ENGINEERING AND SCIENCE

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Nuclear Reactor . . . page 26

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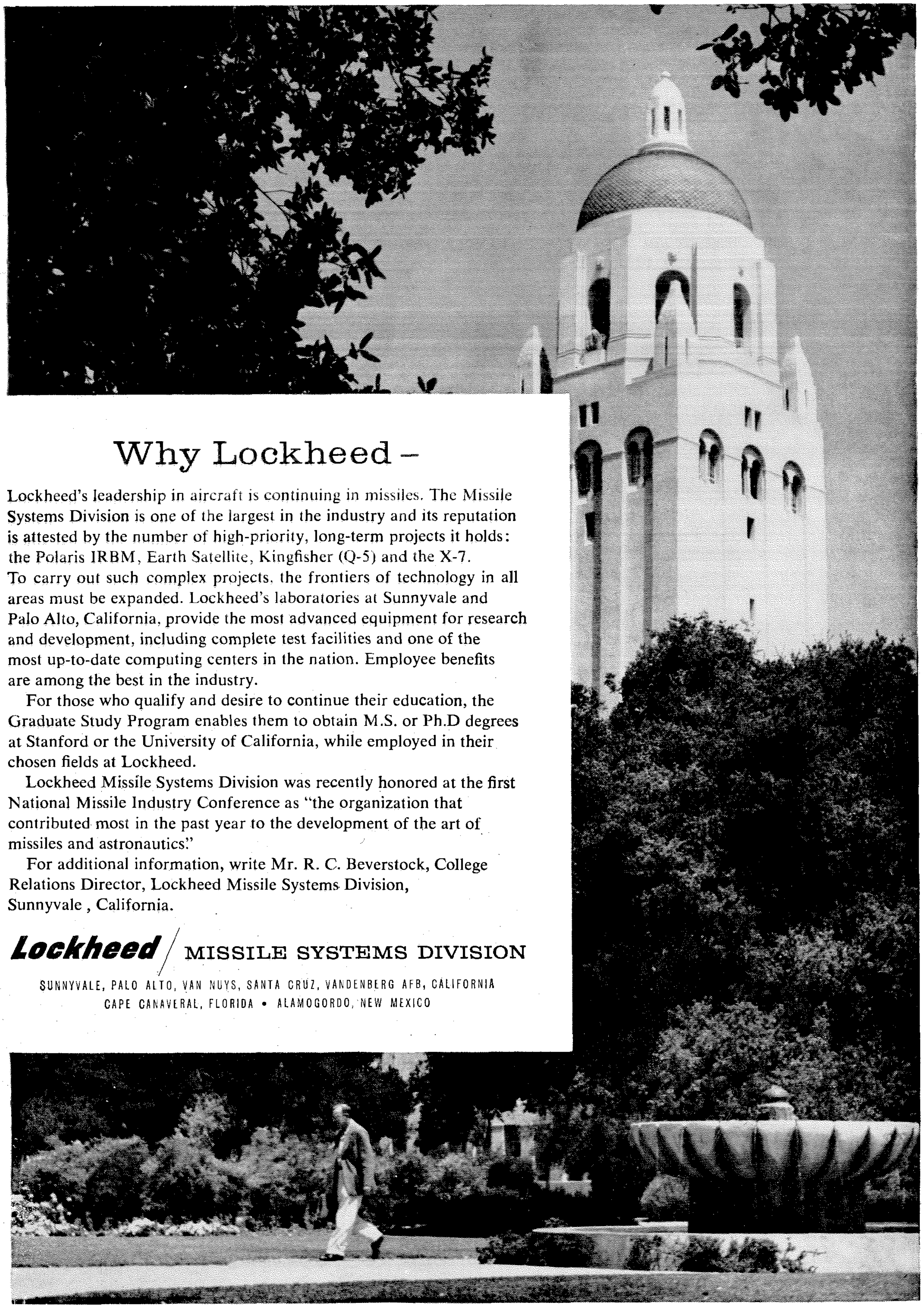

ENGINEERING | AND | SCIENCE

DECEMBER, 1958 VOLUME XXII NUMBER 3

On Our Cover

Harold Lurie, associate professor of applied mechanics at Caltech, assembles a pattern of uranium-filled tubes in the new subcritical nuclear reactor now being used by engineering students in the Institute's new nuclear energy option.

Dr. Lurie, a native of South Africa, received his PhD in aeronautical engineering from Caltech in 1950, and also served as a lecturer in aeronautics here. After three years with the Rand Corporation in Santa Monica, he came back to Caltech as an assistant professor in 1953. In 1956-57 he spent a year's leave of absence at the Oak Ridge National Laboratory, then returned to the campus and developed the nuclear study program which he describes on page 26.

Richard H. Jahns

has been interested in the geology of southern California ever since he first went on field trips in this area as a Caltech undergraduate in the '30's. This interest became even livelier a few years ago when Dr. Jahns edited the mammoth *Geology of Southern California*, and these days he spends a good deal of his spare time studying problem areas in this region. He calls this work "scientific doodling" — a label with which you will heartily disagree when you read his absorbing report on page 13.

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Letters

All About Libraries

George W. Beadle, chairman of Caltech's biology division, has always had a strong interest in library management. In England as Eastman Visiting Professor at Oxford University for 1958-59, Dr. Beadle set out this fall to make use of the Oxford libraries. The following is a true account of his experiences, which he wrote and sent to friends at Caltech interested in library matters.

It all started this way: The Demonstrator in Genetics asked me where he could find a good summary of the mechanism by which bacteria exchange genetic material.

"Easy," I said. "There's an excellent review in the *Scientific American* of about a year ago. You see it, of course?"

"No, not regularly. We don't have it in the Department Library," (Botany) "but it will be in the Radcliffe Science Library, just down the street."

I made a mental note of that for I had decided that I would initiate my lecture series at Oxford with a review of evolution beginning with the origin of the elements and I knew I could find excellent summaries of the present state of knowledge in the recent volumes of the *Scientific American*.

Next day, I went down to Radcliffe to learn my way around. I was duly signed up in the big book, given permission to use the library and instructed in its organization.

First I checked for the May number of the Proceedings of the National Academy of Sciences that I knew had contained a paper I wanted to read. It hadn't yet crossed the Atlantic and made its way through the Bodleian-Radcliffe accession machinery. This was not too surprising even though I had already received, in Oxford, by ordinary mail, the August number. Things do move a bit slower here and one must learn patience . . .

"Now to get that issue of the *Scientific American*," I said to myself.

I checked the periodical catalog. No card for the *Scientific American*.

Realizing that it was almost teatime and that I'd miss that pleasant half-hour if I didn't hurry back, I returned to the Botany Department—with the report that the Radcliffe didn't have the *Scientific American*.

"Oh, you *must* be mistaken," said the Demonstrator in Genetics. "It just has to be there."

The next day I tried again, with the friendly assistance of a gentleman who, I judged from his behavior, was the head librarian.

"Well, now," he explained, "that periodical is just a bit popular for us and I don't believe we have it."

He confirmed my check of the card file, reviewed the "on order" list and then went to the World List.

"Oh, this is why we don't have it. You see, it is in Forestry and in the Bodleian."

"Fine," I said. "Forestry is right next to Botany and it will be convenient."

So I went to Forestry, hunted up the "Enquiries" office and said confidently and cheerily to the young lady in charge: "I'm in Botany and I should like to use your library. You seem to have an up-and-coming Department here, one with commendable enterprise and good judgment. You have the *Scientific American* in your library. Botany and Radcliffe do not."

She beamed at me, invited me to use her library and took me directly to the librarian.

I stated my desires—permission to use the Forestry library and specifically right then to consult the *Scientific American* which I understood they had.

"Oh, I'm sorry, I'm afraid we don't receive it any more. Rather popular, don't you know."

It turned out, on further inquiry, that they had discontinued the *Scientific American* in 1933.

But there might be other material I'd need, so I asked for and received indoctrination in the use of the Forestry library, including signing the "Library Book." This library is not catalogued in the same way as Botany (and Botany differs from Radcliffe). Even within Forestry there are two catalogs — one for books published

continued on page 6

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prior to 1934 and a different one for more recent books.

We did, before I left Forestry, check another periodical catalog of the Oxford libraries. The *Scientific American* was indicated as being in the Department of Agriculture (of the University).

The next day on the way to lunch I stopped in at Agriculture, found the office, stated my request and was escorted to the library and introduced to the librarian. I again said who I was, what I wanted in general, and specifically inquired about the *Scientific American.*

"Oh, I'm sorry. I'm afraid you're mistaken. We don't subscribe to many popular journals, you know."

Right beside him was a rack of farm journals.

I later re-checked the catalog of the Oxford libraries. The *Scientific American is* listed in Agriculture.

The next day I resolved to solve the specific problem of reference to the *Scientific American* by going to the main library—the Bodleian.

I was directed to the right building and to a certain lady and I found her, a most pleasant and cooperative person, taking library pledges from a gathering of new students. I queued up and waited my turn; again I stated my desire.

"Are you a member of the University?"

"Yes, I'm the Eastman Visiting Professor this year and am in the Botany Department."

"I'm sorry to cause you inconvenience but I'm afraid I shall have to ask you to take the pledge."

So I pledged:

> *"I hereby undertake not to abstract from the Library, nor to mark, deface, or injure in any way, any volume, document, or other object belonging to it; nor to bring into the Library or kindle therein any fire or flame, and not to smoke in the Library; and I promise to obey all regulations of the Library."*

"Oh, yes," she continued, "and now I must ask you to fill out this application."

She handed me a form and said: "Are you by chance a member of a College?"

"Yes, I'm a Fellow of Balliol."

"Oh, I'm so sorry. I didn't understand. In that case you need not fill out the form."

I concluded that Fellows of Balliol outrank Eastman Professors.

I followed her directions to the periodical card catalog – in another building – and confidently set out to find the *Scientific American.*

No card.

No *Scientific American.*

No *Scientific American* in the Bodleian.

No *Scientific American* in the whole of Oxford!

But no, that may not be true. For the Bodleian and its branches – Radcliffe Camera, New Library, Radcliffe Science Library, Rhodes House Library and Indian Institute Library – are not the only libraries in Oxford University.

There are 24 College libraries, all separate, each individual in its system of cataloging, its hours and its rules. Women may not enter some; I haven't yet investigated whether men may use the libraries of the several women's Colleges.

And in addition to the 24 College libraries there is the Balliol-Trinity Library of Science – separate from the regular Balliol and Trinity libraries and distinct from the Radcliffe Science Library.

There is no central catalog of College libraries.

So I may be wrong. The *Scientific American* may be in one of the College libraries – or maybe in all of them.

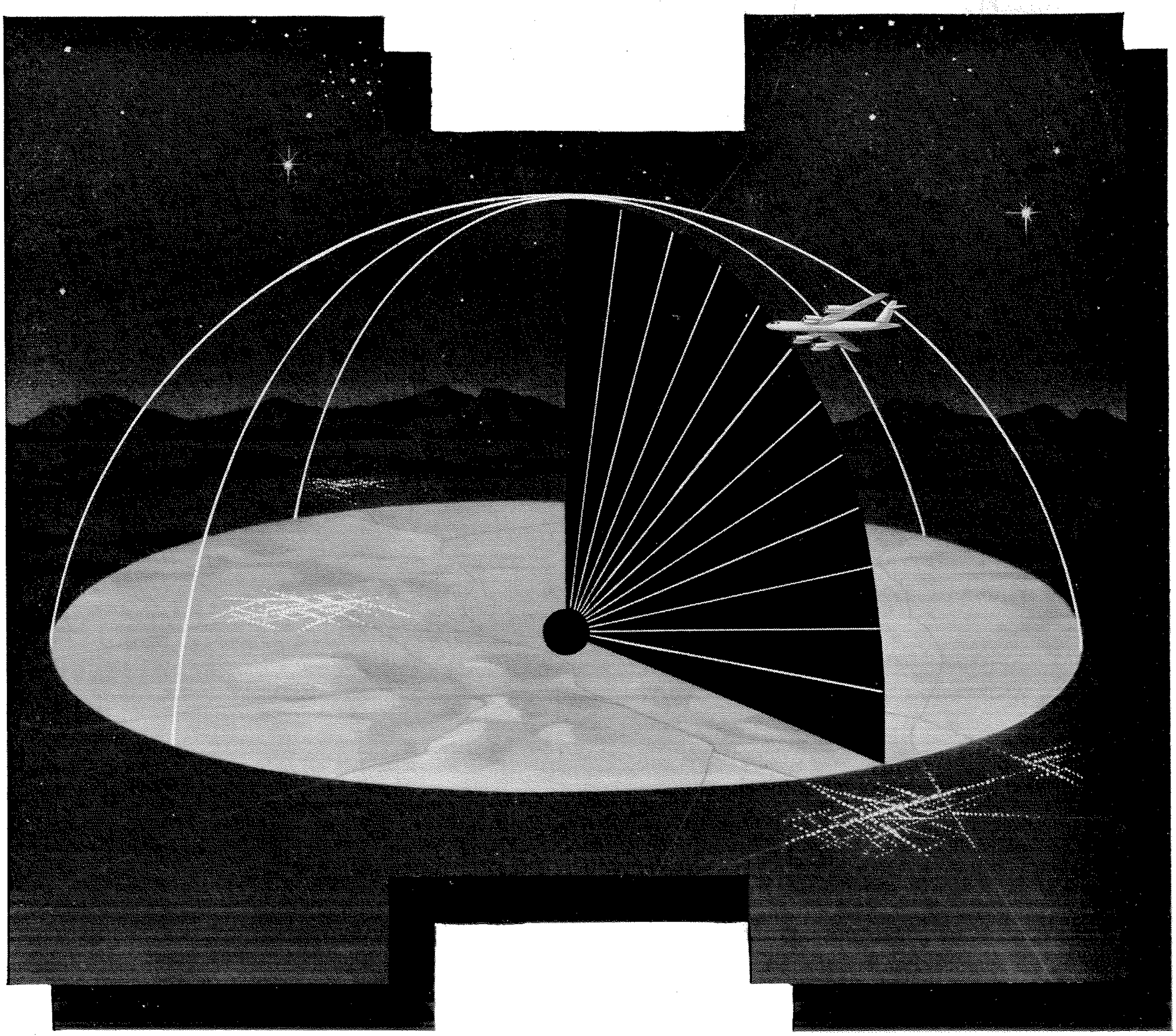
I figure that if I were to consult all the reference material relevant to my survey of evolution from the beginning of the universe to the advent of modern man, I should have to make use of 17 different libraries. I don't think I'll manage it by Thursday of next week.

So I guess I'll just have to send home for my file of *Scientific Americans* and another batch of reprints.

Oxford is a marvelous institution – or perhaps one should say, a loose federation of institutions – and I shouldn't want to see it changed. All the same, I'm certainly glad Caltech is going to have a centralized main library where I can learn about evolution, from hydrogen to man, in one building.

– G. W. Beadle

MAKING UMBRELLAS



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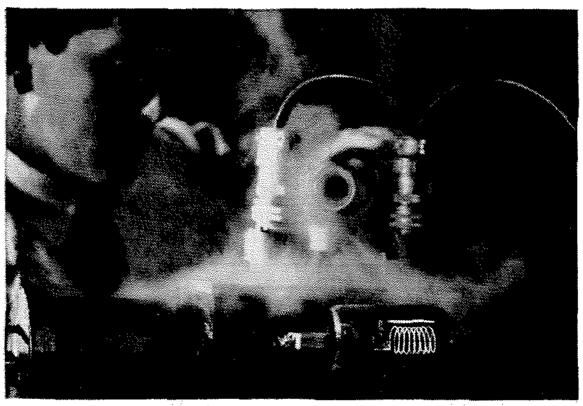

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Books

Man's World of Sound

by John R. Pierce and Edward E. David, Jr.

Doubleday and Company, Inc. *$5.00*

Reviewed by Robert V. Langmuir

This is a book which treats speech, hearing and the related fields of psychology and acoustics at an intermediate level. Essentially no knowledge of physics or mathematics is presumed on the part of the reader, yet the book is not easy reading for there is considerable content here – much of it new and very interesting to this reviewer who is *not* an expert in acoustics. It is very refreshing to find among the complicated technologies of today one that can be explained in some detail and at quite a high level to an amateur in science without using the calculus.

