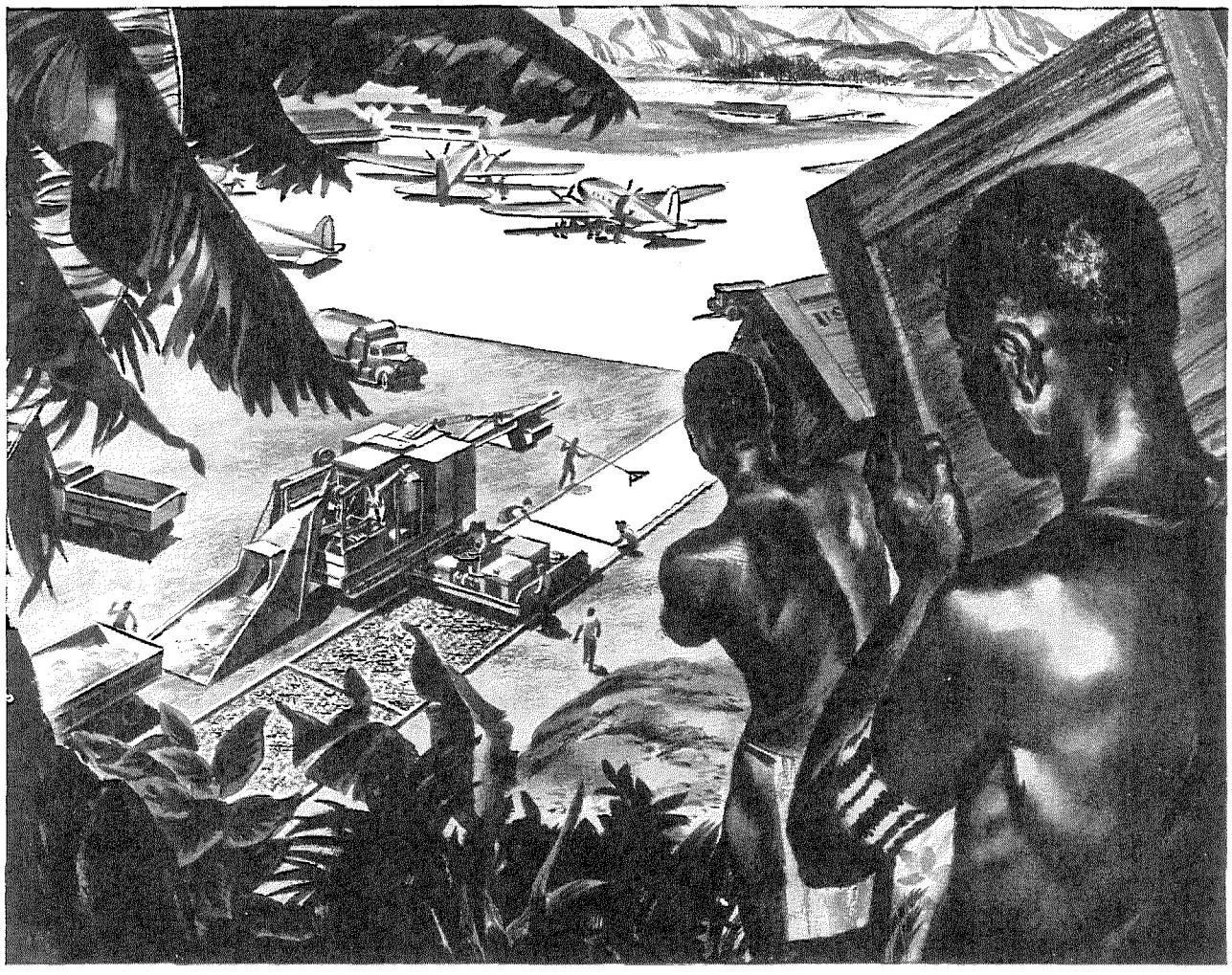
ALUMNI SHOULD be interested in the following letter which Bob Sharp, President of the Alumni Association, recently received from Dr. DuBridge, President of the Institute.

