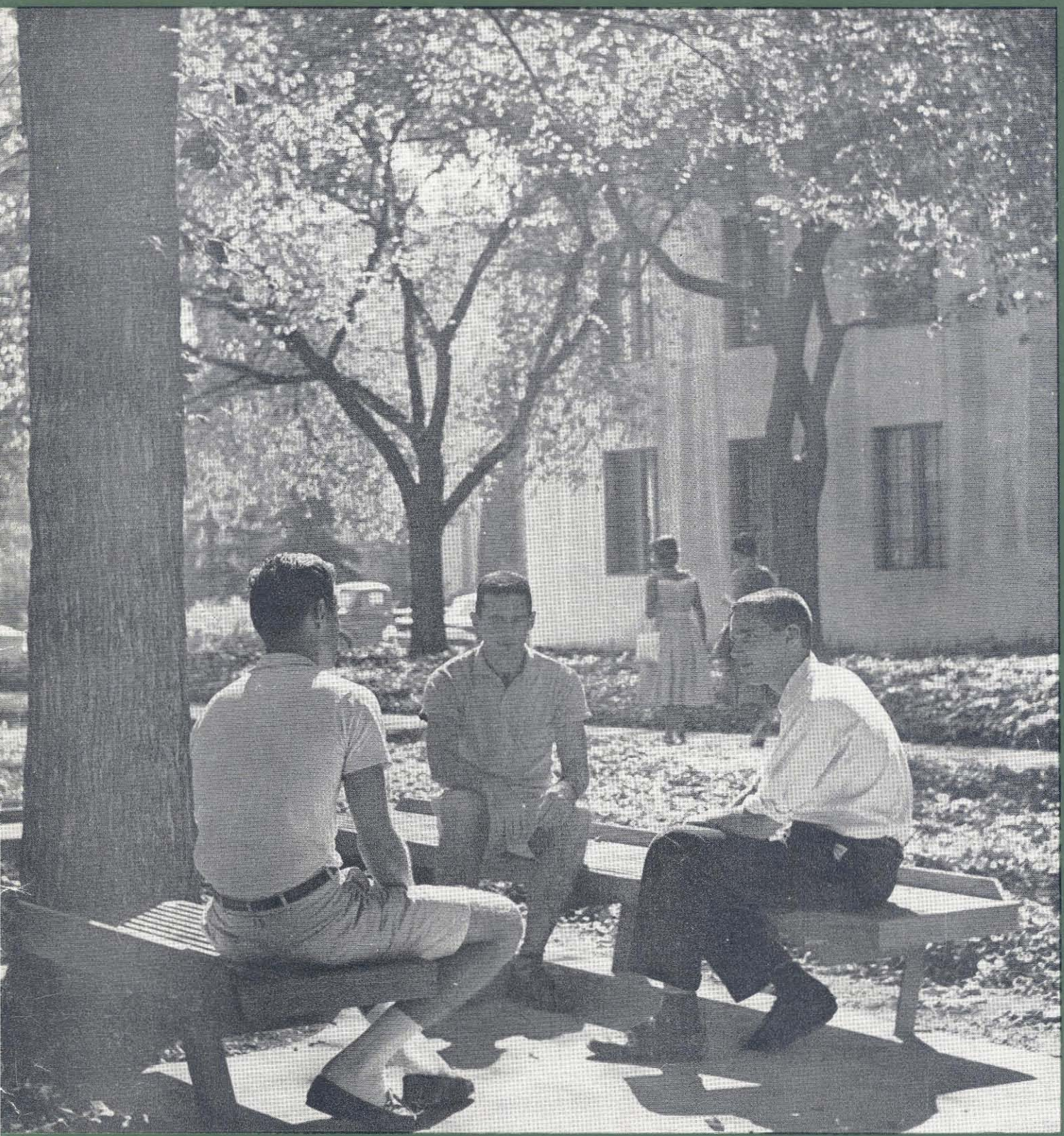
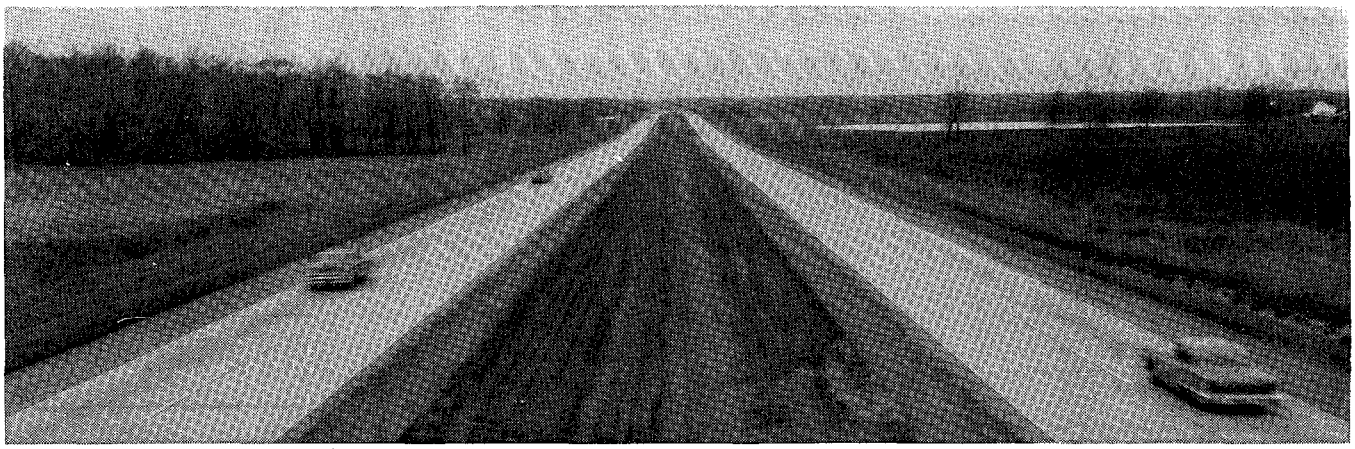
ENGINEERING | AND | SCIENCE

October, 1958



Summer at Caltech . . . page 25

Published at the California Institute of Technology



Design a 2-lane steel bridge to cross a modern highway—

$44,000 in cash awards!

American Bridge Division of United States Steel announces a $44,000 STEEL HIGHWAY BRIDGE DESIGN COMPETITION dedicated to stimulating the engineering mind to a more imaginative, more effective use of steel in the construction of small bridges.

If you, as a professional or design engineer or as a college engineering student, can come up with a more imaginative, attractive and economical design, not only may you win up to $15,000 in award money, but your efforts may contribute materially to the most challenging road-building program ever undertaken. For, according to conservative estimates, the tremendous 41,000-mile Federal Highway Program will call for the construction of at least a bridge a mile!

The competition involves solving a relatively simple but important problem that will not demand too much of your time.

Send for your entry booklet now: Contains complete information on the Steel Highway Bridge Design Competition—everything you need to know to prepare your entry. Just fill in and mail the coupon and get started with your design without delay.

Awards for College Engineering Students

	each
1st Award	$4,000.00
1st Honorable Mention	$2,000.00
2nd Honorable Mention	$1,000.00
Four 3rd Honorable Mentions	$ 500.00

Awards for Professional Engineers

	each
1st Award	$15,000.00
1st Honorable Mention	$10,000.00
2nd Honorable Mention	$ 5,000.00
Five 3rd Honorable Mentions	$ 1,000.00

Problem: Get two lanes of traffic across a modern 4-lane highway in accordance with latest standards for today's highways.