Both of the authors are research scientists at the Bell Telephone Laboratories in Murray Hill, New Jersey. John R. Pierce, director of research in electrical communication, received all his degrees at Caltech—a BS in 1933, an MS in 1934 and a PhD in 1936. His most recent book *Electrons, Waves and Messages,* was published in 1956.

Edward E. David, Jr., a graduate of Georgia Tech and MIT, is assistant director of visual and acoustics research at the Bell Laboratories.

The book first discusses some of the physical aspects of sound—the relation of frequency and wavelength —and has a simple discussion of resonators. Next is a fascinating discussion of the details of the human vocal system. It is almost impossible to read this silently as the reader must immediately check just what the tongue is doing when, for instance, he pronounces the vowels in "eat" and "lost." The acoustics analysis of speech is very interesting—particularly the comparative ease with which various speech sounds are described by phonetic symbols and the difficulty of representing them by physical means such as frequency content, wave form, etc.

The chapters on hearing by their very nature contain as much physiology and psychology as physics and acoustics. Here there is much of interest to the hi-fi fan, in particular the discussion of what can be accomplished by various stereo systems.

The last chapter is a summary of the unsolved problems in this field and a plea for scientific amateurs to jump in and get their feet wet with some research of their own. This field is one of the few left where the natural philosopher or non-expert is almost sure to make many of the important contributions of the future.

I can recommend this book highly for just such amateurs – those with a strong interest in science, with or without much formal training.

Robert Langmuir is professor of electrical engineering at Caltech and has been here ever since he received his PhD in 1943.

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

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RESIDENTIAL ILLS

in the Heartbreak Hills of Southern California

by Richard H. Jahns

The house shuddered slightly to the tune of creaking joists and a low background rumble that Earnest Winner, half-rising from his comfortable pillow, fuzzily identified with a modest earthquake. A mumbled comment to his wife, a few muscular twitches after reassuming a horizontal position, and he was again asleep. Presumably his rest was a pleasant and untroubled one, for Mr. Winner was yet unaware that he had become a serious loser.

Early the next morning, his young son burst excitedly into the bedroom, shrilling, "Daddy, Daddy, the garage is gone!" And this disquieting message proved to be quite accurate, as the almost-new garage and its contents, including the family automobile, two bicycles, and a beloved assemblage of power tools, had indeed vanished from sight of the house—along with the rearward one-third of the entire lot.

What had appeared the previous afternoon as an irregular "settling crack" that traversed the back lawn and garden was now the ragged edge of a sheer drop-off, at which the remaining segment of the driveway terminated absurdly. One can imagine Mr. Winner's emotions when he looked over the edge and saw that he had lost a substantial part of his property to the deep canyon lying behind it. The missing part of his backyard now formed an uneven bench part way down the canyon wall. There, tilted at crazy angles about 50 feet below him, rested the dislocated elements of his garage. One headlight of his car seemed to peer inquiringly at him through the wreckage.

The unhappy Winner didn't yet know that his contribution to the canyon was merely the latest of many in this small part of the Pacific Palisades district, not a few of the slides having occurred during the years since settlement of the Greater Los Angeles area began to expand in this direction. He was soon to find out, though, that some of his neighbors had been suffering even more serious losses from successive slides nibbling away at their properties. He also was to discover that several lots, *including his own*, had been occupied by houses at least once before! Fissuring, settling, and gross migration of the ground had damaged these structures and had withdrawn so much support from beneath them that they had been condemned as unsafe for further occupancy. All had been removed, down to the last shingle and stud, then the lots had been regraded and sold to the next persons desiring a fine view of the Pacific Ocean. These transactions, of course, were unaccompanied by pertinent comments on recent geologic history.

This is where Mr. Winner had come in. Now, as he contemplates his personal disaster, he wonders why he wasn't made aware of what he tardily recognizes as obvious. Possibly he also is thinking in terms of whom he can sue, for what, and on what grounds.

Meanwhile, Mr. and Mrs. Purdy Gesser have just reached an agonizing decision as to the disposition of their modern home in the Portuguese Bend area of the Palos Verdes Hills. They reflect, as they look through their enormous picture window across moonlit waters toward the dark silhouette of Catalina Island, that this is their "dream house," built to their own plans at a lovely spot of their own choosing. They recall how they had "thought of everything"—an area with mild climate and relative freedom from smog, a quiet, pleasant neighborhood within easy driving distance of schools, church, shopping centers, and Purdy's office, a large view lot with all utilities available, and a fine home that they could afford through careful management of their resources. But now, after less than three years, the picture window is badly cracked, the walls and floors are buckled, the patio and adjacent ground are warped and ruptured, and the kitchen and living room are held six feet above the sagging foundation by enormous jacks. The house is a split-level structure, though it wasn't built that way!

Two years ago the Gessers, along with many neighboring families, had begun to realize that something was terribly wrong. Doors that had been sticking no longer could be closed, tiny cracks in the walls had become inch-wide gaps, the roof had developed a dozen unaccountable leaks, and water and gas pipes had been broken several times, generally at points of minimal accessibility. Soon the word was out—the Gesser home was one of many built on an enormous landslide mass, a mass that, somehow reactivated, was now moving slowly toward the nearby sea. It didn't help to learn that geologists had long ago recognized and described the area as one of ancient landsliding, and that this particular slide was discussed in several published reports readily available to the public.

"When will the movement stop? Will it stop in time for us to save our home?" These questions were asked again and again by the Gessers as they clung to living in a wracked house that was disintegrating a bit more each day. Having gone completely through the emotional wringer, they finally supply their own answer: "Not soon enough." They will salvage what furniture, fixtures, and materials they can, and will make a fresh start somewhere else. However, any start on a new home must be deferred, perhaps for many years. The financial loss must be recouped, as insurance barely will cover the costs of moving, demolition, and storage of possessions, and the intrinsic value of the ground itself is understandably limited.

The location of the Heartbreak Hills

The Winners and the Gessers are just two families among thousands who have taken up residence in the Heartbreak Hills of southern California, and their personal tragedies constitute a small sample of what has happened or is likely to happen to those others who have not given appropriate thought to the ground on which they live. But what and where are the Heartbreak Hills? This figurative name can be given to those areas of irregular terrain in which problems of stability confront the developer of building sites; such problems include elements of surface erosion and deposition, undesirable settling, and mass movements of material, acting either singly or in some combination, slowly or rapidly, and on a small or large scale. It should be added that flat ground itself is no guarantee of complete stability, as the foundation engineer can testify.

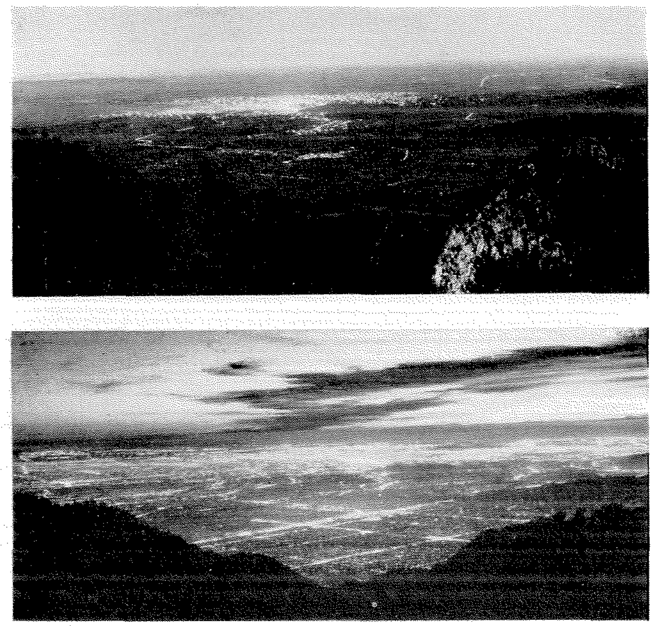
Heartbreak Hills are present in most areas of the world, and numerous situations justifying such identification could be cited for nearly every major urban locale. However, the name can be properly applied only to specific parts of these areas, and such geologically unfavorable parts generally are small. Thus unsafe foundation conditions begat of landsliding are restricted to local portions of the Pacific Palisades area, just as most of the Palos Verdes Hills and even some of the Portuguese Bend area itself are geologically safe for homesite development. On the other hand, these are only two of many areas in southern California where significant geological hazards have been recognized.

The fundamental problem

The fundamental problem is one of distinguishing the naturally safe from the naturally unsafe locality, and of identifying the naturally safe locality that can be made unsafe through the actions of man. Often the problem is easily solved, but at times it involves the interpretation of complex geological relationships that challenge the most competent investigator. The general situation in southern California has been outlined by one geologist as follows: "The highly varied topography and climate of the region, together with the complexity of its rocks and their structure, form a background of physical factors that cannot be ignored in the development of this region by man. Some of these factors are related directly to floods, earthquakes, mass movement of ground, and other recurring events over which man has little fundamental control, and others are developed by some of man's own activities. Failure to anticipate or properly to evaluate these factors during past development of the region has led to unfortunate, and at times disastrous, consequences . . . Only during recent years has there been widespread recognition of the need for careful geologic appraisal of engineering problems in southern California. Normal study of the positive factors in location and design of buildings, dams, aqueducts, and other structures, for example, is now being supplemented by consideration of the nature and movement of solid and liquid materials in the subsurface, the position and behavior of active faults in the area, the movement of surface water in the area during previous centuries, and other features that are likely to have significant long-term effects."

The burgeoning population of southern California, especially during the past two decades, has revealed in various painful ways the locations of more and more Heartbreak Hills. Nearly six million persons now reside in the Greater Los Angeles area alone, and current predictions are focusing upon ten million persons by 1980. As settlement has spread for many square miles across the basin and valley areas (see p. 15), increasing numbers of people almost literally have been driven into the intervening and surrounding hills. Hillside living has real advantages, too. The higher areas offer the last available residential sites within reasonable distances of major employment centers, and they make it possible for families to live away from the congestion, noises, odors, and other objectionable features of metropolitan districts. They also provide excellent views for the home owners, and the topographic irregularities broaden the possibilities for architectural expression in the homes themselves.

For decades southern Californians, while making jokes about their well-known dry rivers and arroyos, have built many of their homes across and within these obvious lines of drainage, evidently on the naive assumption that surface waters nevermore would put in an appearance. That this approach lacks certain elements of wisdom has been demonstrated in forceful ways by several floods. The extraordinary New Year's Day flood of 1934, for example, ravished the valley occupied by La Cañada, La Crescenta, Montrose, and Tujunga, smashing or undercutting some homes and filling many others with coarse debris. Even more impressive was the havoc wrought by the great flood of March 1938, especially in the San Fernando Valley area. Here extensive settlement during the 20's and 30's had superimposed entire communities upon the natural pattern of drainage, and numerous channels had been modified or even eliminated by artificial fills without adequate provision for future runoff. Flood waters spread widely across the valley floor, scouring deep gullies in streets and yards, destroying many structures, and depositing thick accumulations of gravelly muck over large areas.



Population growth in Greater Los Angeles. Top, a moonlight view of Pasadena and Los Angeles in 1908. Bottom, essentially the same area in 1950.

Flood-control installations

Some storms in southern California bring several inches of rain within periods of an hour or less, and twenty inches in twenty-four hours has been recorded more than once in the mountain areas. Most of these storms occur during the winter months, when the ground already is saturated or nearly so, and the problems of runoff are complicated in the lowland areas by a steadily expanding blanket of pavement, buildings, and other impervious works of man. Fortunately, many of these areas in the coastal region are now protected by flood-control installations of various kinds, but it may be several decades before such works are widely introduced elsewhere in southern California, especially in communities where more realistic homesite and grading regulations are needed.

Man has been surprisingly sluggish in extending the lessons of lowland drainage to the hillside areas, where topography accentuates the potential dangers to residential structures. During the period since World War II, heavy earth-moving equipment has been widely used in reshaping the landscape for development of residential sites in the Santa Monica Mountains, the foothill fringe of the San Gabriel Mountains, the Puente and San Jose Hills, and many other parts of the Greater Los Angeles area. Ridges and slopes have been notched with little regard for the nature of the materials removed or newly exposed in the cuts, and canyon bottoms have been filled to provide additional sites for homes and other structures. Disaster has been inevitable.

The heavy rains of January and March 1952 sent tremendous volumes of water down the bare surfaces of raw cuts and fills, gullying them deeply and moving huge quantities of muck and debris around and into homes and streets, so that many recently opened hillside tracts appeared as "seas of mud." What man had done to modify the terrain was vigorously extended by nature. In many places, temporary remedial measures merely aggravated the situation, as damaging runoff from subsequent storms was diverted to other vulnerable targets. Even those canyon dwellers who had relaxed in the assumed protection of debris-collecting basins that had been developed up-drainage from them found that their safety was transitory. Many of the basins were quickly filled to capacity with solid matter, which eliminated their protective function.

Uncontrolled flow of water does far more than scour the surface in one place and deposit objectionable debris in another. When it enters the subsurface, especially in and near fresh cuts and loose masses of fill, it can contribute forcefully to gross instability of the ground. Not only does it add weight and pressure as a pore-filling fluid, but it can seriously weaken the ground through lubrication of potential slippage surfaces and the scouring away of interstitial fine-grained matter. Its effects upon the volume, plasticity, and other characteristics of clay minerals can be disagreeably significant. Thus it has been a major factor in

Settlement of coastal terraces in the Pacific Palisades area, 1946. Large landslide masses (X) face the ocean, and a steep-walled cut (C) exposes old slide debris.

most types of ground failure. The exact subsurface paths of water circulation often are difficult to establish, but it generally is possible to predict the gross effects of artificial cutting or filling.

Many homes have been damaged by essentially local settling of the foundation materials, in amounts ranging from an inch to several feet. Often this is attributable to the placing of fill on natural slopes from which neither existing vegetation nor soft soils were removed; these natural unconsolidated materials tend to promote settling and slippage beneath the fill. The excavation of some cuts has exposed avenues of natural groundwater drainage, so that seeps have appeared in the cut faces. Not only do such seeps have undesirable effects upon lawns, gardens, and the foundations of structures, but the water commonly migrates downward beneath the structures and lubricates potential surfaces of slip in the underlying bedrock. All too often, one effect triggers off another.

Homes in some hillside areas have been erected upon soft, unconsolidated materials that are quite unable to bear the additional load. Downslope migration is the inevitable result. Although southern Californians have learned to live with earthquakes and have made admirable progress in the construction of earthquake-resistant buildings, they have given little thought to the intrinsic stability of the soft ground upon which many of them have built their homes. Nor, in general, have they considered the possible triggering effects of earthquakes upon subsidence and lateral movements of such ground.

By far the most spectacular examples of mass movement in southern California are landslides that involve large bodies of bedrock. Although specific conditions vary from one occurrence to another, all these slides can be ascribed to an unfavorable relationship between steepness of slope and inherent strength of the rocks beneath the slope. On this score, the most troublesome rocks in the Greater Los Angeles area are siltstones and sandstones whose shaly structure permits slippage along their surfaces of stratification. Many other kinds of rocks also are liable to sliding where they are soft or are weakened by the presence of numerous bedding planes, fractures, faults, or other structural discontinuities.

On October 28, 1937, surface cracks were observed on the hillside above Riverside Drive, not far from the Los Angeles Civic Center, and soon it became apparent that a huge section of the hill was slowly moving downward toward the nearby Los Angeles River. On November 26 more than a million tons of soil and rock suddenly moved downward, covering Riverside Drive and seriously damaging buildings and utility lines. About half a million dollars was expended in removing the slide material and in making major repairs. The event made interesting news, but to most persons it was only a temporary nuisance that soon was forgotten.

Some years ago the old highway between El Monte and Pomona was covered by a slide mass on Kellogg Hill. Study of this mass showed that its removal probably would do little more than make room for additional material poised higher on the slope, so highway engineers relocated the road around the toe of the slide.