Dear Mr. Sharp:

Each year the Institute sends to its principal contributors a copy of its Annual Report, with a note of appreciation. I assure you that I take particular pleasure in doing this in the case of the alumni. The Alumni Association of Caltech is only a few years old, yet today it is one of the three or four *most important* benefactors of the Institute. All of us have the greatest admiration and respect for the work of the Alumni officers and directors, and for all of the individual alumni whose contributions have made the Alumni Fund what it is today. I hope that you as President can convey to your Board and to your membership the deep gratitude of the Institute.

Sincerely,

L. A. DuBridge



Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

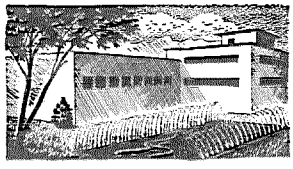
Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

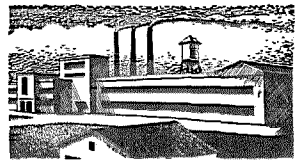
WORTHINGTON

The Sign of Value Around the World

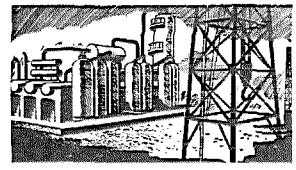
1.14



Good Water and Sanitation—engines pumps • water treatment • comminutors air compressors • air tools



Lower-Cost Manufacturing—pumps compressors • steam turbines • motors power transmission • air conditioning



Petroleum Products—compressors engines • pumps • chilling equipment refrigeration • decoking systems

More Abundant Food—compressors fertilizer mixers • air conditioning refrigeration • pumps

PERSONALS

1920

Russell M. Otis, Ph.D. '24, has been elected vice-president in charge of engineering, research and patents, of the Lane-Wells Company in Los Angeles.

1921

Charles Quirmbach took over the presidency of the Western Square Dance Association of San Gabriel Valley this year. Last year's president was Allen Dunn '29.

1922

Arthur M. Whistler has been promoted to chief process engineer of the Fluor Corporation in Los Angeles. He has recently moved to Pasadena and just became a grandfather for the second time.

1923

John H. Puls reports that he has a daughter, Diane, age 21, at U.C.L.A., and a son, David, 18, who is a freshman at Whittier College. John is still West Coast Division Manager of the Texas Company's producing department in Los Angeles.

1924

Fred J. Groat has recently become Supervising Electric Utilities Engineer in the Division of Water Resources at Sacramento. The new position will give him more responsibility in power matters in the office of the State Engineer.

1925

Tracy L. Atherton is Topographic Engineer in the Division of Water Resources at Sacramento. He transferred there from the State Lands Commission about a year ago.

Neal D. Smith, formerly city manager of Santa Cruz, was named by Lockheed Aircraft Corporation to coordinate community development at its new jet test center in Palmdale, Calif. Neal will work with Antelope Valley authorities on matters of community housing and facilities. Also president of the city managers' department of the League of California Cities, Neal presided at the annual Spring Conference held in Riverside in February.

John E. Maurer is owner of a paper converting business in Pomona, operated under the name of Tidi Products.

1928

Ed Joujon-Roche was transferred last year to the exploration department of the Shell Oil Company in Long Beach as a geologist, after a five-year session as supervisor of training and safety for the Pacific Coast area in the exploration and production departments of Shell Oil. Ed returned recently from a business trip to Houston, Texas, where he had a reunion with *Charles "Fat" Lewis* '28, chief engineer of the Cook Heat Treating Company there.

1929

William L. Berry is in charge of the State-Wide Water Resources Investigation in the Division of Water Resources in Sacramento. Bill recently became a Principal Hydraulic Engineer.

Allen Dunn and his wife had their first son, Gregory, in October, 1950. Paulette, their eldest daughter, was married in October, 1951, in Arcadia.

1930

N. D. Whitman, Jr., M.S. '32, has two children, lives in San Marino and does consulting work in Pasadena. He is also doing some Navy work on the side.