Objectives: Originality of design, greater utilization of the inherent properties of steel, economy, and aesthetic appeal.

Requirements: Just one. The steel bridge must comply with the Geometric Standards for the National System of Interstate and Defense Highways using H-20-816-44 loading. The type of structure, the type of connections, span length and number of piers, if any, are completely up to you since you are designing with steel.

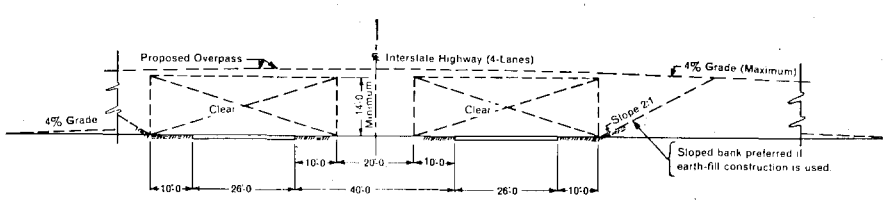
Eligibility: The competition is open to all professional and design engineers and college engineering students except employees and/or members, and their immediate families, of the following firms and groups:

United States Steel and its subsidiaries, divisions, agents and dealers
Structural steel fabricating firms
American Institute of Steel Construction
Rules Committee and Judges

See list of awards above.

Rules and Judging: The competition will be under the supervision of the American Institute of Steel Construction, which has appointed a Rules Committee and a panel of judges composed of prominent consulting engineers and architects.

Deadline: Entries must be postmarked or expressed to arrive not later than midnight, May 31, 1959. *USS is a registered trademark*



ELEVATION and CLEARANCE DIAGRAM

Competition Editor, Room 1831
American Bridge Division
525 William Penn Place
Pittsburgh, Pennsylvania

Please send me a copy of your $44,000 Steel Highway Bridge Design Competition entry booklet.

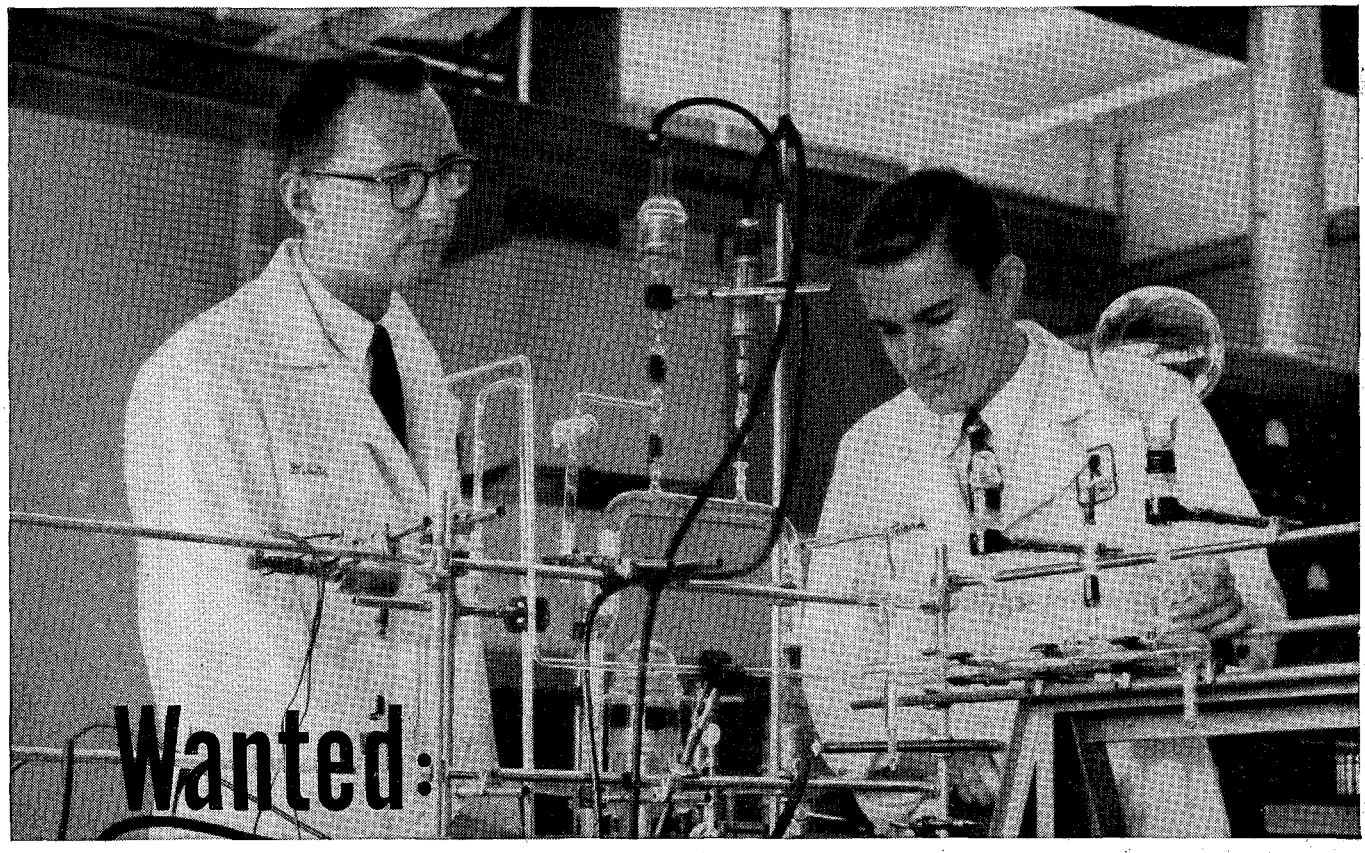
Name.....

Professional or Design Engineer ☐
Engineering Student ☐ **(Check one)**

Street.....

City.....**State**.....

United States Steel



TEAMMATES—Young physicist Donald Swets—MS 1955—teams up with GM Research Laboratories physicist Robert C. Frank (r.) to use mass spectrometer for basic research on gases in metals. Glass tubing apparatus was developed specifically for this GM Research project.

Barrier Breakers

If you're the kind of engineer who wants to do big things in a big way, perhaps General Motors has a place for you.

For at GM, "The Inquiring Mind" is free to roam—free to explore the scientific world in an effort to find new and better roads to progress.

And the men who search for—and find—these new paths, also find opportunity without limit.

For GM is quick to recognize ability—quick to reward it with ever-increasing responsibility—quick to promote talented men to supervisory and executive positions throughout its organization.

Where will you use your abilities and talents? The fields cover the entire spectrum of engineering and science.

Automobiles, trucks, locomotives, aircraft, yes. But power transistors and solar energy, too. Astronautics, astrodynamics and electronics, as well. Rocket propulsion, missile guidance, the entire field of space engineering and science are all concerns of various General Motors Divisions.

And you will not necessarily be confined to just one of these fields. Depending on where your talents lie, you'll find yourself concerned with many fields at various times.

Breaking barriers of technology is a specialty with the engineers and scientists who work at General Motors' 35 Divisions and 126 plants in 71 cities and 19 states—and at our Technical Center near Detroit. If that's the kind of work that fascinates you, let us hear from you.