The Pacific Palisades area recently has become well known for its large slides, although geological evidence indicates that sliding has occurred again and again in this locality for thousands of years. As shown above, human settlement has extended over a broad, *Landslide mass covering U.S. Highway 101 in the Pacific Palisades area, March 1958. Note that somewhat earlier sliding has concealed the cut (C) shown on the page opposite.*

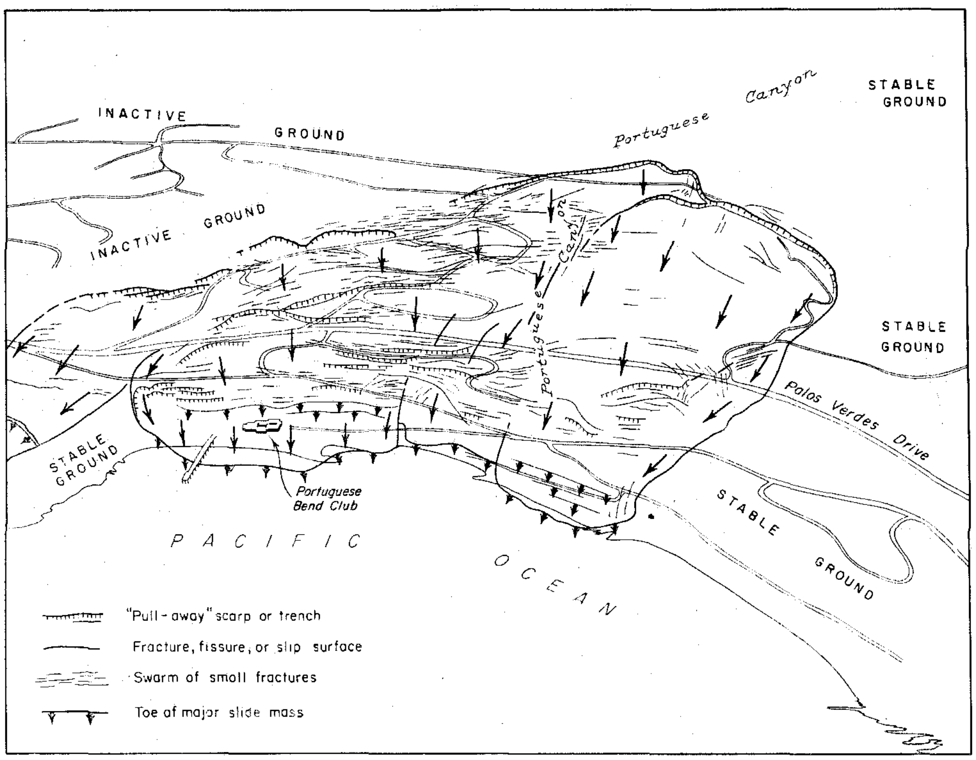
terrace-like area that is gashed by several deep, steep-walled canyons and is bounded on one side by a high sea cliff. This surface is underlain by sands and gravels whose stratification is essentially horizontal. These materials are relatively stable, and in the eastern part of the area, where they are very thick and form the entire sea cliff, little major landsliding has taken place during the past century. In the western (or left-hand) part of the area shown on page 16, the sands and gravels form a rather thin veneer over older and weaker shaly rocks. These rocks have been tilted and folded, and along much of the ocean front, where their bedding planes dip at moderate angles toward the beach, slippage has been promoted by water introduced through the overlying pervious sands and gravels, and also by wave erosion that has removed support from the base of the sea cliff. The natural erosion by wave action has been largely eliminated through the development of beaches and the construction of embankments along U.S. Highway 101, but man has increased the contributions of water to the structurally weak shaly rocks, chiefly through the irrigation of his lawns and gardens.

Sliding has occurred at points along the ocean front and along the sides of tributary canyons wherever the structure of the bedrock is unfavorably oriented. The crescentic expression of one large slide can be seen on page 16; this mass is traversed by the loops of road extending from the edge of the cliff downward to Highway 101. Mass movements have occurred repeatedly during recent years, the latest episode following heavy winter rains in 1958. The position of this slide and its effect in trimming back the edge of the sea cliff are shown above. To the left of this mass are several other, slightly older slides.

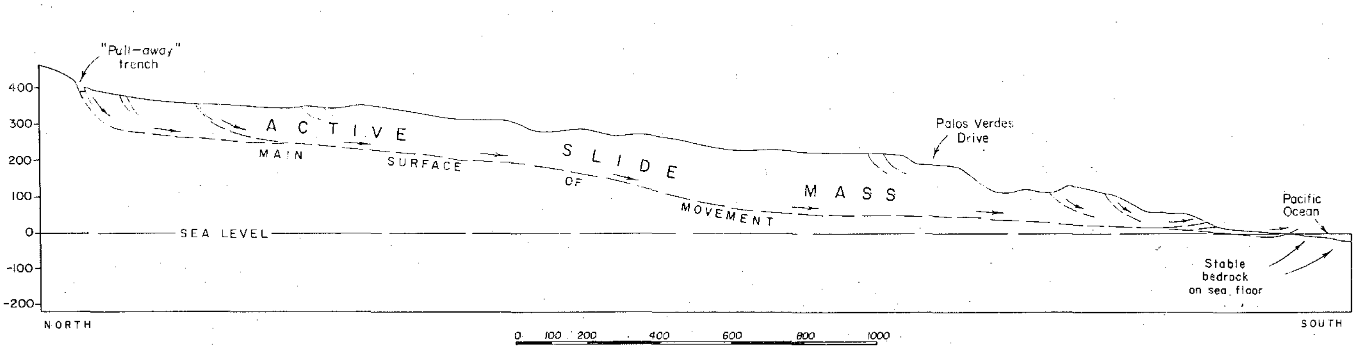
Failure in seaward-dipping shaly rocks also has been responsible for landsliding at Point Fermin, in the Palos Verdes Hills. Movement of an enormous mass was first recognized in 1929, and sliding toward the ocean reached major proportions a little more than a decade later. The migrating mass is about 1,000 feet long and 50 to 400 feet wide, and its upper surface, originally about 100 feet above sea level, is now depressed 10 to 40 feet beneath the level of the adjacent ground to which it formerly was attached. Fortunately, the early movements were sufficiently slow to permit evacuation of the area without serious injury or loss of life. All buildings on the slid block have been removed, and the fissured surface is now a weed-grown "no man's land."

The most spectacular and damaging of southern California's recent slides is that in the Portuguese Bend area. Here a broad, platter-like mass of deformed soft shaly rocks has been sliding intermittently toward the ocean for a long period of time, probably measured in thousands of years. The latest episode of movements, which began in July 1956 and is continuing today, involves only the eastern part of this ancient slide mass. The moving ground occupies an area of nearly 200 acres, on which more than 150 homes rest in various stages of destruction. The currently active mass, 100 to 200 feet thick, is easing itself seaward over a gently undulating surface of major slippage. It is no accident that this surface conforms in a general way to the attitude of stratification in the underlying rocks, and corresponds in general position to the occurrence of a lubricating layer of altered volcanic ash. This ash consists largely of clay minerals. It is soft and slippery when wet, and has been encountered in numerous test holes bored through the slide.

The Portuguese Bend area in the Palos Verdes Hills, looking north-northwest, 1955. Most of the homes in the central foreground and middle distance are now abandoned.



General features of the active slide mass within the area shown above. Arrows indicate major directions of slide movement.



Generalized section through the Portuguese Bend area in the vicinity of Portuguese Canyon, showing the undulatory surface of principal slippage beneath the active slide mass. The toe of the mass curls slightly upward over stable bedrock along the ocean shore.

The principal features of the slide mass are shown on the page opposite. Its curving upper margin is characterized by a series of fresh scarps and "pull-away" trenches. Preserved along the walls of these trenches are grooves and striations that indicate the downward movement of the migrating ground (see below). The lateral margins of the active slide mass are marked by zones of profound shearing. The eastern part of the mass, which has moved farther than the other parts, is separated from the remainder of the slide by a shear zone in the vicinity of Portuguese Canyon (see p. 18). Maximum horizontal movement has amounted to nearly 30 feet. The entire mass is thoroughly fissured and fractured, like the ice in a glacier that is flowing over a very uneven bedrock surface, and it is marked by many structural complications. The snout of the slide appears along the sea coast, in most places as a low ridge of crushed and broken material in the zone of wave action. It is being thrust upward along stable bedrock that forms the sea floor (shown at the bottom of page 18) where it is being attacked by the marine waters.

Damage to structures in the Portuguese Bend community has been so extensive that many of them have been condemned for further occupancy. All have been wracked to some degree, and several have been almost literally torn apart by differential movements of the ground beneath them. An interesting type of failure has occurred near the shoreward end of the pier at the Portuguese Bend Club. The outer part of this pier rests upon stable ground, the inner part on the snout of the slide mass; the resulting compression has caused the buckling shown in the photo above. A large swimming pool near this pier was so severely fissured by the ground movements that it was replaced by a new concrete pool with a plastic liner; despite subsequent movements of the concrete shell, amounting to several feet locally, the plastic liner held water satisfactorily until the whole installation was recently abandoned.

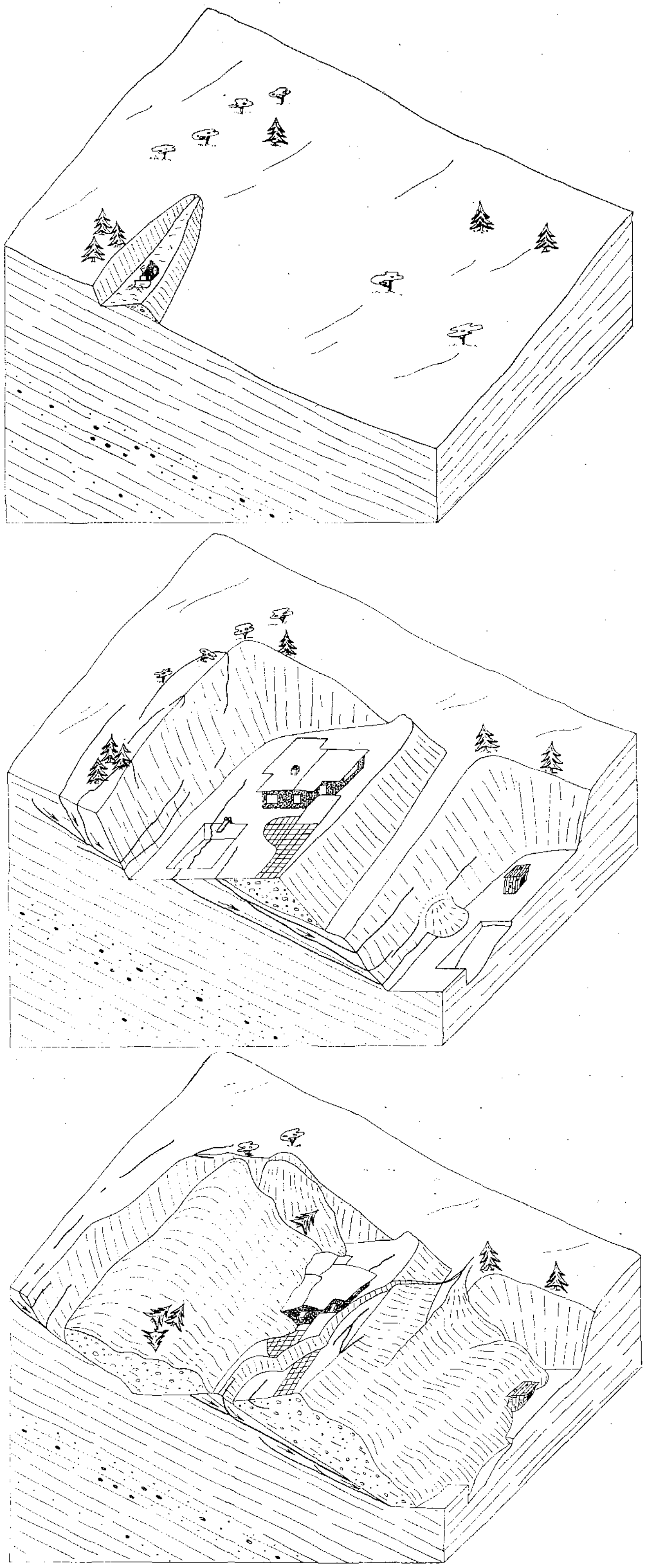
Exposed part of the main slip surface at the head of the Portuguese Bend slide mass. Note the steeply-inclined grooves on this otherwise smooth surface.

Coastwise view of the Portuguese Bend area, December 1956, showing the slide mass in left foreground. The snout of the mass emerges on the ocean bottom along the surf zone between the pier in the foreground and the white breakers in the right distance. Buckling of the pier can be seen near its shoreward end.

The entire Portuguese Bend settlement is rapidly becoming a ghost community. A supplemental tragedy is the effect of the landsliding upon the newly developed tract immediately to the east, which appears within the area of curving streets in the middle distance above. Although these new homes rest upon stable ground, their proximity to the slide has had unfortunate effects on current estimates of their value by the general public.

The basic factors responsible for the present sliding in the Portuguese Bend area probably are little different from those prompting similar movements at this locality during the geologic past, but it is possible that man may have triggered-off the latest movements in any of several ways. Introduction of water to the subsurface, as from irrigation and septic tanks, is particularly suspect. No one can predict with confidence when the movement will cease, but it is almost certain that, once having ceased, it will begin again at some future time. An interesting effort to stop the sliding was made by the County of Los Angeles during 1957, when fifteen caissons of reinforced concrete, each about 4 feet in diameter and 20 feet long, were set in vertical holes bored through the main surface of slippage from points near the toe of the mass. It was hoped that these gigantic pins would have a holding effect akin to that of toothpicks in a Denver sandwich. But this project failed, owing largely to the weakness of the slide materials, which flowed around the pins and tilted some of them in the process.

Man's remarkable capacity for troubling himself has been nowhere more clearly shown than on numerous "dip-slope" hillsides, where the stratification in the underlying rocks is essentially parallel to the ground surface. Excavation of cuts at such localities has caused much damage, particularly in the Santa Monica Mountains and on some of the hills rising



Three stages in the dynamic development of a "dip slope" hillside. Top, a bulldozer cut is made. Middle, two benches have been completed, and the upper one is already occupied by a house and pool. Slippage within the bedrock is beginning to occur, and cracks are appearing on the ground surface. Water, leaking from the upper swimming pool, is soaking into the bedrock and promoting further sliding. Bottom, sliding has occurred on a large scale as nature tries to reestablish a relatively stable dip slope.

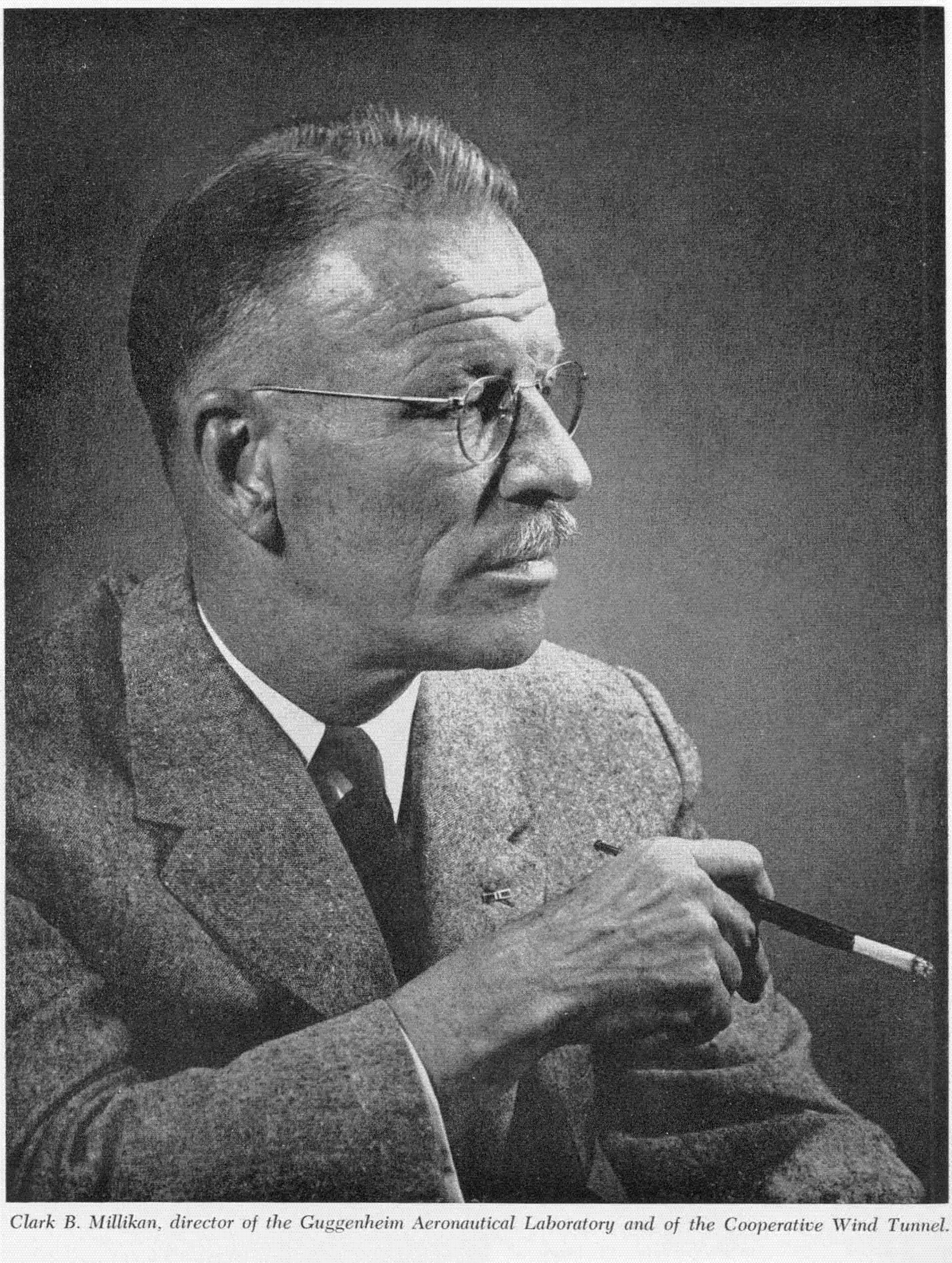
above the broad Los Angeles Plain. At the left is a typical story in the form of three episodes. Lot pads are graded in a dip slope, and homes are built on them. Within a short time, generally less than five years, the beds begin to move past one another, much like the slippage within a tilted deck of cards that is unsupported along its lower edge. As shown in the middle and lower diagrams, cracks and fissures are the surface expressions of slip zones at depth, and the total movement ultimately results in transfer of ground from some parts of the properties and encroachment of enormous slide masses onto other parts. Hundreds of major failures in the Greater Los Angeles area can be attributed to this general situation. It seems plain that cuts should not be developed in hillsides underlain by rocks liable to bedding-slippage, and where the geometric relationships between surface slope and rock structure are essentially as shown in the upper diagram.