1932

Mervin A. Schuhart has been promoted to senior highway engineer and has been transferred to the Sacramento headquarters office of the California Division of Highways.

C. Phillip Schoeller was married to Jane Elizabeth Davis on February 23 in Rio De Janeiro, Brazil, where the couple will live. Phil is a project engineer for the Morrison-Knudsen Company, working on the construction of a railway providing access to a new iron ore development in the interior of Brazil.

Henry A. Bruderlin, after working ten years for Douglas Aircraft, has been self-employed since 1944. He has designed and built several houses, two of which were recently photographed for national magazines. He has four patents on the market on nationally advertised articles, and three more are now in process. He operates silver and copper mining property in the Superstition Mountains in Arizona, and also finds time to do some consulting work on production design and acoustics. Henry, his wife and three children — Jim, 12, Brian, 9, and Sue, 6—are planning a year's trip to the South Seas some time later this year. They will take in the Fijis and Societys to start with, going by commercial routes.

1936

Maurice Sklar, M.S. '38, who is working for the Union Oil Company in Bakersfield,

CONTINUED ON PAGE 46

ALUMNI ASSOCIATION OFFICERS

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VICE-PRESIDENT
John E. Sherborne '34

SECRETARY
Donald S. Clark '29

TREASURER
Henry R. Freeman '25

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Paul Hubay '49
Hallan N. Marsh '22
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VICE-PRESIDENT Robert R. Bowles '41
California Research Corp., 576 Standard Ave., Richmond

SECRETARY-TREASURER Arnold L. Grossberg '42
California Research Corp., 576 Standard Ave., Richmond

The San Francisco Chapter meets for lunch at the Fraternity Club, 345 Bush St., every Thursday.

Washington, D. C., Chapter:

PRESIDENT Comdr. Clarence A. Burmister '25
U. S. Coast & Geodetic Survey

SECRETARY-TREASURER Charles R. Cutler '45
800 World Center Building

Sacramento Chapter:

PRESIDENT Fred Groat '24
California Division of Water Resources, Public Works Building.

SECRETARY-TREASURER Richard Silberstein '41
Arthur A. Sauer, Consulting Structural Engineer, 2203 13th St.

Chicago Chapter:

PRESIDENT LeVan Griffis '37
Armour Research Foundation, 35 W. 33rd St.

VICE-PRESIDENT Eben Vey '41
Illinois Institute of Technology, 3300 S. Federal St.

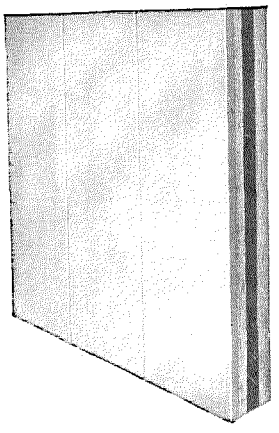
SECRETARY-TREASURER Harrison Lingle '43
Cherry Burrell Corp., 427 W. Randolph St.

What's Happening at CRUCIBLE

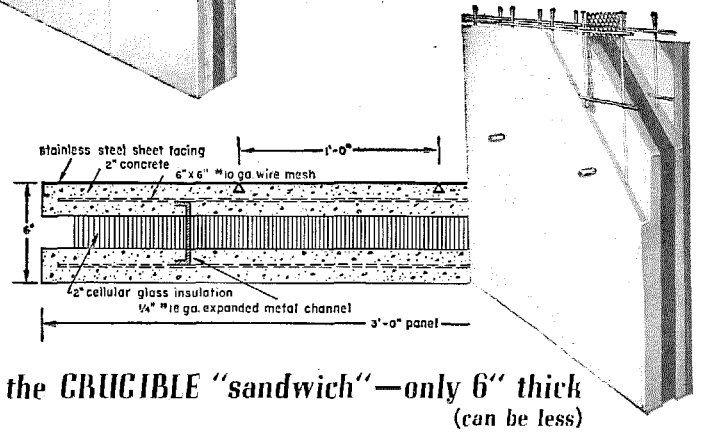
about stainless curtain walls

Modern construction methods have changed walls from the self-supporting type to a mere covering which does not support its own weight for more than one or two stories. Hence the definition of "curtain wall":—the facing or enclosure of the structural steel frame. This frame supports the entire weight of modern buildings.