GENERAL MOTORS

Personnel Staff, Detroit 2, Michigan

GM Positions now available in these fields for men holding Bachelor's, Master's and Doctor's degrees:

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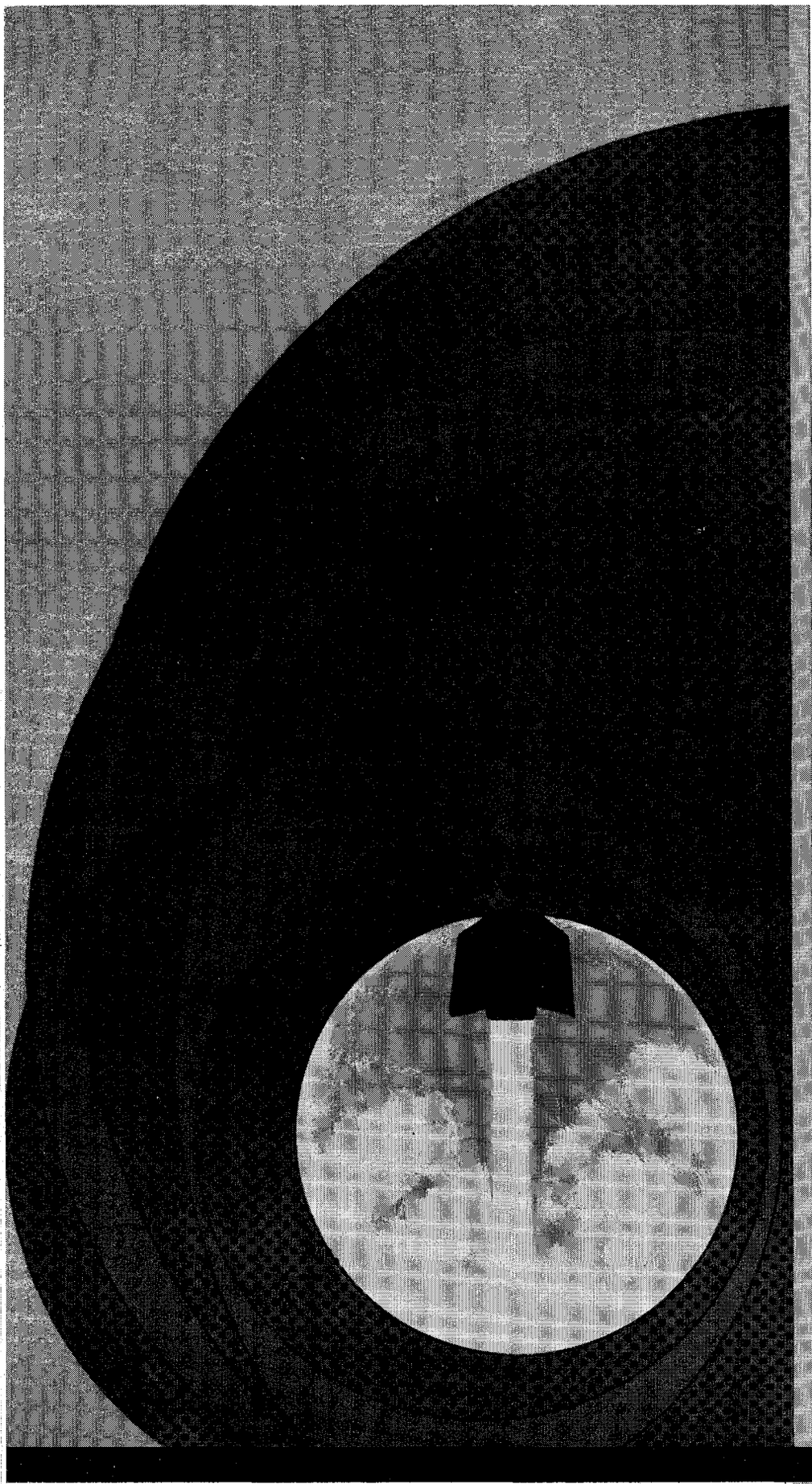
Metallurgical Engineering • Aeronautical Engineering • Ceramic Engineering
Mathematics • Industrial Design • Physics • Chemistry



ACOUSTIC NOISE

When huge rocket engines lift a ballistic missile or satellite vehicle into the air, the thundering noise of the engines violently shakes intricate electronic components and the missile structure itself. Acoustic noise is one of the many environments that must be thoroughly explored and understood by the missile designer.

But it is expensive and impractical to conduct acoustic noise tests by operating rocket engines on the ground. Noise—of the same frequencies and amplitudes as rocket engine noise—must be produced in the laboratory.

Engineers at Avco's Research and Advanced Development Division have met this problem by designing a versatile high-intensity acoustic noise generator. Based on electromagnetic principles, it creates noise environments of the same frequency spectra as rocket or jet engines.

This successful effort is now part of the division's complete environmental testing laboratory, where it is producing information for Avco scientists and engineers responsible for ICBM nose cones.

Acoustic noise work is one of the many development programs that proceed simultaneously with theoretical and applied research at RAD. The mutual stimulation of scientists and engineers in many disciplines occurs naturally at Avco, where the search for new knowledge and its application go forward under one roof.

Research and Advanced Development is more than a descriptive title at Avco. It is a concept that promotes creativity.

Avco

Research and Advanced Development division

For information on unusual career opportunities for exceptionally qualified scientists and engineers, write to: Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Div., 201 Lowell Street, Wilmington, Mass.

ENGINEERING | AND | SCIENCE

On Our Cover

three Caltech undergraduates try out the new campus benches—which are just one of the lively developments described by Brad Efron '60 in his report about summer on the campus, on page 25.

James Bonner

describes some exciting new research in progress in "The Biology of Microsomes" on page 20. Dr. Bonner, a biochemist and plant physiologist, is professor of biology at Caltech. This year he is also serving as acting chairman of the division of biology while chairman George W. Beadle is at Oxford University as Eastman Visiting Professor.

L. Winchester Jones,

Caltech's dean of admissions, discusses "The Need for College Scholarships" on page 31. This article has been adapted from a talk given by Dean Jones on October 3 to the Achievement Rewards for College Scientists Foundation, Inc., in Los Angeles. This organization has been set up by a group of Los Angeles women to obtain private funds to assist young science students. The immediate goal of ARCS is to raise money for scholarships and fellowships at Caltech.

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Books

The King's Agent

by J. Kent Clark
Charles Scribner's Sons, N.Y. . . . $5.95

Reviewed by John A. Hawgood

By writing a "Restoration Novel" (the action opens at the battle of Sedgemoor in 1685) J. Kent Clark, associate professor of English at Caltech, inevitably challenges comparison with two classics of that genre—Thackeray's *Henry Esmond* and Kathleen Winsor's *Forever Amber.*

It may be said at once, and without reproach, that Dr. Clark's offering is likely to achieve neither the lasting fame of the former nor the immediate notoriety of the latter, but it is nevertheless going to be read and enjoyed by a great many people. It was already scheduled, before publication, as the October selection of the Dollar Book Club—and it is far superior, both in literary craftsmanship and in its treatment of history, to the run-of-the-mill historical romance.

The King's Agent is based upon careful research, much of it pursued in the Huntington Library, which is particularly strong in material on seventeenth-century British history, the preserve of the late well-beloved Godfrey Davies, who would surely have enjoyed reading this book immensely.

But Dr. Clark wears his learning lightly, and disguises its fount successfully. The tale is crisply told in a modern but not too slangy idiom.

A noted writer, a Pulitzer Prize-winner with at least three of his stories made into movies, and with best sellers among the paperbacks, recently gave the formula for a successful historical novel to a neophyte at the game as: "An attempted seduction before page 100; an encounter with a scarlet woman before page 200; a completed seduction before page 300. Then—Bingo!"