It seems obvious that man cannot take for granted the ground he lives on, and that responsibility for troubles stemming from a careless attitude rarely can be fixed upon someone else, legally or otherwise. The geologist has long been aware of stability problems, although not all geologists have enjoyed uniformly pleasant experiences with their own properties! Geologic relationships in the Heartbreak Hills are now receiving fuller attention from the engineer, who recognizes that it is more satisfactory to prevent or avoid conditions of instability than to deal with their unfortunate results after they have occurred. The responsible public official, having learned that wise development of hillside land can be insured only by regulation, is continuing to press for grading requirements that are realistic and broadly applicable. He has had strong opposition from many quarters, but fortunately has been able to take advantage of public reaction to several disasters. Thus Gilbert E. Morris, who heads the Department of Building and Safety of the City of Los Angeles, was able to put through a forceful and effective grading ordnance as a result of the 1952 floods, and thousands of persons already have been protected through denial of building permits for sites where hazardous conditions exist or would have been created through proposed development.

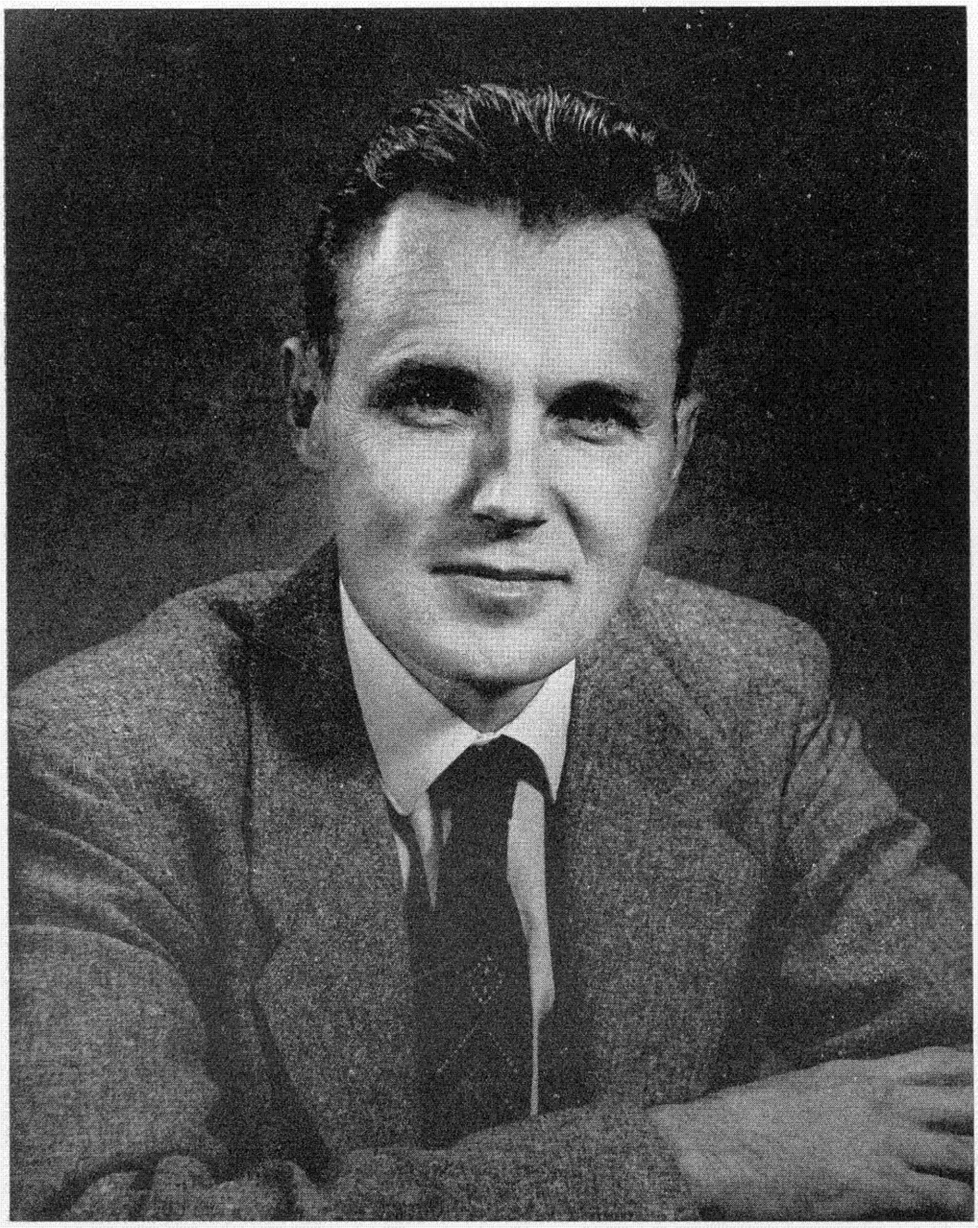
The public itself must become more aware of the general problem and more sympathetic toward existing and future regulatory measures, lest the disastrous effects of instability continue their alarming increases of the past decades. One may well be sincerely sorry for the individual victims—for all the Winners and all the Gessers—but it also is well to note that everyone ultimately pays the piper in numerous indirect forms, including increased tax, insurance, and utility rates, and, in many instances, lowered property values. All of us, therefore, will have to give more attention to the matter of keeping our property where it belongs if we are to enjoy what amounts to peaceful coexistence with southern California's geology.

V. A Portfolio of Faculty Portraits

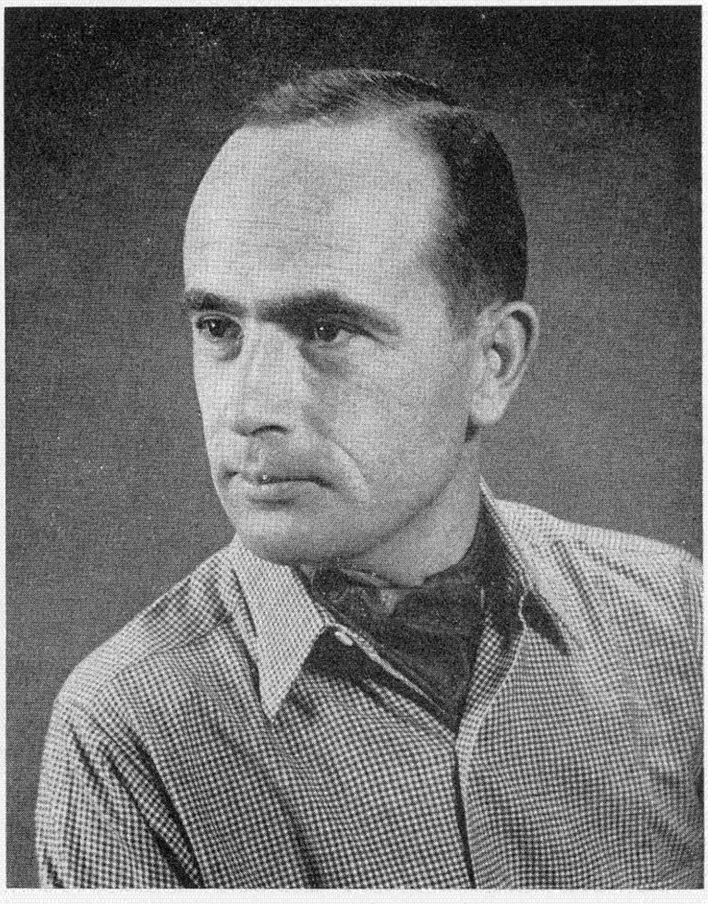
by Harvey



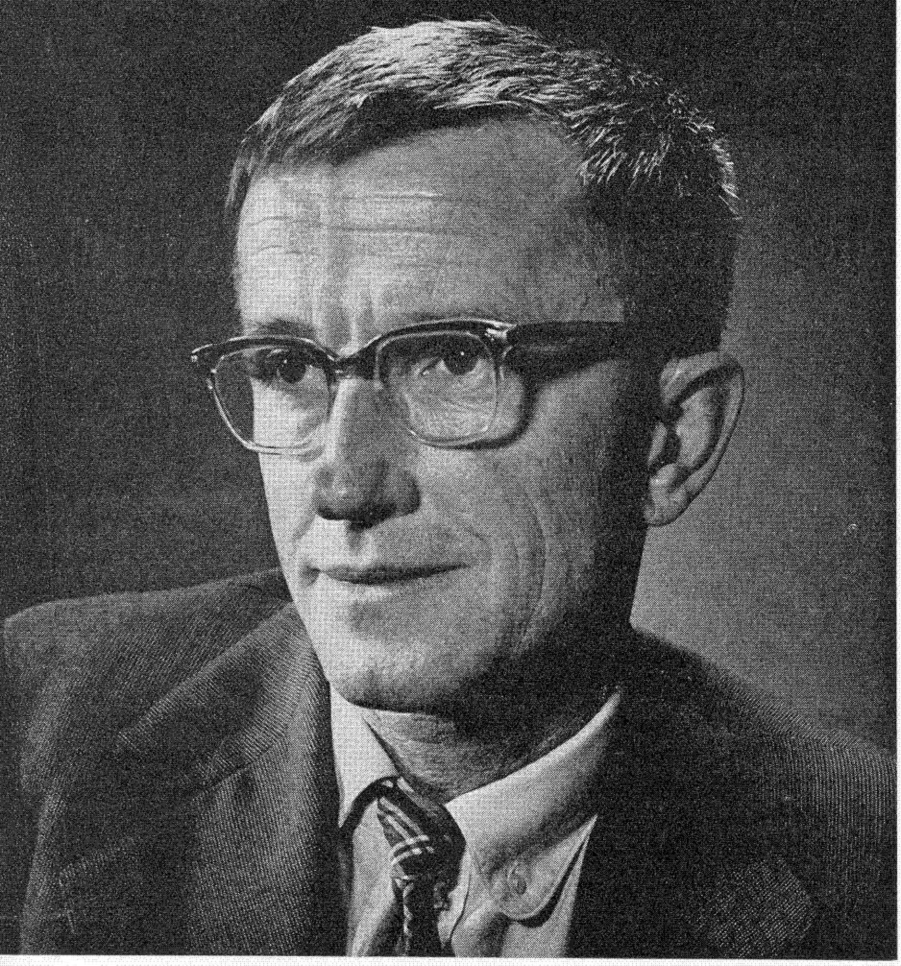
Clark B. Millikan, director of the Guggenheim Aeronautical Laboratory and of the Cooperative Wind Tunnel.



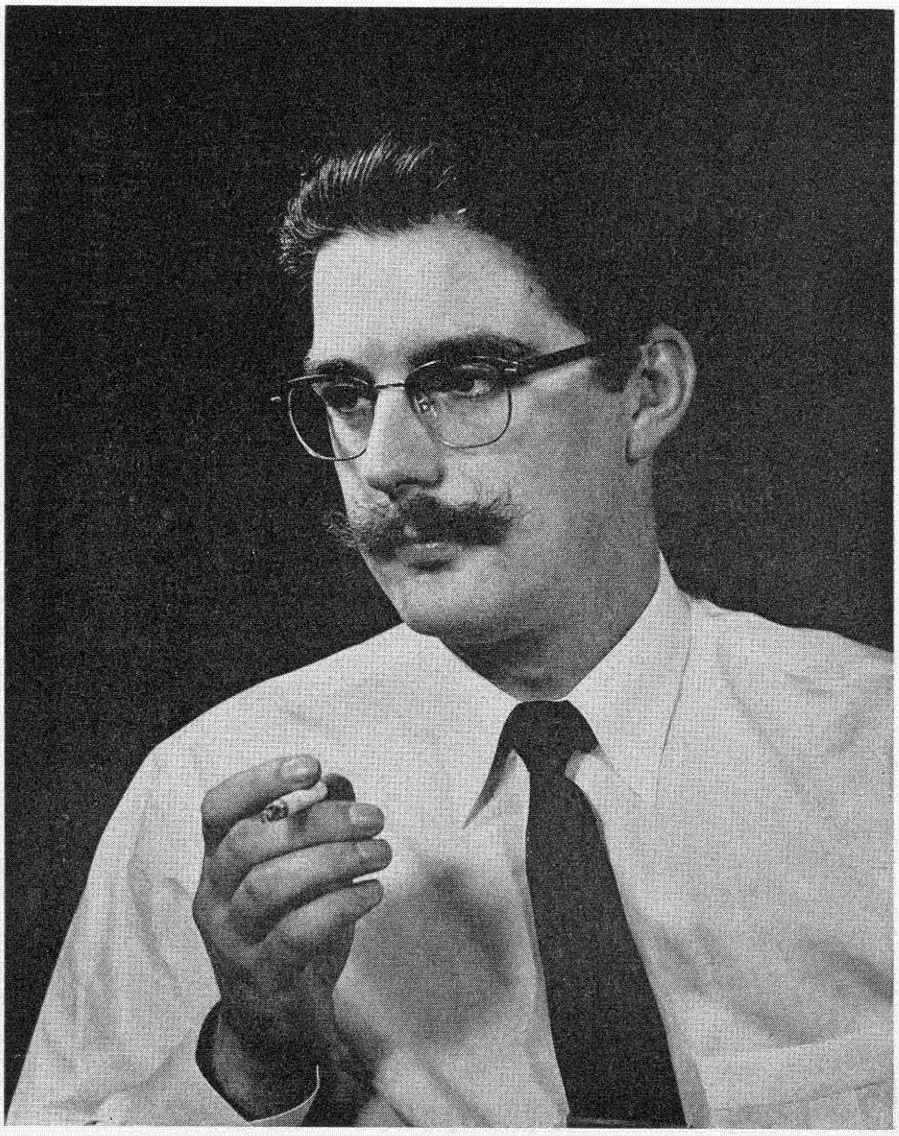
Robert B. Leighton,
associate professor of physics.



David C. Elliott,
associate professor of history.