The need has existed for a covering that would not only clothe the building, but be lightweight, economical and space saving. Because these requirements are more than adequately met with stainless steel curtain wall construction, this method is becoming increasingly popular with cost and space conscious owners, builders and architects.



the CRUCIBLE "sandwich"



the CRUCIBLE "sandwich"—only 6" thick (can be less)

Crucible stainless steel curtain wall panels are in the form of 6-inch thick "sandwiches". The facing consists of flanged, light-gauge stainless steel sheets with a factory, or site-fabricated, sandwich consisting of cellular glass insulation between two layers of concrete with connecting reinforcing. Crucible 18-8 stainless as the outside face offers excellent resistance to weather and fire while providing eternal beauty with a minimum of maintenance; the inside face can be finished or painted to suit the requirements of modern building interiors. Since 18-8 is restricted in use, a good substitute material, type 430 stainless, now government decontrolled, offers the same benefits as 18-8 stainless.

moisture penetration

The unique characteristics of the cellular glass insulation stop moisture vapor migration from one face of the panel to the other. The cellular insulation properly designed and installed assures that condensation will not take place *anywhere* within the sandwich.

insulation

Although less than half as thick as the usual wall construction, this Crucible stainless steel panel construction has more than twice the insulating value. The "U" value (overall thermal conductivity) is approximately 0.15 BTU Hr./Sq.Ft./°F.

fire resistance

The Crucible sandwich met the requirements of a standard 4-hour fire test conducted in the testing laboratories of the National Bureau of Standards. This meets all old building codes and is double, or better, the requirements of modern enlightened building codes.

erection and fabrication

Since a building frame is not precision built, the attachment of the panel walls to the frame is done with fastening devices that provide necessary 3-dimensional adjustment. Panels can be made at the building site, and a 24-hour casting-to-fastening cycle is possible.

technical service available

Though the use of some stainless steel is now restricted, Crucible metallurgists and development personnel are continuing to investigate improved methods of curtain wall and other construction so that better buildings can be built when stainless is more freely available. For more information write: CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, Pittsburgh, Penna.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

is the new secretary-treasurer for the northern district, Pacific Section, of the Society of Economic Geologists.

1938

Frederic H. Moore has recently been promoted to head up process engineering design in the Los Angeles office of the Refining Engineering Department of the Texas Company. Fred has worked for the Texas Company for 14 years.

Ralph W. Jones has been admitted to partnership in Booz, Allen and Hamilton, Management Consultants. He will continue to make his headquarters in Los Angeles, to serve the expanded West Coast business of his firm. After graduating from Tech Ralph went to work as an engineer for the Byron Jackson Company. Later he became chief engineer and works manager of the St. Paul (Minnesota) Engineering and Manufacturing Company. He was also engaged on engineering projects for the Army, the Navy and Caltech. He has been with Booz, Allen and Hamilton since 1947.

1939

Charles H. Townes, Ph.D., is now a physicist-consultant for the National Bureau of Standards in Washington, D. C., where he recently collaborated on a compilation of molecular microwave spectra tables. Since 1948 he has been an associate professor of physics at Columbia University in New York. Prior to that, he was a member of the technical staff of the Bell Telephone Laboratories.

Dave H. Scott, who works for Texaco in Los Angeles, was recently elected vice president for the southern district, Pacific Section, of the Society of Economic Geologists.

1940

Gordon B. Weir, M.S., is appearing on television with a weather show five nights a week, twice nightly, at 6:15 and 11:10 p.m., on KECA-TV, Channel 7. This, Gordon says, puts him in competition with Beany. At present he is on a sustaining basis, but since he's looking for a sponsor, all fan mail will be gratefully received.

1941

Bob Galeski, who works for the Honolulu Oil Company in Bakersfield, has been named vice president for the northern district, Pacific Section, of the Society of Economic Geologists.