Dr. Clark waits until page 274 (with preliminary fumblings to keep things moving on pages 167 and 235). He thus measures up adequately to this yardstick, yet holds his fire quite prettily. But to make up for the belated and somewhat inverted seduction (the heroine, tired of waiting, had to come and get him!) our hero has his "required" encounter with a scarlet woman (the King's mistress, Catherine Sedley, Duchess of Dorchester) as early as page 83:

" 'Please stop gaping and sit down, Mr. Barnard . . . Have you never seen a woman before?' "

His second is on page 215:

"Ralph rose. 'You won't take it personally if I kiss you goodbye?'

" 'Not at all.' "

(After which we almost expect Catherine—out of character as well as of period—to gush, "And next time you must come to tea, and meet Mother.")

He meets Catherine for the third and last time on page 323:

" 'I would hate to believe you are more concerned with your head than with my body.'

" 'A habit, Kit,' he said. 'Only a disgusting habit.'

" 'Break it, by all means,' she said.' "

But he didn't. It was too ingrained. So they parted forever, Sir Ralph Barnard's virtue (in this direction at least) still intact.

Nevertheless, these three conversations with the notorious Catherine Sedley are retailed with great skill and are perhaps the most entertaining parts of the book.

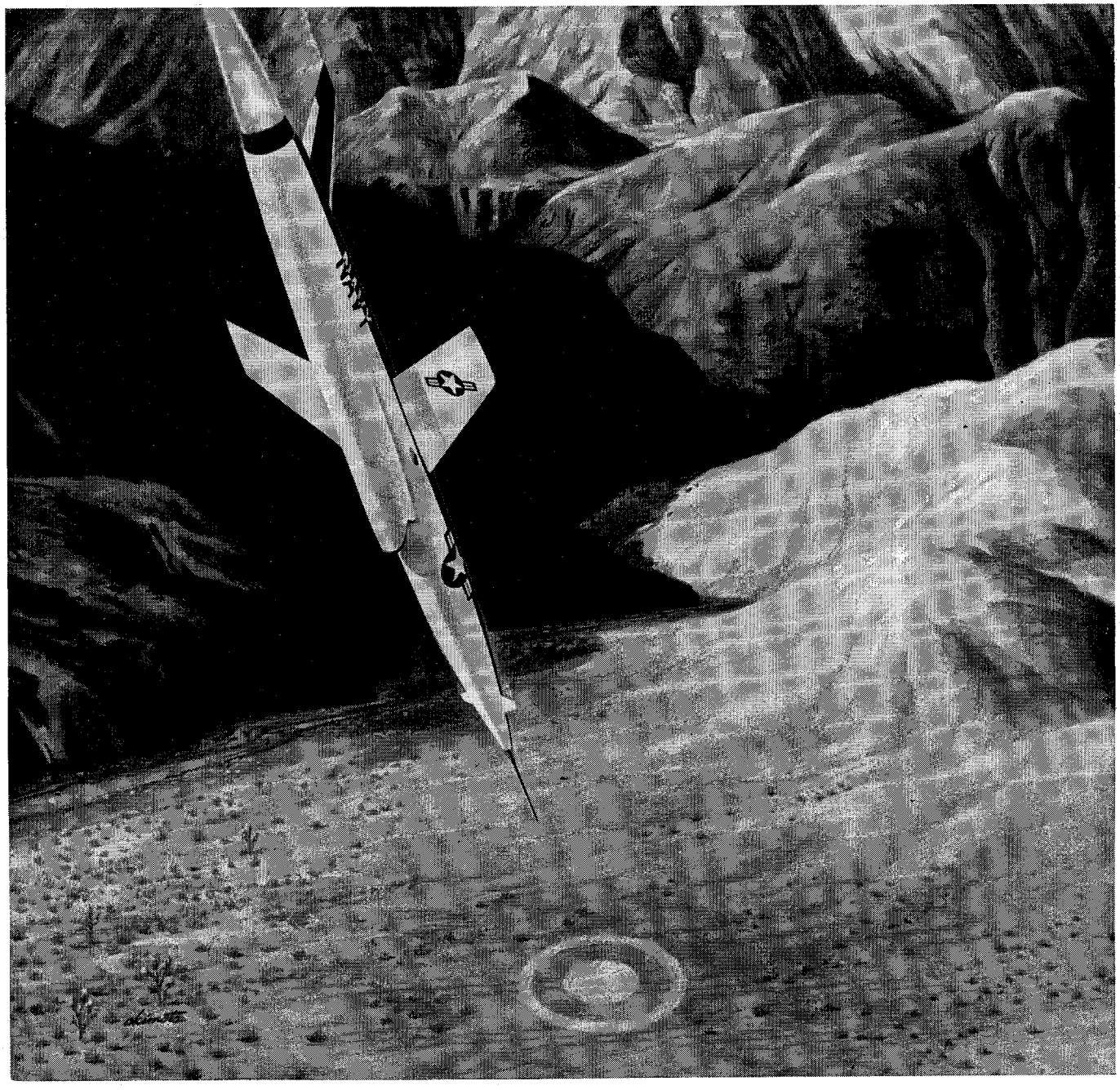
If the hero, Ralph Barnard, emerges as a somewhat stuffy character (if not indeed, in places, a downright prig) this, at least, as with his heroine, is what the plot demands, and it rings the changes most refreshingly on the usual swashbuckling, epigram-dropping, garter-snapping Restoration gallant of fiction.

Sir Ralph may be a trifle slow in the boudoir but he can undress a French diplomatic courier (male) in double-quick time, after first stunning him by one well-directed blow with a blunt instrument, and can discover his secret despatches, hidden in his wig, in the twinkling of an eye.

Though the narrative neither rollicks nor roisters, the plot is a good and fast one, subtly and at times elegantly woven.

Hollywood should take notice of this novel. It has a fine, upstanding

continued on page 8



Which of the following are practical applications of COPPER or COPPER ALLOYS?

- ☐ 1. Ship fittings.
- ☐ 2. Television antennae.
- ☐ 3. Heat sinks for missile nose cones.
- ☐ 4. Architectural extrusions.
- ☐ 5. Prefabricated plumbing lines.
- ☐ 6. Pipelines for sodium hydroxide.
- ☐ 7. Collector vanes for solar heating.
- ☐ 8. Resistance heating elements.
- ☐ 9. Resistance-welding electrodes.
- ☐ 10. Gold-plated jewelry.

Now try your hand at these True-False Selections:

- ☐ 11. Proved copper reserves have decreased in the last 20 years. ☐T, ☐F.
- ☐ 12. On the machinability rating scale, Free-Cutting Brass rates 100. ☐T, ☐F.
- ☐ 13. The green patina of copper can be developed artificially. ☐T, ☐F.
- ☐ 14. Copper and copper alloy parts should be joined only by riveting. ☐T, ☐F.
- ☐ 15. Nickel Silver is an alloy of nickel and silver. ☐T, ☐F.

1. Yes. Copper, and many of its alloys, have excellent resistance to salt water corrosion.

2. No. The important properties of copper are not needed and lighter, cheaper metals are usually used.

3. Yes. Copper's high heat conductivity protects the delicate instruments inside by quickly dissipating the surface heat of re-entry.

4. Yes. Architectural bronze extrudes readily and is used for a wide variety of architectural shapes.

5. Yes. Because copper tubing can be easily and firmly soldered, it lends itself well to prefabrication. The few unassembled joints are soldered on the site, eliminating the use of threaded fittings.