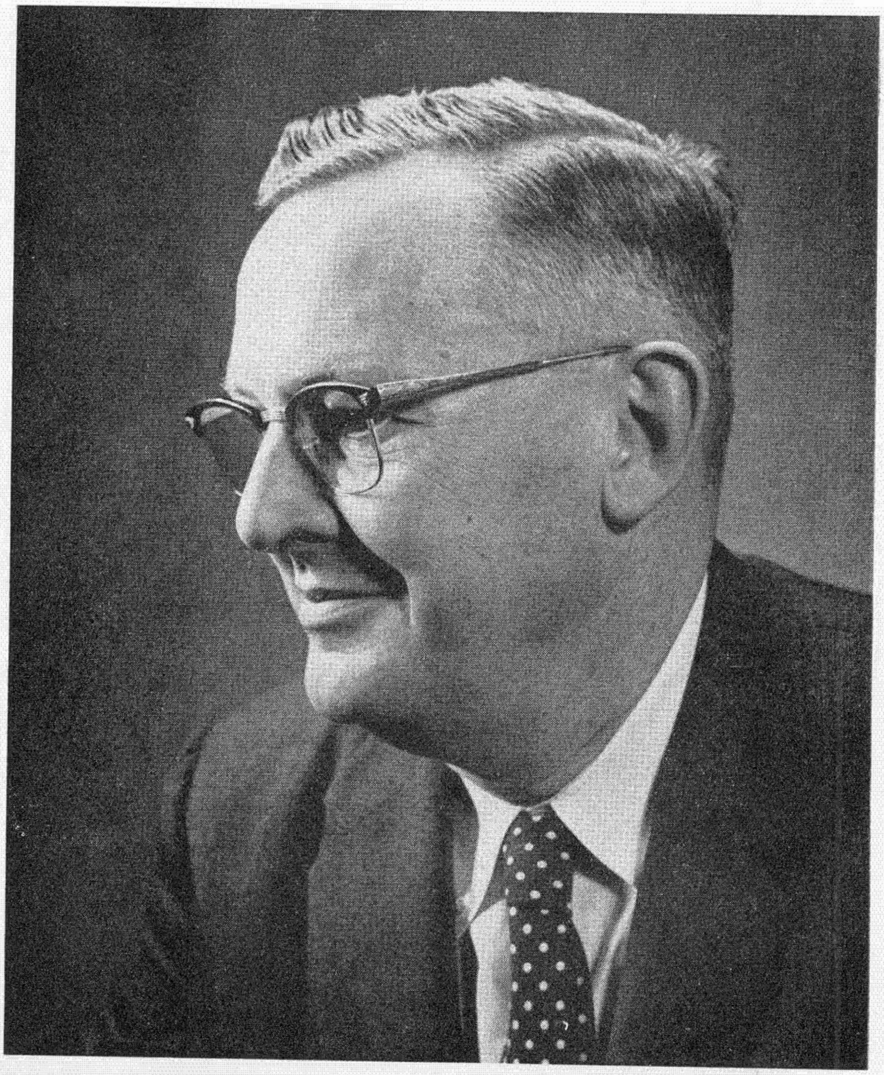


Max Delbruck,
professor of biology.



Robert D. Middlebrook,
associate professor of
electrical engineering.

Charles C. Lauritsen, professor of physics.



Carl G. Niemann, professor of organic chemistry.

Leon T. Silver, assistant professor of geology.

Nuclear Engineering at Caltech

by Harold Lurie

A subcritical nuclear reactor, to be used in nuclear studies, has just been assembled at Caltech. The compact $10,000 reactor is the first of its type to be installed in an American college or university under a grant of the Atomic Energy Commission's education program.

The reactor was designed and manufactured by the Nuclear-Chicago Corporation for student instruction. With this reactor most of the characteristics of an operating power-producing reactor can be demonstrated and studied. It consists of a stainless steel tank four feet in diameter and five feet high, in which is inserted a grid of vertical aluminum tubes arranged in a symmetrical pattern. There are 260 vertical tubes standing in this tank, each containing five slugs of natural uranium metal. There are 1,299 slugs in the whole assembly, the total weight of uranium being about 2¾ tons. The uranium, valued at $100,000, is on loan to the Institute from the AEC.

Harold Lurie, associate professor of applied mechanics, assembles a pattern of uranium-filled tubes in Caltech's new subcritical nuclear reactor.

The volume between the tubes is filled with about 435 gallons of purified water, which not only serves as a shield but also slows the neutrons so they can more effectively bombard and split the uranium atoms. The center tube contains a neutron source made of a mixture of five curies of plutonium and beryllium. The neutrons from this source are slowed down by the water and then absorbed by the uranium to cause fission. The fission process in the assembly results in a multiplication of the neutrons by a factor of approximately seven.

The chain reaction cannot be maintained in the absence of a neutron source, and in this respect the assembly differs from a power-producing reactor. This characteristic of being unable to achieve criticality (i.e., a self-sustaining chain reaction) makes the assembly inherently safe for student use, as a nuclear accident is impossible. However, the subcritical reactor is quite adequate for studying many of the steady-state characteristics of a full-scale power reactor. The student may therefore become intimately acquainted with the applications of reactor theory and design. For example, by changing the geometric configuration of the uranium lattice, he can check for himself what effect this would have on the characteristics of a critical reactor.

The influence of atomic energy on engineering has become increasingly evident ever since the discovery of nuclear fission. But it is only within the past decade that reactor technology has advanced to the point where its future is assured. Submarine nuclear power plants demonstrated very dramatically that a new branch of engineering had been weaned. Stationary nuclear power plants are presently being installed, with many more in the planning stage, and applications of nuclear systems to such other fields as aircraft and rocket propulsion are being seriously studied. Radioactivity and isotopes, too, are playing an increasingly important role in industrial applications.

At Caltech the possibility of incorporating education in the atomic energy field was recognized several years ago – but how to delineate an appropriate area of study was not at all obvious. In view of the "glamor" of nuclear energy, there was a danger of over-emphasizing its importance with respect to the established branches of engineering. There was also some doubt whether, from an engineering point of view, additional specialization was called for. It seemed apparent that at least some of the applications to reactor technology could be incorporated in the existing engineering curriculum.

In point of fact, reactor technology encompasses an unusually wide field of the engineering sciences, and includes many of the conventional subjects as well as those peculiar to the new industry. There are major contributions to be made in reactor development by engineers of every specialization. But such mechanical, electrical or chemical engineers, for example, must have some familiarity with the *application* of modern (as well as classical) physics if they are to apply their specialties to reactor technology. The program at Caltech was formulated with this in mind. In addition, the curriculum was designed to provide suitable courses for those students who wanted to specialize in reactor theory in its application to engineering.

The additional courses which have been introduced include the study of applied nuclear physics, reactor theory, shielding and radiochemistry. These special courses were thought to be taught most appropriately in the graduate school. No changes in the undergraduate curriculum were envisaged, except that examples from the nuclear field have been included in the undergraduate subjects wherever appropriate. The additional courses have been included in a new fifth year nuclear energy option in mechanical engineering – a parallel option to the previously existing ones of jet propulsion and physical metallurgy. Accordingly, a student interested in nuclear engineering will take a regular engineering course in his undergraduate work, and continue in the fifth year in the nuclear energy option of mechanical engineering. Graduate students in other engineering options can take, as electives, selected subjects in the new option to enable them to apply their specialties to reactor development.

Final operations in the assembly of the $10,000 subcritical nuclear reactor.

Five slugs of uranium are loaded into each of the 260 tubes that go into the atomic reactor. The uranium, valued at $100,000, is an AEC loan.

The graduate program developed in this way has been approved by the Atomic Energy Commission as fulfilling the requirements for students receiving an AEC Special Fellowship in Nuclear Science and Engineering. These fellowships are similar to those offered by the National Science Foundation, and allow a student up to three years of graduate study at a school whose nuclear engineering program has been approved by the AEC. This year there are seven graduate students enrolled in the nuclear energy option, of whom four hold AEC fellowships.

An essential part of the nuclear course is training in the laboratory. As a result of an AEC grant, a new laboratory has been equipped to teach engineering students the techniques of nuclear measurements. The laboratory contains a representative group of radiation-measurement instruments which can be used by the students to provide familiarity with those phenomena which are encountered in the reactor business. With the subcritical reactor installed in this laboratory, it is felt that Caltech is now in a position to offer a balanced and appropriate program to students interested in this phase of engineering.

Russia Revisited

by Horace Gilbert

In 1931 I visited Soviet Russia to observe the First Five Year Plan. Although I was and am an enthusiastic proponent of our free enterprise economy, as a student of industrial economics I was interested in the way a nation proposed to industrialize quickly, using the socialist method.

The principal impression I gained was that the program was most difficult. The establishment of heavy industry adequate for the production, first, of military goods and, eventually, of goods and services the Russian people could enjoy, was an overwhelming task. Foreign industrial know-how was being used extensively, and the socialist state was forcing capital formation at a high rate. Then general direction of the industrialization efforts was not hard to plan; the combination of Communist Party zeal with police-state methods was making possible some progress with the execution of the plan.

Last summer I revisited Russia to observe the industrial progress that had been made. I retraced much of the route of my 1931 visit: Moscow, Stalingrad, Rostov-on-Don, Kiev, and Leningrad. In a few cases I was able to visit the same factories. I flew from Copenhagen to Moscow in a new Russian jet; from Stalingrad to Rostov I traveled by boat over the new Volga-Don Canal; from Rostov to Kiev I went by rail; the rest of my trips were on an old-style propeller-type airplane.

Horace Gilbert, professor of business economics.

In planning the trip I had decided to look especially at the consumers' goods section of the Soviet economy. Perhaps the ultimate test of the success of industrialization is the extent to which it has supplied the economic needs of the people. I knew that the successive Five Year Plans had continued to emphasize heavy industry and the production of military goods, and I remembered that the German occupation during World War II had wreaked great damage on many industrial installations. But even so I thought that now, 40 years after the Bolshevik revolution, significant progress would have been made in the production of consumers' goods. Furthermore, because of limited time, I had decided to concentrate on a small part of the total Soviet economy.

My interest in the progress Russia was making with consumers' goods derived from another consideration: In a socialist state, I had visualized, it should be possible to design a small number of products emphasizing functional usefulness, and to produce such articles by highly automatic methods.

In the United States and in other countries where production must adapt itself to the demands of style-conscious markets and frequent model changes, it is technically difficult to secure such production efficiencies. An extension of this thought leads to the possibility that a socialist state might successfully take over world markets, in the case of consumers' goods that are simply functional and easy to produce.

The significance of such a possible development is especially great when the sophisticated design and high costs of our products are noted. In many world markets, critically important in political respects, United States products are bought for prestige reasons, and thus miss the point of providing the com-

An economist returns to Russia after 27 years and discovers some surprising things about the country's industrial progress.

mon people with a practical means of improving their well-being.

What did I find? Very little of what I expected. Consumers' goods are still a relatively neglected sector of the Soviet economy. I carried out my plan to examine closely what the Russian people are consuming. The easiest way to do this, in addition to keeping my eyes open, was to spend hours in the shops.

In the cities, people looked well enough, although their clothes were not made of good materials, and in style little quality was apparent. The shelves of the stores were loaded with goods and articles, many of which were like those in our general stores 50 years ago. Goods of modern design – such as electric irons – were in great demand, and when a supply reached the shops, queues formed quickly and the supply disappeared, perhaps for weeks.

Food stores appeared to be well stocked with staples, including meat, but fresh fruit and vegetables were scarce and most of them very expensive. The new boulevards of the cities have few automobiles on them, but individuals as private citizens are permitted to have cars. The number produced is small, so the waiting lists are long. Public transportation generally is good, especially the Moscow subway, so there is little real need for private automobiles.

Housing is still short in spite of major programs for construction of apartments. Private individuals are permitted to build their own houses, and this type of living is preferred. The pattern of consumer demands for material things, it can be seen, resembles that in this country, but the present level is severely proletarian. A beginning may have been made on what we would call comfortable living, but there is practically no luxurious living.

In the rural communities there is said to be little dissatisfaction with the simple products available; it will probably take a long time and several technical advances, such as availability of electricity, before the desire for better living becomes strong among the rural population.

My first concluding observation is that the Soviet Russian consumer economy has attained a decent proletarian level, and, if this is what Marx intended, the Soviet socialist economic effort can be called a success. The fact that the picture is a drab one to American or Western European eyes should not be allowed to discredit the Soviet accomplishment.

But, most significantly, the Russian people, at least in the urban communities, are demanding a better life! There is wide discontent with the proletarian level of their economy. The official Communist Party doctrine—that Soviet Russia eventually will catch up with and then surpass Western Europe and even the United States in per capita productivity—is partly the reason.

In 1931 I heard the propaganda expression that through industrialization all Russians would have Fords and bathrooms – the symbols of the standard of living so earnestly desired. The statistical measures of the successive Five Year Plans do show marked overall progress, but the mean proletarian level reached as to present comforts is far behind the goal Russian consumers expected. On the Volga-Don Canal boat a lawyer from Sverdlovsk summarized his discontent with the situation in the statement, "But life is so short!"

Since my investigation of consumers' goods industries was somewhat frustrated by the situation I encountered, I turned to a sketchy observation of heavy industry. This was another story! The successive Five Year Plans for industrialization, in emphasizing heavy industry, have met with considerable success.

I was able to join a delegation of German and French engineers visiting the First State Ball-Bearing Plant, in Moscow. It is a showplace because it includes a completely automatic process for machining the ball-bearing components, their precision measurement with electronic devices, and automatic assembly of the matched components. It was truly something of which the Russians could be proud, except for one thing: its output was erratic and low. Technically it deserved to be a showplace, but operationally I am afraid it was not an unqualified success.

The real problem facing the Soviet economic ministries is bureaucracy. Parkinson's Law is in operation.

The rest of this plant consisted of conventional ball-bearing manufacturing operations—unit machines operated principally by women, somewhat awkward materials handling, much visual inspection, and considerable hand work. The output of this section of the plant, however, was tremendous. It was not a showplace; we saw it incidentally on the way out.

Another very interesting plant was the Stalingrad Tractor Plant. I had been there in 1931, and I remembered some of the problems the management was trying to solve then. By good luck my request to visit the plant came to the Technical Director, who had been there in 1931, so I visited the plant under the most favorable circumstances. It produces 400 track-laying tractors a day, and 400 sets of parts for repair purposes. The operations include a few transfer machines, some special-purpose multiple-head machines, and occasional advanced-design materials handling equipment. As a whole, however, the layout was crowded and working conditions were unsafe.

Although the Stalingrad Tractor Plant represented high production, the Technical Director was most interested in talking with me about ways to improve operations. It was obvious to me that he would gain a great deal by visiting similar manufacturing operations in Western Europe or the United States, and I suggested such a trip. From his reaction, however, I gathered he held little hope that he would be permitted to go.

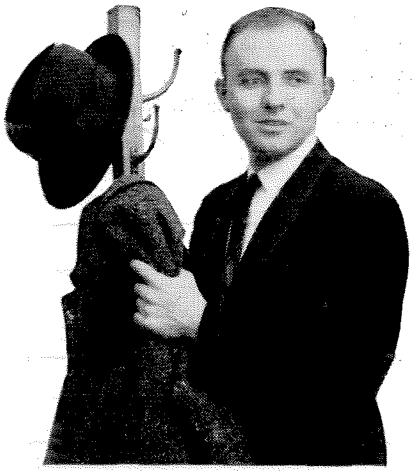
So much for my observations on Soviet Russian industry. The report is neither especially favorable or unfavorable. Slowly the real problem which the Soviet economic ministries are facing dawned on me: it is the administrative organization of the industrial operations, or, in a word, bureaucracy. So long as the economic sector consisted of the production of a limited number of fairly simple products, the centralized organization worked reasonably well. But the very success of efforts to increase production has created the problem: greater production in basic industries has made possible the expansion and more specialized division of heavy industries. These increases, in turn, have presented the opportunity to allocate more resources to consumers' goods industries. The administrative difficulty has increased geometrically with this greater complexity. What may have been an effective bureaucracy began to break down. Parkinson's Law is in operation.

The key to this situation was revealed by Mr. Khrushchev himself, when, in a speech in February, 1957, he announced the decentralization of 141 All-Union and Republic ministries to 105 regional councils. In September, to adjust to the new situation, the Five Year Plan for 1956-60 was scrapped and was replaced by a Seven Year Plan for 1959-65, which was to follow two annual Plans. In April, 1958, the Machine Tractor Stations, by means of which the agricultural collectives had been rigidly controlled, were eliminated.

This move to permit the making of decisions by managers in closer relation to actual operations, and to lessen the rigidities of the bureaucratic monolith, undoubtedly was well-advised. Practically all well-managed large companies in the United States recognize the principle of decentralization in their administrative organizations. But for Mr. Khrushchev to order the correction of the difficulty was not to bring it about. The economic planning function could not be decentralized. After the order, the planning agency had to take on the important function of coordinating the regional councils. This meant that there had to be additions to the staff—and that there was a consequent tendency toward *re*-centralization.