John H. Carr, M.S. '43, and his wife announced the arrival of John Andrew Carr on March 15, 1952. John is working as a section chief at the Hydro Lab in Azusa.

1942

Frank A. Fleck is chief of a three-man Ordnance Engineering Surveillance Team at the Office of Ordnance Research at Duke University in Durham, North Carolina. The survey team will make engineering analyses and studies, establish qualitative standards for evaluating ordnance engineering projects, and survey the inter-relationships of departmental projects.

An Air Transport Command navigator during World War II, Frank has been in the guided missile industry since 1946, working at the Aerojet Engineering Corps in Azusa, California.

1943

Richard A. Sutton, M.S. '47, is now with the Creole Petroleum Corporation in Venezuela. In a letter written recently to Prof. R. L. Daugherty, Dick reported:

"So far my four years in Venezuela have been enjoyable. We live in congenial camps, the job experience is definitely varied (I'm acting as an electrical engineer at present and have even been a pile driver foreman), the pay is high, the income tax is low (2.2% last year), and the country and customs are interesting.

"Venezuela has some interesting laws. One of them pertains to the 'utilidadu.' It is a profit-sharing plan for the employees which amounts to two months extra pay each year. Also, if a worker is laid off, he is paid a minimum of 30 days pay for each year of service."

Dick will be leaving Venezuela this

month for a short vacation in Aberdeen, Scotland.

Blakemore E. Thomas, M.S., Ph.D. '49, has resigned his job as Assistant Professor in the University of Kansas Geology Department and is now with William Ross Cabeen and Associates, engaged in consulting geology, in Van Nuys, Calif. On February 2 of this year the Thomases became parents of twins—a boy and a girl.

Robert R. Davis is still a design engineer at Beckman Instruments, Inc. in South Pasadena, where he received a five-year pin on February 2. The Davises have two boys, aged 2 and 5, and live in Monrovia.

Bob reports he still likes to ski, tinker with cars and audio amplifiers, is taking classical piano lessons and sings in the church choir. He just sold his classic 1933 Cadillac convertible coupe, after finishing a complete restoration job.

Lt. Ralph M. Willits, who was called back into service in January, 1950, is on the destroyer escort, *D. A. Munro*, now in Korean waters. His wife, Nancy, and his 21-month-old daughter, Kathleen, are waiting for him in Waialua, Oahu, T. H.

1944

Charles B. Miller is Division Engineer of the Pipe Line Department of the Richfield Oil Corporation in Long Beach. The Millers have a new baby girl, Vicki Lee, born on March 31.

Stephen W. Dana, Ph.D., head of the Geology Department at Redlands University, was married on January 25 to Jane M. Allaman.

Lt. Alfred G. Knudson was called to active duty with the Army last June and is now at the Station Hospital in Fort Riley, Kansas.

Phillip L. Adams writes from Orleans, France, that he is an administrative assistant to one of the Army Colonels running the Logistics Division at the headquarters of the supply zone into Germany. He quit his job as an industrial engineer in California and went to Europe with the thought of traveling for a year—but soon found living and traveling costs so high that he decided to get a job. Now, he says, he can travel and get paid for it!

Neville S. Long announced a new addition to the Long family on February 24—a boy named Arthur Dennis. Neville also has a new position with the United Water Conservation District of Santa Paula. The project consists of the location, design and construction of one or two fairly large dams for the purpose of conserving some of the waters of the Santa Clara Valley (Ventura County) watershed. He says he's getting some good hydrological and design experience on this job.

Robert O. Randall announced the arrival of a son, Donald Robert, last December 15.

Floyd B. Weaver is married and has two boys, 6 and 3. After moving around southern California, he has bought a house and settled down in Alhambra. Floyd is working as a field engineer for Kistner, Curtis & Wright, architects and engineers, inspecting the various jobs during the structural phase of their construction. He is a registered civil engineer and is working toward his structural license.