6. Yes. Copper-nickel alloys have good resistance to many alkalies and are often used in contact with them.

7. Yes. Large vanes of copper are blackened and mounted on a roof to collect the sun's rays. The high thermal conductivity of copper makes it very efficient for this use. The copper carries the heat to a circulating water system.

8. No. The conductivity of copper and its alloys is too high for this purpose.

9. **Yes.** Here the current is introduced through the electrodes to the parts to be welded. Several copper alloys are well suited for this use because of their high strength at elevated temperatures.

10. **Yes.** The low-zinc brasses are easily worked and are readily plated for high-quality costume jewelry. Most copper alloys lend themselves well to polishing and plating.

11. **False.** Reserves have increased. Published figures are no indication of long run availability or total mineral deposits. The industry lists only those reserves which have been "proved" for immediate development. Since the copper industry has grown in these years, so, too, have the proved reserves. Future copper supplies are vastly greater than any known "reserve" figures would indicate.

12. **True.** Free-Cutting Brass usually can be turned at maximum spindle speed and many other copper alloys at high speeds. A large number of copper alloys are available for easy machining.

13. **True.** The Copper & Brass Research Association has developed a spray process which has been successfully used to give architectural and ornamental parts an attractive green patina much faster than nature would do it.

14. **False.** Good joints between copper or copper alloy parts can be made by soldering, brazing or welding.

15. **False.** The Nickel Silvers are copper alloys. They derive their name from their silver-like color. A typical composition is 65% copper, 18% nickel, 17% zinc, and no silver at all.

The copper alloys, of which there are more than forty that are standard and many more that are special in current use, have many properties just as unique as this "silver" that isn't silver. If you'd like to learn more about them, or if you really flunked this quiz, send for your copy of "A Guide to Copper and its Alloys." The Copper & Brass Research Association, 420 Lexington Avenue, New York 17, N. Y., will be happy to supply it.

hero (who is nevertheless a lawyer by profession and a secret agent by avocation), a lovely, eloquent but deceitful heroine, a noble prostitute, an ignoble monarch, a lost cause, a court scene, a hunting scene, several battlefields, cloaks, daggers and plenty of sword and boudoir play.

Hollywood casting

Letting my imagination range over the freeways I already begin to cast *The King's Agent* for its ultimate but surely inevitable embalmment in celluloid. With a little bit of cooperation between the major studios, Sir Ralph Barnard (James Stewart) serves King James II (Sir Ralph Richardson, barely needing to overact) chats and flirts with the king's mistress, Catherine Sedley (Marilyn Monroe), loves the cruel, double-crossing Esther Hemphill (Katharine Hepburn) marries the delectable Henriette (Taina Elg), and fights the villainous Randall (Basil Rathbone) in a back street of Paris.

There are also bit parts for Sir Laurence Olivier (Colonel Jack Churchill, afterwards Duke of Marlborough), Charles Laughton (Judge Jeffries), Bing Crosby (the Papal Nuncio) and Frank Sinatra (William of Orange—why not? He should try everything at least once), but not alas for either Alan Ladd or Brigitte Bardot, for all the characters talk a lot and with animation, while *nearly* all the time they are all more than adequately clothed.

John A. Hawgood, professor of modern history and chairman of the School of History at the University of Birmingham in England, holds doctor's degrees from London and Heidelberg and received part of his training at Yale and Wisconsin Universities. He has spent four out of the last five summers in California, doing research at the Huntington Library.

No More War!

by Linus Pauling

Dodd, Mead, N.Y. $3.50

Reviewed by Wolfgang K. H. Panofsky

This is an important book in two respects: it explains such things as the difference between atomic and nuclear explosions, the nature of ionizing radiation, and similar technical material, in an unusually lucid and popular language; and it documents the author's views on the current controversy over nuclear testing.

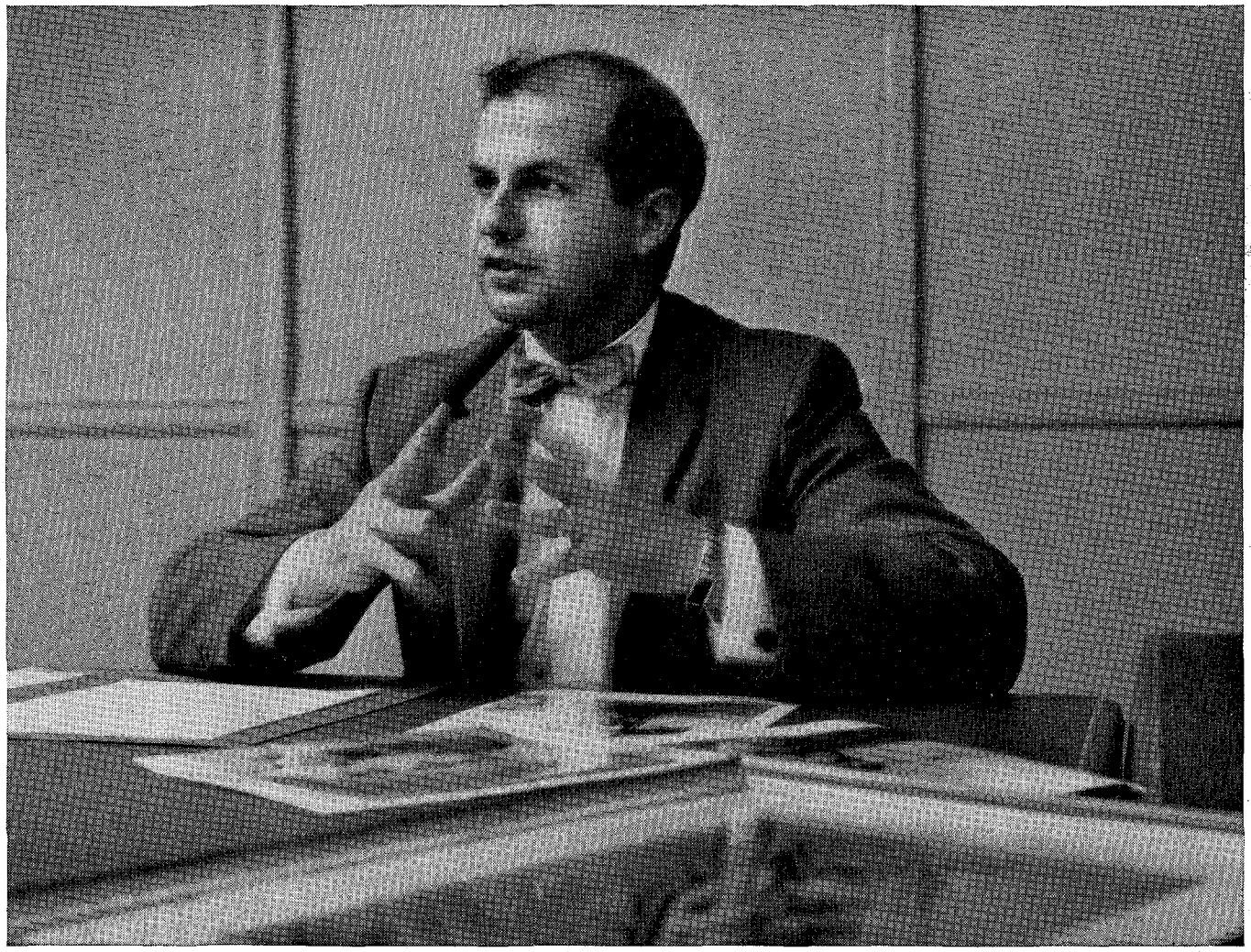
Dr. Pauling, professor of chemistry at Caltech, makes it quite clear that there exists no substantial disagreement among the scientists whose views are on record concerning the basic scientific data on background radiation, exposure of the average citizen to medical x-rays, and the contribution to radiation exposure from fallout; and that general agreement exists on the influence of radiation exposure on genetic changes, life-span shortening, and the more specific hazards to health (with the exception of disagreement on the effects of extremely small doses on the incidence rates of lukemia and bone cancer). Pauling documents the hazards of atomic war, including the radiation effects associated with atomic bombing, and it is unlikely that anyone will disagree with him that these hazards far outweigh all other dangers ever faced by man; his conclusion, as expressed in the title of the book, is that war is no longer a "morally defensible" means of settling the differences among men and governments.