I attach great significance to the difficulty Soviet Russia is facing in trying to run 100 percent of the nation's economic operations. Unless the bureaucratic friction can be reduced, the talents of able managers cannot be fully utilized, progress with industrialization will be slowed down, military projects will be delayed, and, most important from the political point of view, the pressure from Russia's urban population for a better living now, will increase.

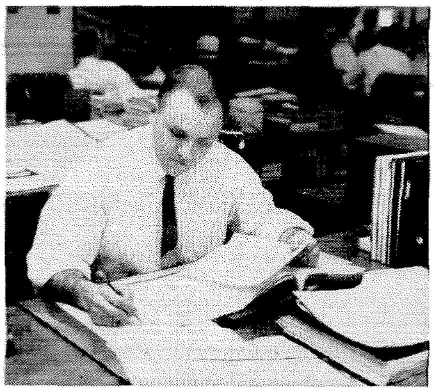
Soviet Russia is up against a serious problem in the administration of its economy. It is too early to predict failure. We must guard against being overly impressed by the accomplishments embodied in such projects as Sputnik. By a system of priorities and with no regard for cost, Soviet Russia can very well excel in a few lines at a time. It is quite another thing to bring about needed advances on a broad front.



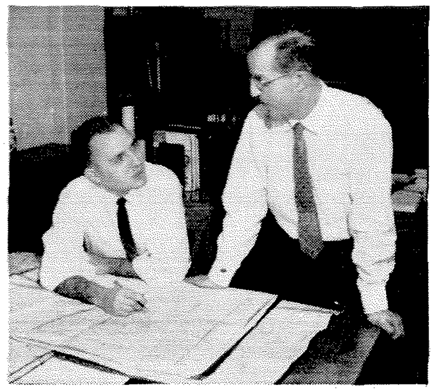
KEITH LYNN, B.S.E.E., PURDUE, '52, INVITES YOU TO

"Spend a day with me at work"

"I'm an Equipment Engineer for Illinois Bell Telephone Company in Chicago. Speaking personally, I find Bell Telephone engineering darned interesting and very rewarding. But judge for yourself."



"**8:30 a.m.** We start at my desk. I'm studying recommendations for additional dial facilities at the central office in suburban Glenview. This is the beginning of a new engineering assignment for me."

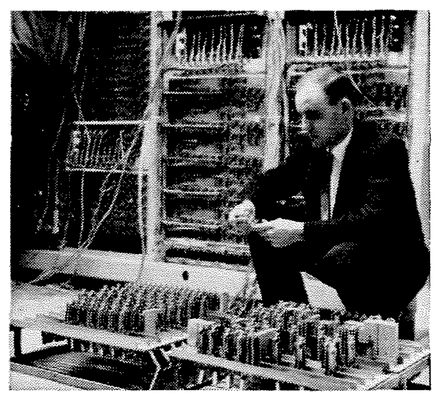


"**10:20 a.m.** I discuss a proposed layout for the additional central office equipment with Supervising Engineer Sam P. Abate. Since I'll want to see the installation area this afternoon, I order a car."

"**11:00 a.m.** At an interdepartmental conference I help plan procedures for another job I'm working on. Working with other departments broadens your experience and know-how tremendously."

"**2:00 p.m.** After lunch I drive out to the Glenview office. Here, in the frame room, I'm checking floor space required by the proposed equipment. The way our business is growing, every square foot counts."

"**3:10 p.m.** Then I drive to the office at nearby Skokie where a recent assignment of mine is in its final stages. Here I'm suggesting a modification to the Western Electric installation foreman."



"**3:30 p.m.** Before starting back to Chicago, I examine a piece of Out Sender equipment being removed from the Skokie office. This unit might fit in just fine at another office. I'll look into it."

"Well, that was today. Tomorrow will be different. As you can see, I take a job from the beginning and follow it through. Often I have a lot of jobs in various stages at the same time. I think most engineers would agree, that keeps work interesting."

Keith Lynn is one of many young engineers who are finding rewarding careers in the Bell Telephone Companies. Find out about opportunities for *you*. Talk with the Bell interviewer when he visits your campus. And read the Bell Telephone booklet on file in your Placement Office.

BELL TELEPHONE COMPANIES

A Little Thinking Weather

Fall is a strange thing at Caltech. It may be summer-hot but still the leaves turn brown and drop off the trees. Then sometimes it gets cold and the papers are full of oranges dying and it feels good like back East. You can see the hills clearly silhouetted against the crisp blue sky and everybody remarks on the way to class in the morning how you can see the hills.

It's easier to think when the weather is like that; you know, when you don't have to worry about your eyes running and you don't have a headache and you can breathe without coughing. You can think about a lot of things because there's so much to decide and there's so much to do and it's good to think about things besides math and physics and EE and chemistry once in a while. You can think about the girls of the summer-happy-time or the gang back home if there is any left or about what you're going to do Thanksgiving and Christmas or maybe just about how you'd like to sleep for one week and start all over again. You may think about school, too. I don't mean about the courses you're taking and adding up post-midterm grade points and figuring everything. You have to think about how maybe there are other things you want around the old school besides just studying and trying to get a point one GPA higher than your roommate or the guy across the hall. This is a time to make a lot of decisions because everything starts in the fall and you have to make a policy and try to stick to it for three terms. You have to decide if you want to get in all those activities and how much you'll really enjoy them and how much they'll hurt your studying. You have to decide how many times a week you want to go out and if it's worth it and all. You have to decide whether school is worth it all in the first place and how to adjust to it.

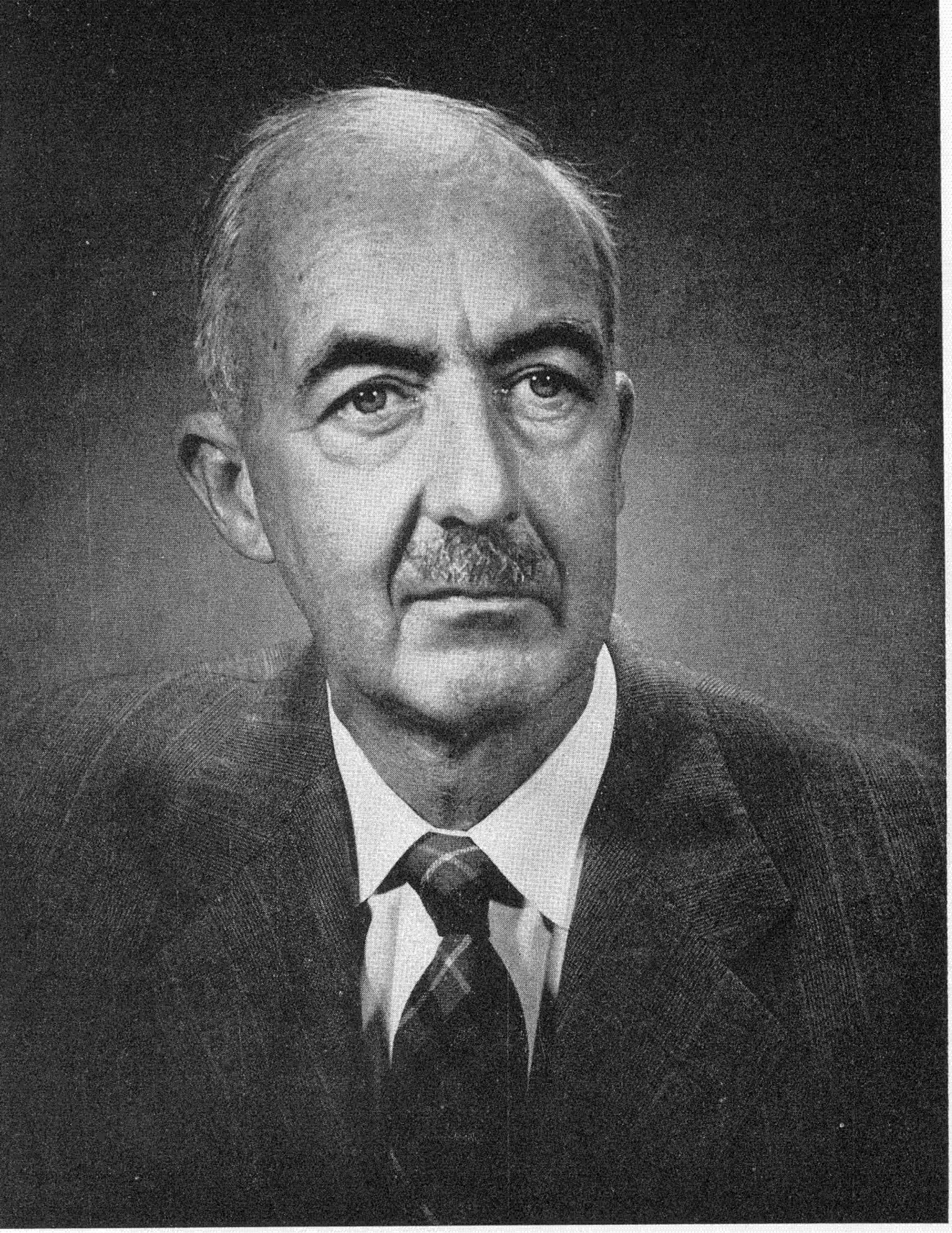
No involvements

They started telling you in that first fall just how it was: Don't get involved with too many activities and concentrate on your studies because that's what you came here for. So you figured all your time in study hours wasted and you felt bad most of the time because you weren't doing anything. You fooled around and you got into bull-sessions and you beefed about too much work and you didn't get into any activities because they took too much time. Besides, you didn't even know what you wanted and you were mixed up. You didn't think too positively that fall. You hated school because it demanded too much from your will power but your parents would disown you if you ever just thought about quitting so you didn't think about that. You stumbled through three terms of confusion which you don't even remember any more.

The pleasant present

And now you're a sophomore. You're a lot older and a lot wiser. You don't think so much of the past or the future summer-happy-time, but instead you concentrate on the present. You read somewhere that the European university produces scholars and the American one creates citizens. Well, you realize that you better become a little of a citizen before you get thrown into the world. You better know something about other things besides engineering and science. So you start really trying at exchanges and calling up the girls after and going out at least once a weekend. You work on the news staff of the *California Tech.* When there is someone on campus that you're interested in you go to hear him. You work hard on Interhouse even if it is during midterm week and even though you're not very convinced of the idea at all because you don't want someone else to do your share. You get active in your house and you start to realize how the campus is run. Most of all a lot of the confusion has worn off. You may study a few hours less a week but when you do study you can concentrate much better. You really are getting a feeling for what you want out of Caltech and you are willing to sacrifice some of your studying time to reap it. You feel pretty lucky every time you see a confused classmate flunk out that you did a little thinking while the air was crisp and cold and the crazy leaves were falling.

— *Martin Carnoy '60*



Ian Campbell, professor of petrology at Caltech, who leaves to become State Mineralogist and Chief of the Division of Mines of the State of California.

The Month at Caltech

Departure

Ian Campbell, professor of petrology at Caltech, starts a year's leave of absence next month to take the position of State Mineralogist and Chief of the Division of Mines of the State of California. He has been at Caltech since 1931.

He received his professional training at the University of Oregon, Northwestern University and Harvard University and has taught at Louisiana State University and at Harvard as well as Caltech. He has also served as a member of the United States Geological Survey and as an economic geologist to oil, mining and utility companies. He is known as one of the foremost authorities in the country on non-metallic mineral deposits.

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1959-1960

Space Technology Laboratories Fellowships

Doctoral & Postdoctoral Study

at the California Institute of Technology

or the Massachusetts Institute of Technology

Emphasis in the study program will be on Systems Engineering

Space Technology Fellowships have been established in recognition of the great scarcity of scientists and engineers who have the very special qualifications required for work in Systems Engineering, and of the rapidly increasing national need for such individuals. Recipients of these Fellowships will have an opportunity to pursue a broad course of graduate study in the fundamental mathematics, physics, and engineering required for careers in these fields, and will also have an opportunity to associate and work with experienced engineers and scientists.

Systems Engineering encompasses difficult advanced design problems of the type which involve interactions, compromises, and a high degree of optimization between portions of complex complete systems. This includes taking into account the characteristics of human beings who must operate and otherwise interact with the systems.

The program for each Fellow covers approximately a twelve-month period, part of which is spent at Space Technology Laboratories, and the remainder at the California Institute of Technology or the Massachusetts Institute of Technology working toward the Doctor's degree, or in postdoctoral study. Fellows in good standing may apply for renewal of the Fellowship for a second year.

Eligibility The general requirements for eligibility are that the candidate be an American citizen who has completed one or more years of graduate study in mathematics, engineering or science before July 1959. The Fellowships will also be open to persons who have already received a Doctor's degree and who wish to undertake an additional year of study focused specifically on Systems Engineering.

Awards The awards for each Fellowship granted will consist of three portions. The first will be an educational grant disbursed through the Institute attended of not less than $2,000, with possible upward adjustment for candidates with family responsibilities. The second portion will be the salary paid to the Fellow for summer and part-time work at Space Technology Laboratories. The salary will depend upon his age and experience and amount of time worked, but will normally be approximately $2,000. The third portion will be a grant of $2,100 to the school to cover tuition and research expenses.

Application Procedure

For a descriptive booklet and application forms, write to Space Technology Laboratories Fellowship Committee. Completed applications together with reference forms and a transcript of undergraduate and graduate courses and grades must be transmitted to the Committee not later than January 21, 1959.

Space Technology Laboratories

P.O. BOX 95001, LOS ANGELES 45, CALIFORNIA

In his 27 years at Caltech, Dr. Campbell has been both a distinguished teacher and administrator. From 1950-52 he served as acting chairman of the geology division and since 1952 has been executive officer. A member of the Caltech Faculty Board since 1950, he was appointed vice-chairman in 1951 and chairman in 1952.

Beside serving in both world wars, Dr. Campbell has taken on a multitude of off-campus duties with professional groups, a local draft board (he has been chairman since 1948), a wartime rationing board and Boy Scout Council — to name just a few.

Yuen Chu Leung

Yuen Chu Leung, senior research fellow in chemistry at Caltech, died on November 11 in Pasadena. She had been at the Institute since 1953 when she became a member of a group working with Dr. Linus Pauling and Dr. Robert P. Corey on the general problem of the structure of proteins.

Dr. Leung was born in Shanghai, China, in 1926. She was a graduate of the National University of Amoy where she was a student of Dr. Chai-Si Lu, a former research fellow at Caltech. In 1949 she came to the Rice Institute in Texas where she received her MS in 1951 and her PhD in 1953 as a student of Dr. Jürg Waser, now professor of chemistry at Caltech. During the past two years, Dr. Leung headed a group which has made prolonged studies on the ultimate structure of crystalline proteins. With Dr. Richard E. Marsh, she determined the positions of all of the atoms in the most complex protein fragment whose structure has been completely determined to date. Dr. Leung is survived by her husband, Pui Lo Leung, a mechanical engineer, and a 16-month-old son, Michael Leung.

Civilian JPL

Caltech's Jet Propulsion Laboratory was transferred this month from Army to civilian control. By order of President Eisenhower, the Laboratory's facilities have been made available to the National Aeronautics and Space Administration, an organization devoted to research in interplanetary communications and a peaceful conquest of space.

JPL will continue to be operated by Caltech, under the direction of William H. Pickering. Army projects already underway at the Laboratory will continue until they are completed sometime in 1959. For over a year, JPL has been occupied on the Sergeant program, a development of operational ballistic guided

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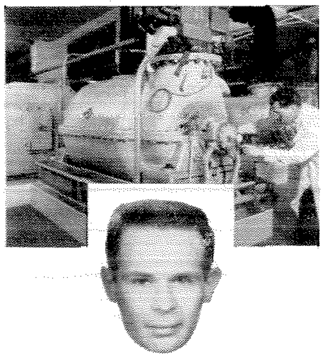
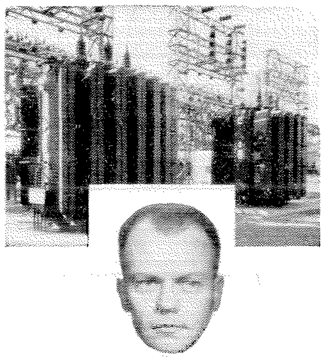
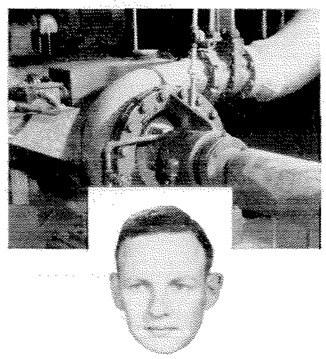
Allis-Chalmers training course has



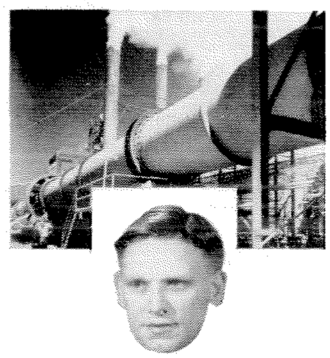
Aeronautical engineer Robert Claude, Parks College of Aero Technology, BS Aero Eng. '50, engineers compressors for wind tunnels.