1945

Bertram Keilin, M.S., Ph.D. '50, is now giving a course in elementary chemistry to a group of mechanics at Caltech's Jet Propulsion Laboratory. The group meets once a week, on Tuesday evenings, at JPL, and the course is working out so well that Bert is planning to conduct future classes in basic physics and mathematics.

1946

John Sheldon Showell, M.S. '49, received his Ph.D. from the University of Minnesota on March 20.

Lt. Fremont E. Reichwein is a gunnery officer assigned to the U.S.S. Mt. Katmai, an ammunition ship now en route to Korea. Fremont has been in the United States only twice in the last two years, and, at present writing, intends to remain in the Navy.

1947

Captain Donald D. Mon, after graduation from Stanford Law School and admis-

CONTINUED ON PAGE 48

ALUMNI CALENDAR

June 4 — Annual Meeting
Date to come — Family Day

CALTECH ATHLETIC SCHEDULE

SWIMMING

Fri.	Apr. 18	Caltech (Vars. & JV) and Whittier	at PCC
Fri.	Apr. 25	Caltech (Vars. & JV)	at Occidental
Wed.	Apr. 30	Caltech (Vars. & JV) and Redlands	at PCC

TRACK

Sat.	Apr. 12	Interclass Meet	
Sat.	Apr. 19	Caltech, Redlands, Occidental (Vars. & JV)	at Occidental
Sat.	Apr. 26	Pomona (Vars. & JV)	at Caltech

TENNIS

Wed.	Apr. 16	Whittier at Caltech
	(JV)	Caltech at Whittier
Sat.	Apr. 19	Oxy at Caltech
Sat.	Apr. 26	Pomona (JV) at Caltech
		Loyola at Caltech
Wed.	Apr. 30	Caltech at Chapman

GOLF

Fri.	Apr. 18	Caltech, Whittier, and Pomona at Montebello

BASEBALL

Tue.	Apr. 8	Nazarenes at Caltech
Sat.	Apr. 12	Caltech at Whittier
Mon.	Apr. 14	E.L.A.J.C. at Caltech
Tue.	Apr. 15	L.A. State at Caltech
Sat.	Apr. 19	Caltech at Redlands
Sat.	Apr. 26	Chapman at Caltech
Tue.	Apr. 29	LaVerne at Caltech
Wed.	Apr. 30	Whittier at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES
7:30 P.M. — 201 BRIDGE

Apr. 18	"Stellar Spectroscopy"	by Dr. A. J. Deutsch
Apr. 25	"Cosmic Rays"	by Prof. E. W. Cowan
May 2	"Frequency Effects in Electric Power Applications"	by Prof. F. W. Maxstadt

PERSONALS . . . CONTINUED

sion to the California Bar, was recalled to the Air Forces. He now serves as an Inspector General with the Western Air Procurement District, stationed in Los Angeles. His particular field is inspection of contractual relationships in Air Force procurement. When he is released in October, 1952, Don hopes to practice law in Pasadena. He is currently living in Sierra Madre, and is still single.

Peter Swerling is at present employed half-time at the Rand Corporation in Santa Monica, and is also working for a Ph.D. in math at U.C.L.A.

1948

Lt. James T. Rostron, M.S., was recalled to active Naval service in the Civil Engineer Corps in June, 1951. He is attached to the District Public Works Office in Kodiak, Alaska. Jim is resident officer in charge of construction for a 5½ million dollar contract involving construction of new transmitter facilities, Taxiway extension, and Kodiak road relocation.

Thomas H. Hamilton married Margaret L. Upson in 1948 and now has three children—Sally Louise, Susan Margaret, and Carolyn Nancy. Until September of 1951, Tom worked as a chemical engineer with The Texas Company. He is now a coding tower engineer with the Fluor Corporation in Los Angeles.

1949

Dennis V. Long is now Lt. (j.g.) in the Navy Civil Engineer Corps and is stationed at Davisville, Rhode Island, where he is the assistant security officer.

John F. Kostelac writes that on March 13, 1952, he received another income tax deduction—a baby girl. The score now stands at an even ration of one boy, one girl.