Dangers of testing

I will now comment on Pauling's discussion of the danger of atomic testing. In his exposition on the exposure of the population to nuclear radiation, he documents the commonly accepted rates: the average American receives in his life span about equal dosages from natural sources and medical diagnostic x-rays, and well under a tenth of either of these amounts from fallout if testing continues. Nevertheless, he singles out the fallout problem as dominant by discussing the additional rather than the relative health damage that could be caused. In so doing, he computes numbers of potentially damaged people which, although they appear large, are extremely difficult to document in a statistically meaningful way.

From the discussion of the fallout problem caused by atomic weapons testing as a health problem—which in my opinion is not a dominant danger *per se* of these times—Pauling develops his appeal for the stopping of testing as being synonymous with an

continued on page 13



Westinghouse is the best place for talented engineers

Howard Zollinger joined Westinghouse in 1951— has since earned MSEE and two U. S. patents

At 28, Howard A. Zollinger, a 1951 BSEE graduate of Michigan College of Mining and Technology is doing " . . . exactly what I always wanted to do." Now a systems design engineer, he specializes in the development of modern materials handling systems to support increasingly automated production techniques. Since completion of the Westinghouse Student Training Course in 1952, he has earned an enviable reputation as an expert in drive systems; and he has submitted fifteen patent disclosures, two of which are about to result in patents in his name.

Most important, *Howard Zollinger is doing exactly what he wants to be doing.* At the completion of his training course, he specifically asked that he be assigned to his present department. And, when he decided that additional graduate study would be helpful, the Westinghouse Graduate Study Program enabled him to combine this study with his regular job. After completing all required course work and his thesis last December, he was awarded his MSEE by the University of Pittsburgh in June.

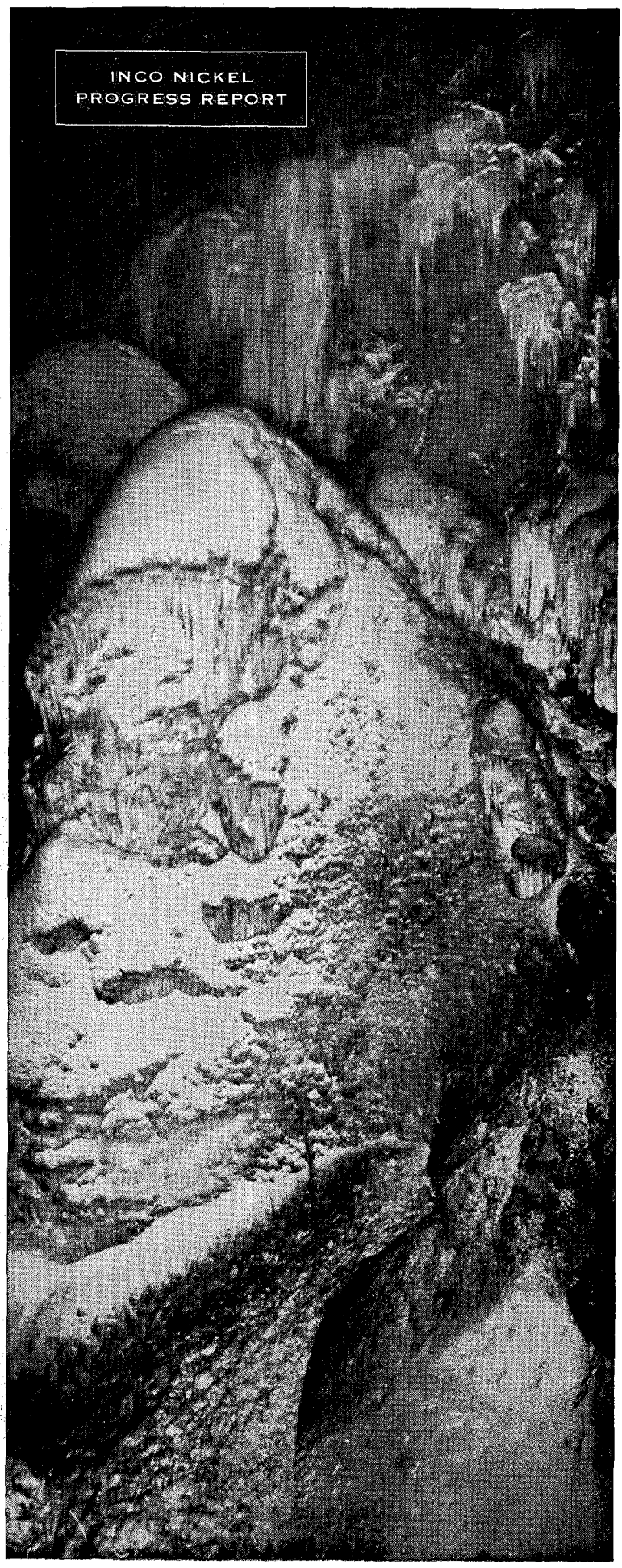
Howard Zollinger is one of many talented young engineers who are finding rewarding careers with Westinghouse. You can, too, if you've got ambition and you're a man of exceptional ability. Our broad product line and decentralized operations provide a diversity of challenging opportunities for talented engineers. Guided missile controls, atomic power, automation, radar, semiconductors, and large power equipment are only a few of the fascinating career fields to be found at Westinghouse.

Why not find out now about the opportunities for *you* at Westinghouse? Write to Mr. L. H. Noggle, Westinghouse Educational Center, Ardmore & Brinton Roads, Pittsburgh 21, Pa.

YOU CAN BE SURE...IF IT'S

Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

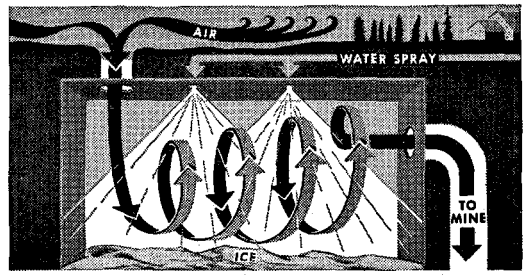


Freezing water to warm a mine

Inco shows a king-size operation that helps mine more Nickel

The bigger the mine, the more men at work, the more *air* they need. Gales of air. Warmed in winter. Cooled in summer. That's the reason for this mammoth "air conditioner" in an Inco-Canada mine.

In winter it raises the temperature of cold air from outside *by making ice.* In summer it uses the ice to cool air that's too hot! (See diagram below)



In winter, cold air is blown through sprays of warmer water. The water loses its heat, freezes into mountains of solid ice. In the process, the latent heat of freezing is transferred to the air, warms it up for use inside the mine.