Application engineering on large power transformers is handled by Michael Waterman, Case Institute of Technology, BSEE, '47.

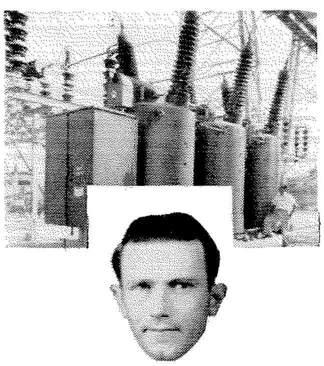


Sale of large centrifugal pumps to a wide range of industries is directed by Howard Godfrey, Oregon State College, ME '48.

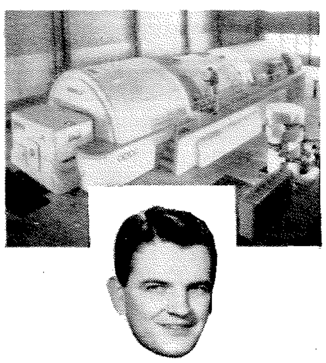


Field sales of America's widest range of industrial equipment is choice of Michael A. Mooney, University College, Dublin, BSE '53.

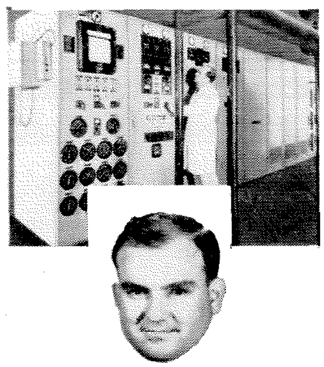
proved excellent springboard to



Sales and promotion man Irving Fisk, Clarkson College, EE '52, works with large power circuit breaking equipment.



Sales manager of large steam turbine generator units is interesting specialty of John M. Crawford, Clemson College, BME '49.



Sales engineering of high voltage electrical control is specialty of Ernest Horne, graduate of Alabama Polytechnic Institute, EE '49.

Nuclear engineer Raymond W. Klecker, University of Southern California, EE '49, is supervisor of design of nuclear reactors.

interesting and varied careers

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A-5601

The Month . . . *continued*

missiles for the Army's arsenal. Four projects which were originally under the direction of the Army are to be continued as projects of the NASA – two lunar probes (one of which was fired on December 6) and two satellite developments.

JPL facilities are valued now at more than $55,000,000, and more than 2,300 scientists, engineers and supporting personnel are employed there. As a space laboratory, one of JPL's most important fields of research will be interplanetary communications.

Dedication

Caltech's $1,500,000 radio astronomy installation in the Owens Valley desert near Bishop, California, will be officially dedicated on December 19. Speakers at the ceremony will include Albert B. Ruddock, chairman of the Caltech Board of Trustees; Rear Admiral Rawson Bennett, chief of Naval Research; John Bolton, professor of radio astronomy at Caltech and scientific director of the new radio observatory; and Caltech President L. A. DuBridge.

Operated by Caltech and financed by the Office of Naval Research, the observatory boasts the world's most versatile radio telescope – twin 90-foot reflectors which will allow Caltech investigators to pinpoint radio signal sources millions of light years away.

ALUMNI WINTER DINNER MEETING

January 22, 1959

Speaker: Thomas E. Curtis
Section Chief of Guidance System Test Engineering at Autonetics, a division of North American Aviation, Mr. Curtis was responsible for operation and maintenance of the inertial navigation system aboard the atom-powered submarine, USS Nautilus, during its voyage last August.

Topic: "96 Hours Under the Polar Ice"
An account of the voyage of the Nautilus and other subpolar excursions.

Cocktails at 6, Dinner at 7

Rodger Young Auditorium
936 West Washington Boulevard
Los Angeles

ALUMNI DIRECTORY SUPPLEMENT

A supplement to the 1958 Alumni Directory will be ready for distribution sometime around the middle of December. This supplement will list the names and addresses *ONLY* of those who received degrees in June, 1958. Copies of this supplement will be sent automatically to paid alumni who received a degree in 1958. Other paid alumni may secure a copy of this supplement by filling in the form below and sending it to the Alumni Office.

Please send a 1958 Directory supplement to:

Name..

Address..

City..State................

Personals

1898

Roy Beebe Blackman died on November 16, 1955, at the age of 78. His daughter writes: "After years of failing health since a critical illness, an operation, and a bad fall in Santo Tomas Internment Camp during the Japanese occupation of Manila, he went to California in 1954 for medical treatment and a change of climate, and lived with my sister and her husband in Castro Valley.

"You may recall that my father visited Caltech in 1933 during a year's tour around the world. He had always been very proud of Caltech. He spent many years in the Philippines and was one of the first American teachers in the Islands. He was also a private land surveyor and engineer.

"Father was buried with military services at the Golden Gate Cemetery in San Bruno as a Spanish-American War veteran."

1926

Henry Phillip Henderson died of a heart attack on Nov. 7 in Burlingame. He was 54 years old. Henry was with the Worthington Pump and Machinery Company and headed the sales organization for the seven western states. He is survived by his wife, a married daughter, and a son, H. P. Jr., a senior in mechanical engineering at Stanford.

Ivan L. Farman, MS '39, retired from the USAF as a Brigadier General in June, 1957, after 29 years of service. He is now a consultant to the Westinghouse Electric Corporation on worldwide military communications. He writes that his son received a BS degree last August from the U.S. Merchant Marine Academy and is now Junior Third Engineer on the *U.S.S. Steel Designer*. Additions to the family? "One 42-foot cruiser in much need of reconditioning."

1933

Wendel A. Morgan, planning engineer at the Washington Water Power Company in Spokane, writes that "my son, Donald, married a Stanford girl, Janice Graves, on September 27. He worked for Ampex Electronics last summer and is continuing to work part-time until he gets his BS degree in EE in March from Stanford. My daughter, Lois, is a junior at the University of California, Berkeley."

1936

Willard L. McRary, MS '37, PhD '40, professor of chemistry at the University of California at Santa Barbara, died of a cerebral hemorrhage in a Baltimore hospital on November 16. He was 44 years old.

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Personals . . . *continued*

He had been on sabbatical leave in Baltimore since last summer while he continued research at Johns Hopkins University on the parasite that causes Brazilian sleeping sickness. He and a co-worker, Elmer R. Noble, discovered an antibiotic drug during their research from 1950 to 1954 which checks the life cycle of the parasite.

He leaves his wife and two daughters – Linda Lee, 16, and Denise, 10.

1938

Robert Barry, president of Barry & Co., consulting management engineers, in Los Angeles, writes that he and his wife have just returned from a 7-week European trip. The Barrys have three children – Bill, who is a freshman at St. Mary's College; Barbara, a junior at Mayfield School in Pasadena; and Jane, who is in junior high school.

Lee Arnold, MS, has been named to fill two posts at New York University's College of Engineering. He has been appointed professor and chairman of the department of aeronautical engineering and director of the Daniel Guggenheim School of Aeronautics. Lee was formerly professor of civil engineering and engineering mechanics at Columbia University's school of engineering. The Arnolds, who live in New York City, have two children.

William O. Wetmore, MS '39, PhD '41, has been appointed special assistant to the vice president of Azusa Operations at the Aerojet-General Corporation in Azusa. He had formerly been vice president and director of research and development at the Hunter Engineering Company. The Wetmores live in Riverside and have two teen-age children.

1940

John W. Jackson, MS, professor of mechanical engineering at the University of Maryland, spent the academic year 1957-58 assisting in the development of a school of engineering at the Middle East Technical University in Ankara, Turkey. During this period he received a Smith-Mundt grant under the International Educational Exchange Service.

1941

Joseph P. LaSalle, PhD, writes: "I have been in the mathematics department at the University of Notre Dame since 1946 and was promoted to professor several years ago. At present I am on leave at the Research Institute for Advanced Study in Baltimore. A center was founded here recently for the study of differential equations. As for our family—we have two children; Marc. 6. and Nannette, 8."

1943

Robert M. Sherwin, MS '50, ChE '52, plant engineer at the Hooker Chemical Corporation in Tacoma, Washington, writes: "When a CIT survey balloon lands practically in the back yard of an alumnus, it's news. The state of Washington, with an area of 67,000 square miles, boasts only 110 alumni. The city of Tacoma has only 4. In October, a parachute with a black metal case slightly larger than a bowling ball landed in a wooded gulch about 2,000 feet from our home. Attached to it was a letter from CIT explaining that the case contained instruments for measuring cosmic rays and that it had been launched by balloon on April 13.

"I would appreciate knowing from an informed source what the mathematical probability is of such an event."

1944

Ruben F. Mettler, MS '47, PhD '49, has been appointed executive vice president and general manager of the newly incorporated Space Technology Labora-

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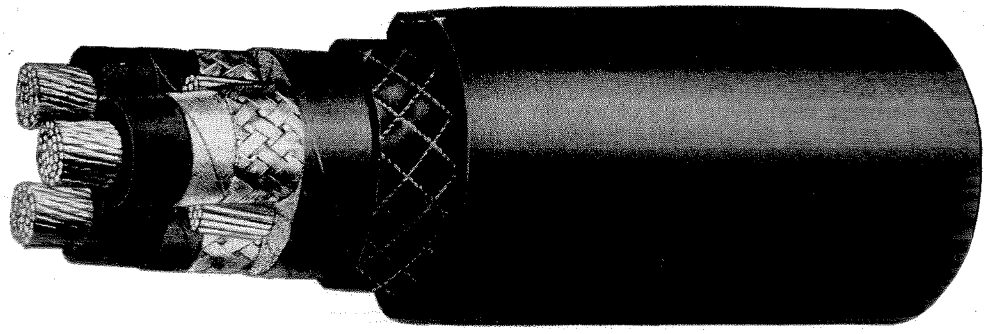

Personals . . . *continued*

tories. He had served as vice president and assistant general manager of the Laboratories, which were formerly a division of the Ramo-Wooldridge Corporation. The Mettlers and their infant son, Matthew, live in Los Angeles.

1946

Lt. Col. John W. Barnes, MS, writes that he is now stationed at Fort Campbell, Ky., where he lives on the post with his wife, Mary, and three children – John, 15; Kathy, 9; and Brian, 6. He is deputy commander of the First Airborne Battle Group of the 502nd Infantry of the 101st Airborne Division. He expects to be transferred to the Pentagon in 1959, where he will probably be assigned to the Missile Division in Research and Development.

Dennis J. Ahern was released from the Navy in 1954 and has since been employed as a sales engineer by the Friez Instrument Division of the Bendix Aviation Corporation in Baltimore, Md. The Aherns have three sons.

Ludwig I. Epstein, MS '41, is now assistant professor of physics and mathematics at Lowell Technological Institute in Massachusetts.

Glynn H. Lockwood, who was a chemical engineer in the gyroscope division of G. M. Giannini & Company, is now working at the Monterey Engineering Laboratory of the Dalmo Victor Company.

1947

Louis E. Klein, MS, is now assistant director of development for the organic division of the Monsanto Chemical Corporation in St. Louis. The Kleins and their three children, Susan, Billy and Jane, have recently moved into a new house in the suburbs of St. Louis.

1948

Wakefield Dort, Jr., MS, writes that he "spent the summer of 1957 in northern Idaho, resulting in the 1958 publication of 'Gold-Bearing Gravels near Murray, Idaho' as pamphlet 116 of the Idaho Bureau of Mines and Geology. I spent the summer of 1958 mapping geology in central Pennsylvania. I'm still associate professor of geology at the University of Kansas."

1949

Vernon L. Smith was promoted to associate professor of economics at Purdue University in July. In September, he began writing a book on the theory of investment and production, on a Ford Foundation Faculty Fellowship. Vern also co-authored a book this year called *Economics, An Analytical Approach,* and wrote several articles on subjects in eco-

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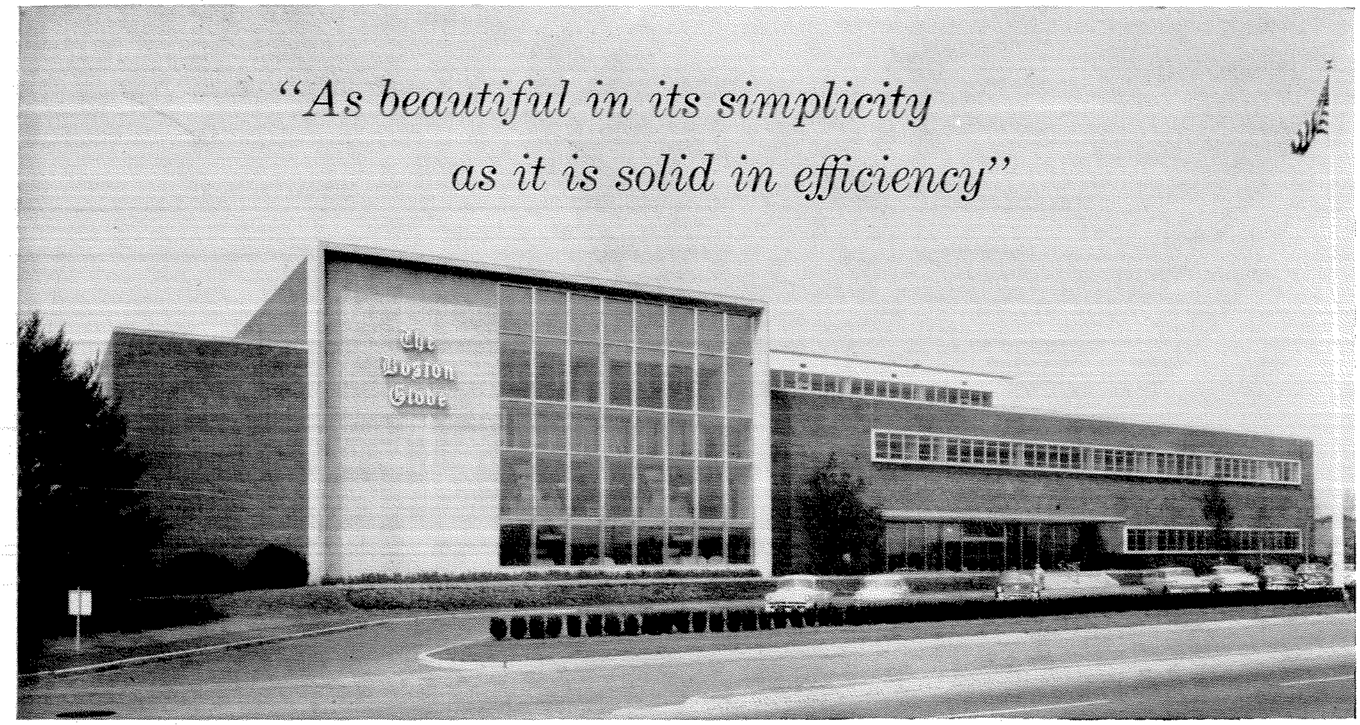

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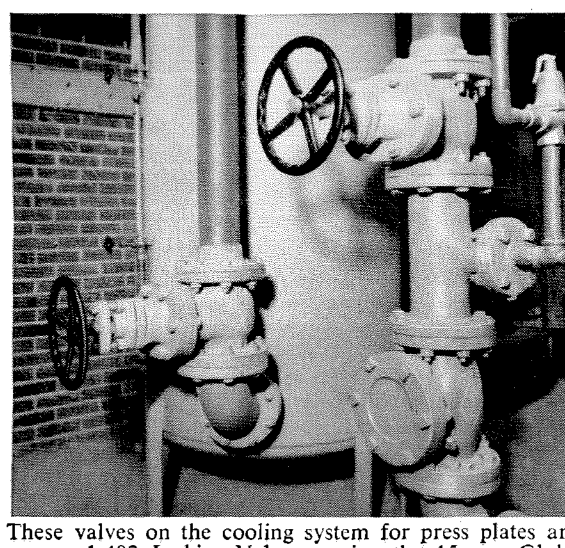
New Boston Globe Building relies on JENKINS VALVES

When the Boston Globe moved into this modern newspaper plant, it *made* news. A showplace for passersby with its battery of 37 presses turning out the news in a "picture window" two stories high, the new $12,000,000 home of the 86-year-old Globe is a model of efficient operation.