1950

Don Smathers was married on April 5. He plans to enter U.C.L.A. in the fall to study for a Ph.D. in organic chemistry.

Bruce Robinson and his wife Joan announced the arrival of a daughter, Margaret Carol, on January 22, 1952.

Joe Birman, M.S., announced the birth of a son, David, last December 22.

William C. Culbertson is working for the U. S. Geological Survey at Miles City, Montana. He spent the last field season mapping strippable coal deposits in eastern Montana.

Harold Sletten, M.S., is at North American Aviation in the Atomic Energy Research Department.

1951

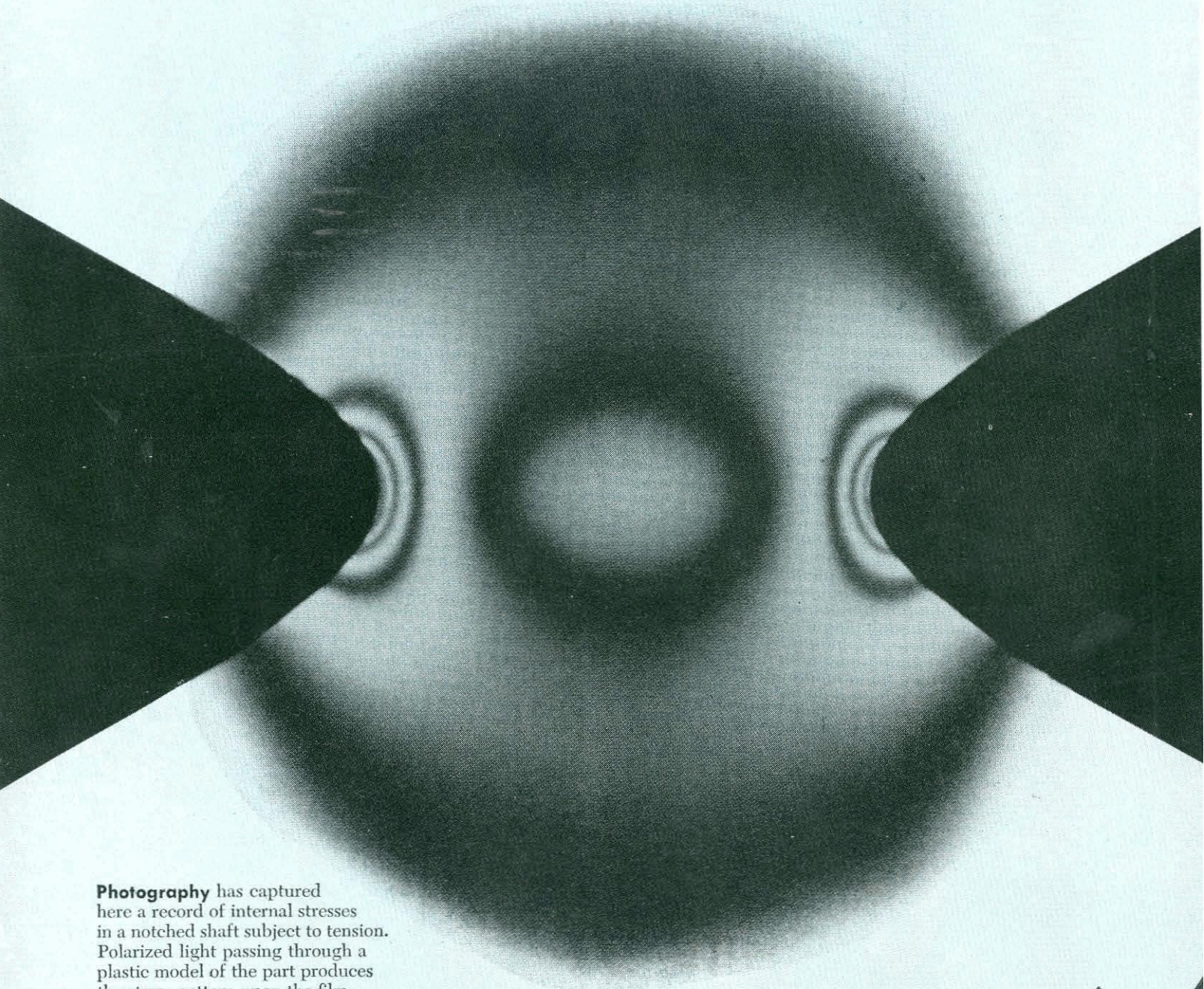
William B. Roberts, M.S., is employed by Shell Oil Company as a geologist. He's working in the Great Basin region, with headquarters at Ely, Nevada.