At full capacity in a winter season, this system alone can generate as much heat as 350,000 gallons of fuel oil. During this period, 150,000 tons of ice may form. (See photo at left)

Installations like this are expensive in time and money. Such outlays are typical of many made by Inco-Canada. Their cost adds up to millions. Results are—to continue the increased production of Nickel.

Mining for Nickel is a 45-minute color film loaned to high school science groups, college engineering classes and technical societies. Write to Educational Service, Development and Research Division,

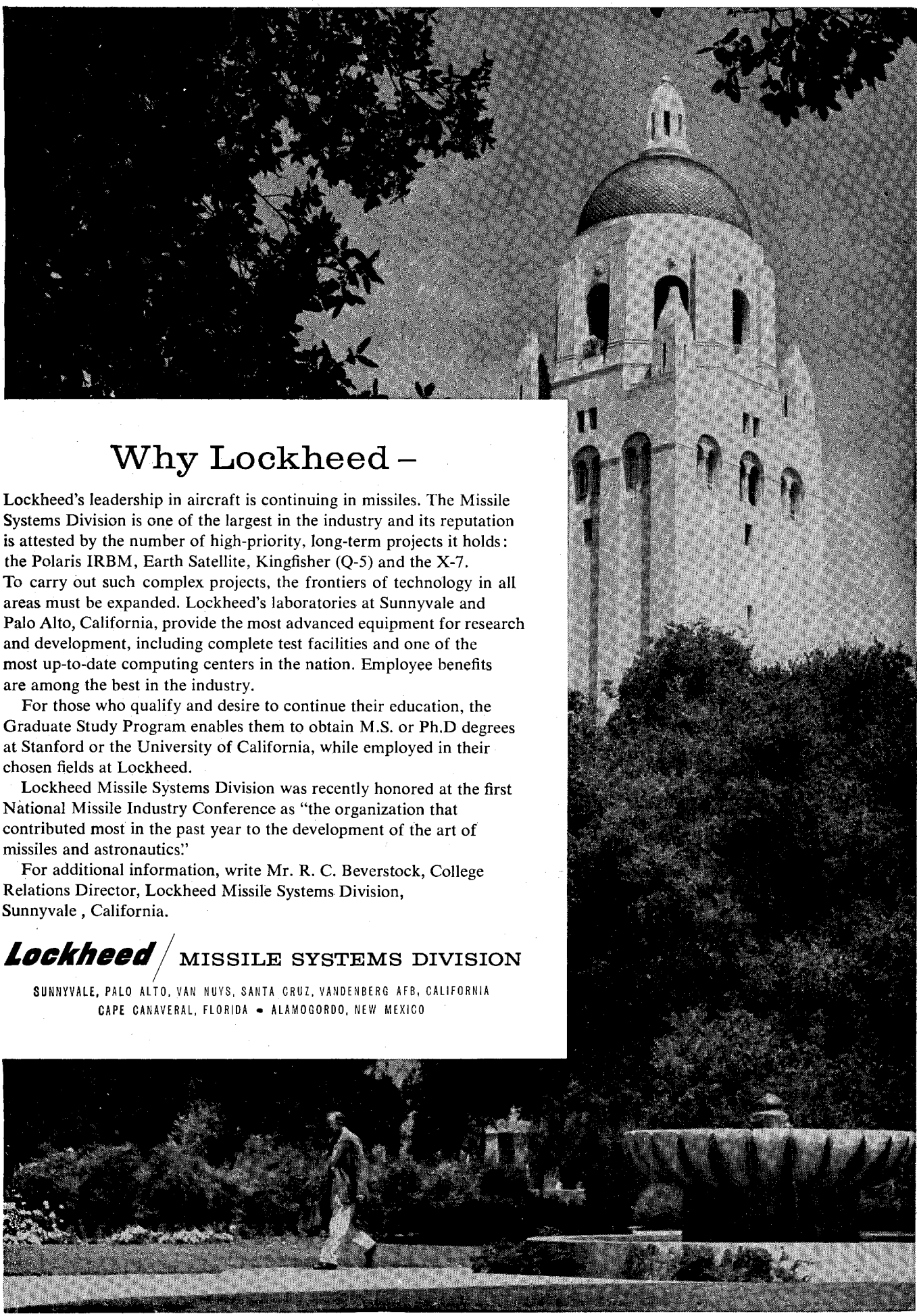
The International Nickel Company, Inc.
New York 5, N. Y.

INCO
TRADE MARK

International Nickel

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) — producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals.

A mountain of ice, built up in this inside-a-mine "air conditioner." The rock chambers, or "stopes," where the ice forms, are high as a 23-story apartment, big enough to house 300 families. Things have to be done in a big way to get Nickel in the tremendous amounts used by industry to make metals that perform better, longer.



Why Lockheed –

Lockheed's leadership in aircraft is continuing in missiles. The Missile Systems Division is one of the largest in the industry and its reputation is attested by the number of high-priority, long-term projects it holds: the Polaris IRBM, Earth Satellite, Kingfisher (Q-5) and the X-7. To carry out such complex projects, the frontiers of technology in all areas must be expanded. Lockheed's laboratories at Sunnyvale and Palo Alto, California, provide the most advanced equipment for research and development, including complete test facilities and one of the most up-to-date computing centers in the nation. Employee benefits are among the best in the industry.

For those who qualify and desire to continue their education, the Graduate Study Program enables them to obtain M.S. or Ph.D degrees at Stanford or the University of California, while employed in their chosen fields at Lockheed.

Lockheed Missile Systems Division was recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics."

For additional information, write Mr. R. C. Beverstock, College Relations Director, Lockheed Missile Systems Division, Sunnyvale , California.

Lockheed / MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, VANDENBERG AFB, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

appeal for abolition of nuclear war. It is this identification which involves questions of the political effect of stopping these tests; arguments concerning these questions are given in the book to only a very minor extent. One of the arguments given—that a test ban would make it less likely for powers other than the United States, the U.S.S.R. and Great Britain to acquire bombs – is clearly fallacious; atomic weapons of not too radical design could be developed by other nations without the need for tests; it should be recalled that the number of weapons which failed to function in the tests has been exceedingly small.

My comments on Pauling's position on continued testing should not be taken to imply that I believe that the opposite arguments—that testing must be continued under any circumstances —are compelling. Rather, I conclude that neither the medical nor the political arguments concerning nuclear weapons testing are sufficiently compelling to allow consideration of this problem apart from the generally pressing need for a halt in the weapons race. Pauling's conclusion that the present superweapons should preclude another world war will be disputed by few; his views in singling out nuclear tests as a logical first step to peace are much less convincing.

Wolfgang K. H. Panofsky is the director of the High Energy Physics Laboratory at Stanford University. He received his PhD at Caltech in 1942.

Guide to Technical Reports

by Henry Dan Piper & Frank E. Davie
Rinehart & Company, Inc., N.Y. $1.00

Reviewed by George R. MacMinn

This exceptionally well-printed, attractive pamphlet of 83 pages says everything essential about its subject with a clearness, conciseness, and readableness for which any writer of technical reports should be grateful. The guide is intended not only for students but also for professional engineers and scientists, and for industrial personnel in any category that may be concerned with technical writing.