Efficiency is seen throughout the building plan. For example, practically all mechanical departments are on the first floor. The stress on efficient, trouble-free operation is equally evident in the equipment specifications which provided for utmost dependability in everything mechanical. To assure complete dependability in the control of water, air, gas, heating and air conditioning lines, Jenkins Valves were chosen.

Because of such confidence, "JENKINS" has been the trusted valve specification of three generations of building men. Yet the valves that have this well-earned confidence *cost you no more*. . . . Jenkins Bros., 100 Park Avenue, New York 17.



These valves on the cooling system for press plates are among 1,402 Jenkins Valves serving the 15-acre Globe building.

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LOOK FOR THE JENKINS DIAMOND ®

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Personals . . . *continued*

nomics, econometrics and mathematical economics.

1950

John R. Reese, MS, division geophysicist for the California Company, was transferred from Denver to Jackson, Mississippi, last year. The Reeses have a daughter, Susan Virginia, 8 months old.

Richard D. DeLauer, AE, PhD '53, on the staff of the Los Alamos Scientific Laboratory in New Mexico, is co-author of *Nuclear Rocket Propulsion*, published by McGraw-Hill this fall.

Breck Parker has left the U.S. Bureau of Mines office in Denver to join the exploration staff of the Homestake Mining Company. He still lives in Denver.

Bruce B. Stowe, lecturer on botany at Harvard University, now has two children—Mark, 2½ and Eric, 6 months.

1951

Robert E. Cobb writes from RMS *Queen Mary* that "my family and I are on vacation after two years in Turkey for Socony Mobil. Spent a few days in Brussels (to see the fair) and Madrid (to see the bullfights) and Lisbon (to just rest) on our way back to the States. At the moment we're en route back to Ankara. I was recently promoted to staff geologist from geological party chief. This means I theoretically spend most of my time in the office rather than in the field."

1953

Rolf Hastrup, MS '54, ME '58, writes that he now has his first permanent job with the Aerojet-General Corporation in Sacramento as a design engineer – and is moving into his first home with his first child, Stefan, born on September 22.

1954

Bruce H. Morgan, MS, is in his second year of teaching sophomore physics as an assistant professor at the U.S. Naval Academy. He will be married to Olivia Denniston of Annapolis on December 27.

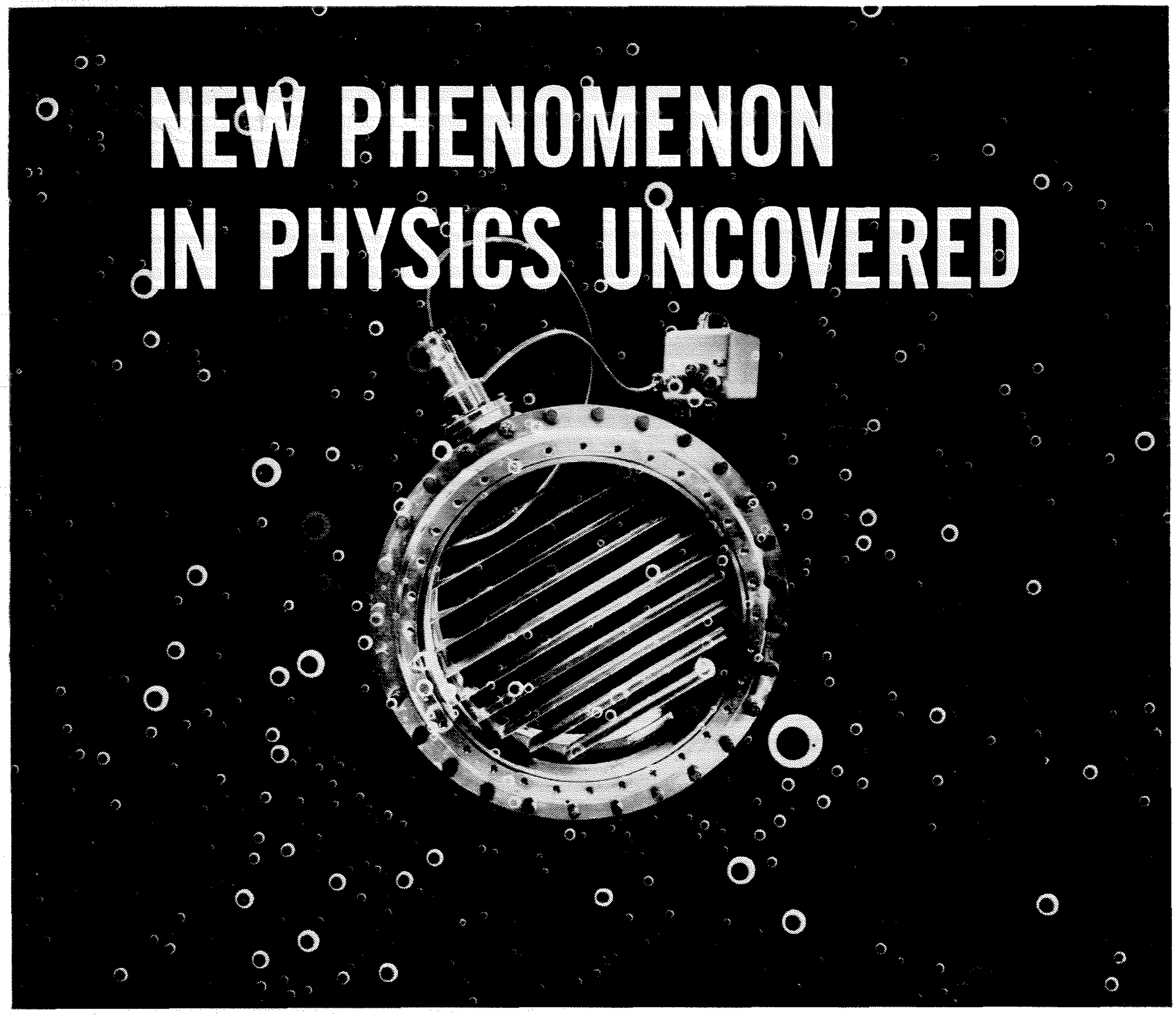
1955

Bruce J. Rogers, PhD, associate professor of plant physiology at Purdue University in Indiana, now has a son, Christopher, 8 months old.

1956

H. Mark Goldenberg, who received his MS from Harvard last summer, and is now studying for his PhD there, was married to Evelyn Baker of Salem this fall.

Robert I. Jetter, graduate student in mechanical engineering at Stanford, was married recently to Elizabeth Hoy of Pasadena.



Investigation in detecting cavitation, or forming of vapor bubbles in liquid flow, led AiResearch engineers to the discovery of an important new phenomenon ... *that flow of bubbles in liquids generates a magnetic field.* This discovery, among other things, helps solve critical flow problems in missile and industrial fields. The AiResearch cavitation detector pictured picks up these tell-tale signals as the liquid passes through the grid, pinpointing the cause of trouble.

Many such pioneering developments are underway in challenging, important work at AiResearch in missile, electronic, nuclear, aircraft and industrial fields.

Specific opportunities exist in system electronics and servo control units; computers and flight instruments; missile auxiliary power units; gas turbine engines, turbine and air motors; cryogenic and nuclear systems; pneumatic valves; industrial turbochargers; air conditioning and pressurization; and heat transfer, including electronic cooling.

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ALUMNI CALENDAR

January 22	Winter Dinner Meeting
March 7	Annual Dinner Dance
April 11	Annual Seminar
June 10	Annual Meeting
June 27	Annual Picnic

CAREERS

Careers Incorporated is now distributing a booklet entitled "Career: For the Experienced Engineer and Scientist" – in which a group of leading employers describe new job opportunities for technical personnel. The book will be sent free to anyone in the classes of 1940 to 1956. These men will also receive a monthly newsletter and confidential registration in the National Manpower Register. Members of other classes can order "Career" through local bookstores—or direct from Simon & Schuster – price $1.95.

For your free copy, write to:

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Include your name, address, college, class and major field.

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Informal luncheons every Thursday

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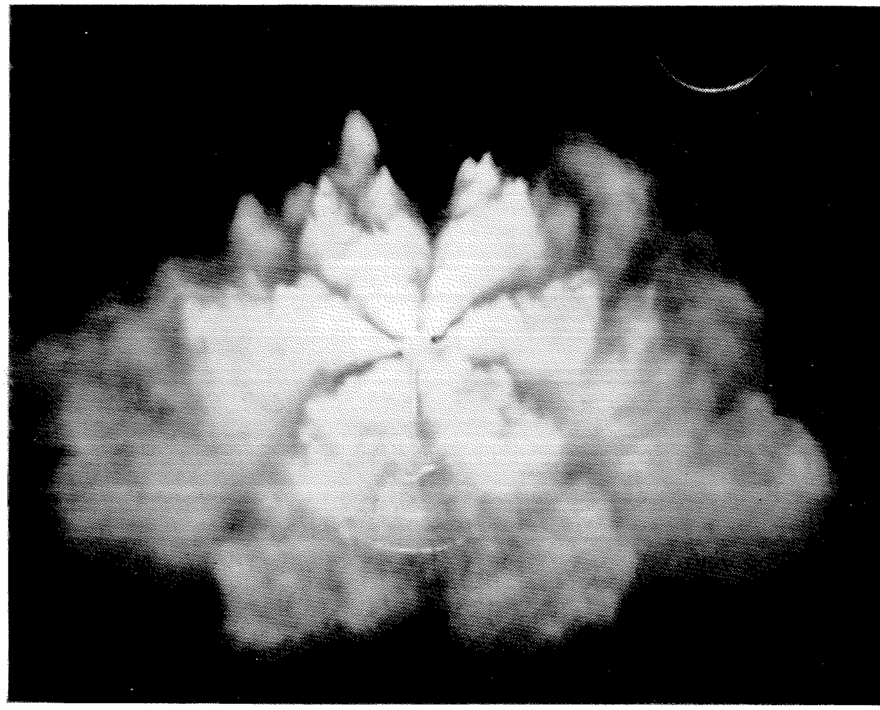
PHOTOGRAPHY AT WORK
No. 33 in a Kodak Series

The Army's first operational rotor-tip propelled jet helicopter—built by Hiller.

The camera has caught the fuel spray pattern within the rear end of the ram-jet engine even though passing by at about 450 miles per hour.



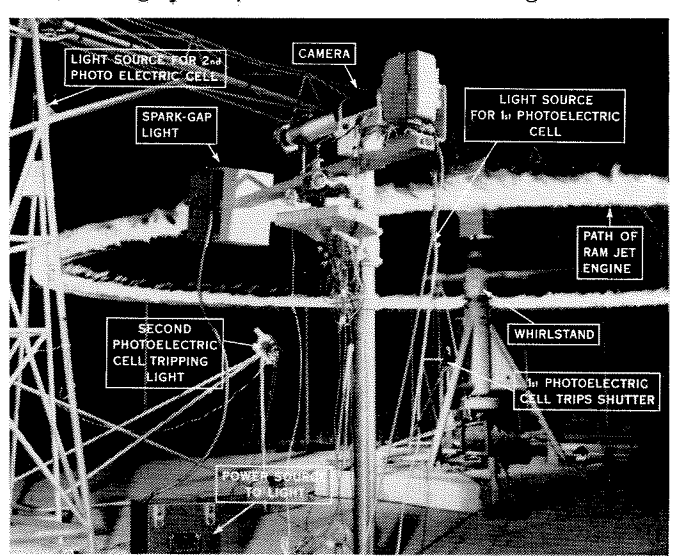
Project:
Inspect rotor tip jets for a whirlybird

Hiller Helicopters wanted facts on the fuel spray pattern of a ram-jet engine whirling at speeds up to 700 feet per second. Photography got the job.

WHEN HILLER HELICOPTERS of Palo Alto, Cal.—a pioneer in vertical take-off aircraft—developed a rotor-tip ram-jet engine, they knew the fuel spray would be subject to high air velocity and centrifugal force up to 1200 G's. Would the fuel spray be deflected outward and cause the jet to lose thrust? They wanted to know. So they set up the camera with its fast eye to catch what otherwise couldn't be seen. And they learned the right angle of air intake and nozzle to obtain the greatest power.

Using photography in research is an old story with Hiller—just as familiar as using it for improving public relations. It's an example of the way photography plays many important roles in modern-day industry.

In whatever work you do you will find that photography will play a part in improving products, aiding quality control and increasing sales.



This is all the human eye could have seen of the whirling ram-jet engine as camera takes its picture.

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

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One of a series*

Interview with General Electric's W. Scott Hill Manager—Engineering Recruiting

Qualities I Look For When Recruiting Engineers

Q. Mr. Hill, what can I do to get the most out of my job interviews?

A. You know, we have the same question. I would recommend that you have some information on what the company does and why you believe you have a contribution to make. Looking over company information in your placement office is helpful. Have in mind some of the things you would like to ask and try to anticipate questions that may refer to your specific interests.

Q. What information do you try to get during your interviews?

A. This is where we must fill in between the lines of the personnel forms. I try to find out why particular study programs have been followed, in order to learn basic motivations. I also try to find particular abilities in fields of science, or mathematics, or alternatively in the more practical courses, since these might not be apparent from personnel records. Throughout the interview we try to judge clarity of thinking since this also gives us some indication of ability and ultimate progress. One good way to judge a person, I find, is to ask myself: Would he be easy to work with and would I like to have him as my close associate?

Q. What part do first impressions play in your evaluation of people?

A. I think we all form a first impression when we meet anyone. Therefore, if a generally neat appearance is presented, I think it helps. It would indicate that you considered this important to yourself and had some pride in the way the interviewer might size you up.

Q. With only academic training as a background, how long will it be before I'll be handling responsible work?

A. Not long at all. If a man joins a training program, or is placed directly on an operating job, he gets assignments which let him work up to more responsible jobs. We are hiring people with definite consideration for their potential in either technical work or the management field, but their initial jobs will be important and responsible.

Q. How will the fact that I've had to work hard in my engineering studies, with no time for a lot of outside activities, affect my employment possibilities?

A. You're concerned, I'd guess, with all the talk of the quest for "well-rounded men." We do look for this characteristic, but being president of the student council isn't the only indication of this trait. Through talking with your professors, for example, we can determine who takes the active role in group projects and gets along well with other students in the class. This can be equally important in our judgment.

Q. How important are high scholastic grades in your decision to hire a man?

A. At G.E. we must have men who are technically competent. Your grades give us a pretty good indication of this and are also a measure of the way you have applied yourself. When we find someone whose grades are lower than might be expected from his other characteristics, we look into it to find out if there are circumstances which may have contributed.

Q. What consideration do you give work experience gained prior to graduation?

A. Often a man with summer work experience in his chosen academic field has a much better idea of what he wants to do. This helps us decide where he would be most likely to succeed or where he should start his career. Many students have had to work hard during college or summers, to support themselves. These men obviously have a motivating desire to become engineers that we find highly desirable.

Q. Do you feel that a man must know exactly what he wants to do when he is being interviewed?

A. No, I don't. It is helpful if he has thought enough about his interests to be able to discuss some general directions he is considering. For example, he might know whether he wants product engineering work, or the marketing of technical products, or the engineering associated with manufacturing. On G-E training programs, rotating assignments are designed to help men find out more about their true interests before they make their final choice.

Q. How do military commitments affect your recruiting?

A. Many young men today have military commitments when they graduate. We feel it is to their advantage and ours to accept employment after graduation and then fulfill their obligations. *We have a limited number of copies of a Department of Defense booklet describing, in detail, the many ways in which the latter can be done. Just write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.* 959-8

*LOOK FOR other interviews discussing: • Advancement in Large Companies • Salary • Personal Development.

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