Stephen Pardee is working for his M.S. in electrical engineering at Caltech on a Westinghouse Fellowship.

Photography gives engineers quick, accurate facts

● In routine work—in unique applications—engineers find photography can supply information obtainable in no other way. It can show you internal stresses in machine parts—you see what modifications in design will increase strength and reduce weight. You can study fast motion by slowing it down with high speed movies. You can record the flick of the cathode-ray trace or get accurate records of other instrument readings.

Photography is already aiding engineering in many important ways, and new applications are being made every day. This has led graduates in the physical sciences and in engineering to find positions with the Eastman Kodak Company. If you are interested, write to the Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.



Photography has captured here a record of internal stresses in a notched shaft subject to tension. Polarized light passing through a plastic model of the part produces the stress pattern upon the film.

FUNCTIONAL PHOTOGRAPHY

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Kodak
TRADE-MARK

WE ASKED GRADUATES TEN YEARS OUT OF COLLEGE:

WHAT MADE YOU DECIDE ON A CAREER WITH GENERAL ELECTRIC?

This advertisement was written by G-E employees who graduated ten years ago—long enough to have gained perspective, but not too long to have forgotten the details of their coming with the Company. These graduates were sent a questionnaire and were requested to return it unsigned. Their answers, listed below in order of mentions, give an informative appraisal of G.E. as a place to work and as a source of career opportunities.

1. G-E TRAINING PROGRAMS

Sample quotes: "I knew that G.E. offered the best training courses." "Liked the idea of rotating assignments and courses." "Wanted to take advantage of the training courses." "G.E. had a training plan which would let me choose a job after reasonable time for investigating jobs available in the Company." "I felt that Test (Test Engineering Program) would make the easiest transition from school to work." "I felt that I would get the best kind of electrical engineering training if I went with G.E." "The Test course appealed to me because of its combination of continued technical instruction plus practical experience on the test floor."

2. VARIETY OF OPPORTUNITIES

"Why does a youngster run away with a circus?" "Believed it was a good chance to find the field I liked best as I wasn't quite *sure* what type of work I wanted to get into." "G.E. goes out of its way to find the corner you are happiest in and best suited for." "The varied opportunities of work let you change jobs without leaving the company." "Only company which offered a job where an engineer could be in on design, sales and application—i.e., 'application engineering.'" "Promise of varied experience made it unnecessary to decide on a particular specialty until I had more opportunity to look the field over."

3. GENERAL ELECTRIC'S REPUTATION

"G.E.'s prestige and reputation appealed to me." "G.E. was more favorably disposed to the coming war effort and was doing work directly contributory." "High caliber persons with whom to work." "Reputation for technical excellence." "G.E.'s reputation as a good employer." "Because with the name of G.E. went a sense of security." "I felt that G.E. was the leader in the electrical field and I wanted to take part."

4. CONSIDERATE TREATMENT

"The only offer I received was from General Electric —other companies interviewed would not consider me because of my reserve officer status." "Among the companies offering jobs to college graduates in 1941, G.E. seemed to take more of a personal interest in its new men." "The G-E representatives made me feel they were interested in *me*."

For a free booklet, "Planning Your Career," a description of such G-E training programs as the Test Engineering Program, Business Training Course, Manufacturing Training Program, Chemical and Metallurgical Program, the Physics Program and Sales Training programs, write to General Electric Co., Dept. 221B-6, Schenectady, N. Y.

You can put your confidence in—

GENERAL ELECTRIC