Direct, practical value is assured by the collaborative authorship of the pamphlet. Henry Dan Piper, associate professor of English at the Institute, has been conducting the course in technical writing here for several years with notable success; in addition he enjoys the advantage of having formerly been employed in the laboratories of E. I. du Pont de Nemours & Co., Inc. Frank E. Davie is a mechanical engineer of many years' experience with the Shell Oil Company. Besides, these authors have had the benefit of suggestions from Dr. Peter Kyropoulos, now of the General Motors Styling Center, Detroit, and from the engineering staff of Technical Communications, Inc., Los Angeles. An earlier version of the guide was thoroughly tested in a division of the Shell Oil Company, and the present text is based on a study of current practices in "well-known and diversified industrial and governmental laboratories and engineering organizations."

One particularly interesting and effective feature of the guide is the presentation of the section on procedure for the formal report in the form of such a report, thus immediately illustrating the principles described.

More than half the space of the pamphlet is given to an appendix of five examples, the first a formal report submitted by a student at Caltech, the four others informal reports of various kinds. "Exhibits" D and E are made especially useful by being presented, each of them, in three parts: (1) the original report; (2) a recommended revision of this first form; (3) a critical analysis of the two forms.

It is gratifying to find that the authors emphasize the importance of the report-writer's studiously projecting himself into the point of view of the intended or expected reader, with as much knowledge, imagination, and psychological acumen as such a not only preliminary but also continuous part of the process may require. Very commendable is the counsel, too, regarding tact, courtesy, and discretion. The student or, indeed, the occupant of high office, may be learning his most valuable lesson when he understands that he is, first and last, a man writing for the benefit of other men as well as serving his own interests.

George MacMinn, professor of English, emeritus, taught the course in technical writing at Caltech for 12 years.

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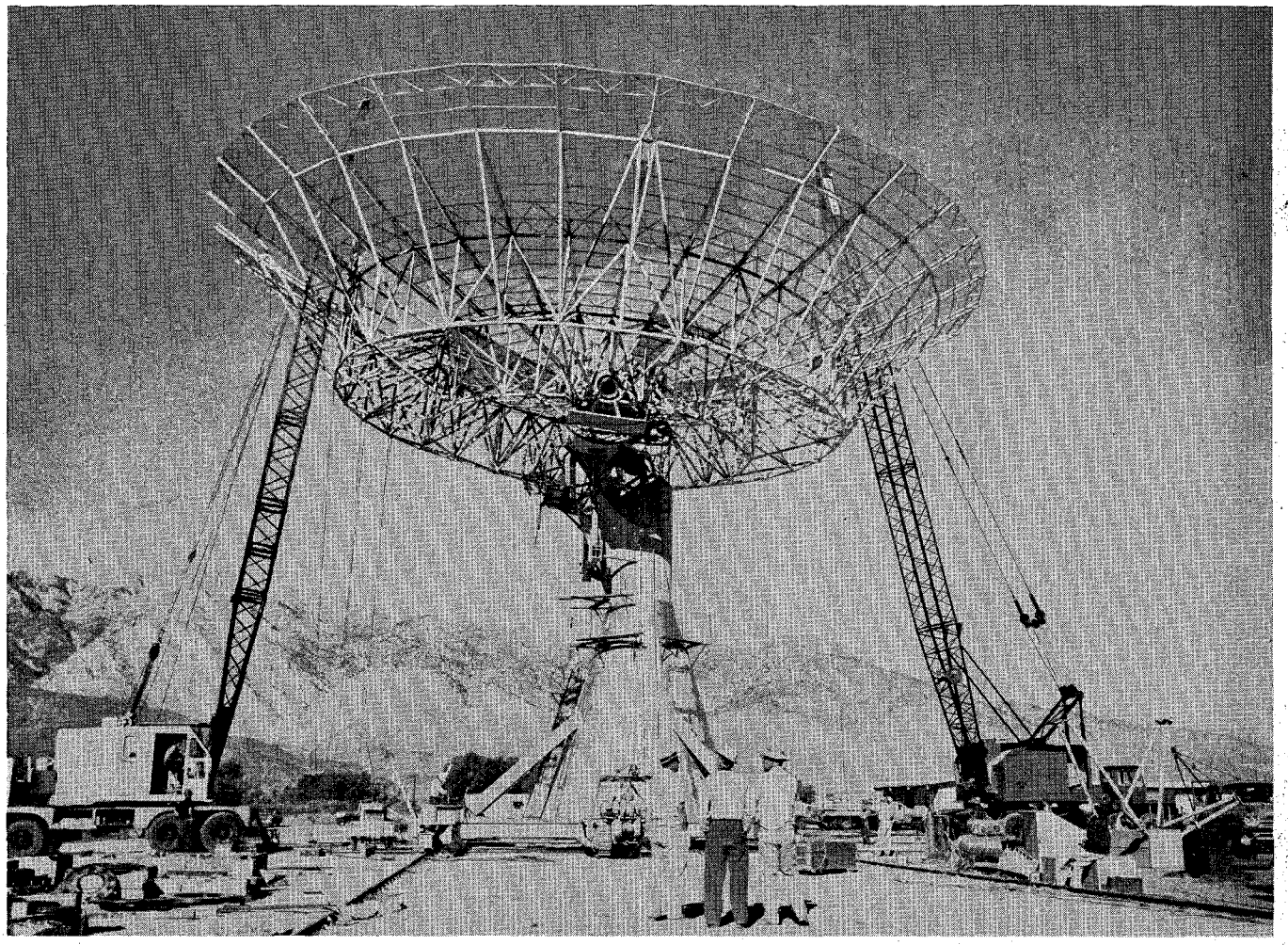
Benjamin Franklin...on science and humanity

"The rapid progress *true* science now makes, occasions my regretting sometimes that I was born so soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter. We may perhaps learn to deprive large masses of their gravity, and give them absolute levity, for the sake of easy transport. Agriculture may diminish its labor and double its produce; all diseases may by sure means be prevented or cured, not excepting even that of old age, and our lives lengthened at pleasure even beyond the antediluvian standard. O that moral science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity!"

—Letter to Joseph Priestley, February 8, 1780



The first of two 90-foot reflector antennas is lifted into place at Caltech's new radio observatory.

Listening to the Stars

A progress report on Caltech's radio astronomy research project

The world's most versatile radio telescope starts operation this month at Caltech's new $1,500,000 radio observatory near Big Pine, California.

The first of two 90-foot reflectors has been hoisted onto its 45-foot pedestal at the observatory and is now ready to start receiving radio signals from space. A twin of this big 150-ton metal dish will be ready for listening in December, and by next spring the two reflectors will be hooked up for use together and the radio observatory will be in full operation.

Operated by Caltech and financed by the Office of Naval Research, the observatory is 250 miles north of the campus, in the Owens Valley desert, shielded from man-made radio and television interference by the high Sierra Nevada and the White Mountain ranges.

The science of radio astronomy is only about 10 years old. Actually, it represents an extension of optical astronomy to a range of wavelengths longer than the eye can see. Optical telescopes are sensitive to radiations from stars and other objects which are in the visible or near-visible range—that is, to light whose wavelength is anywhere from about one to- four-100 thousandths of an inch.

With the advent of radar during the second world war, new short-wave radio receivers were developed, which are sensitive to electromagnetic radiations in

the microwave or very high frequency ranges—from a few twenty-fifths of an inch to a few yards in wavelength.

When the new ultrasensitive short-wave receivers were directed to the sky it was found that radio waves were reaching the earth from the sun and from out in space in all directions. This opened a whole new field of astronomy—the systematic investigation of radiations in the radio range coming from a large number of relatively small sources in the heavens. These sources were called "radio stars" for want of a better name.

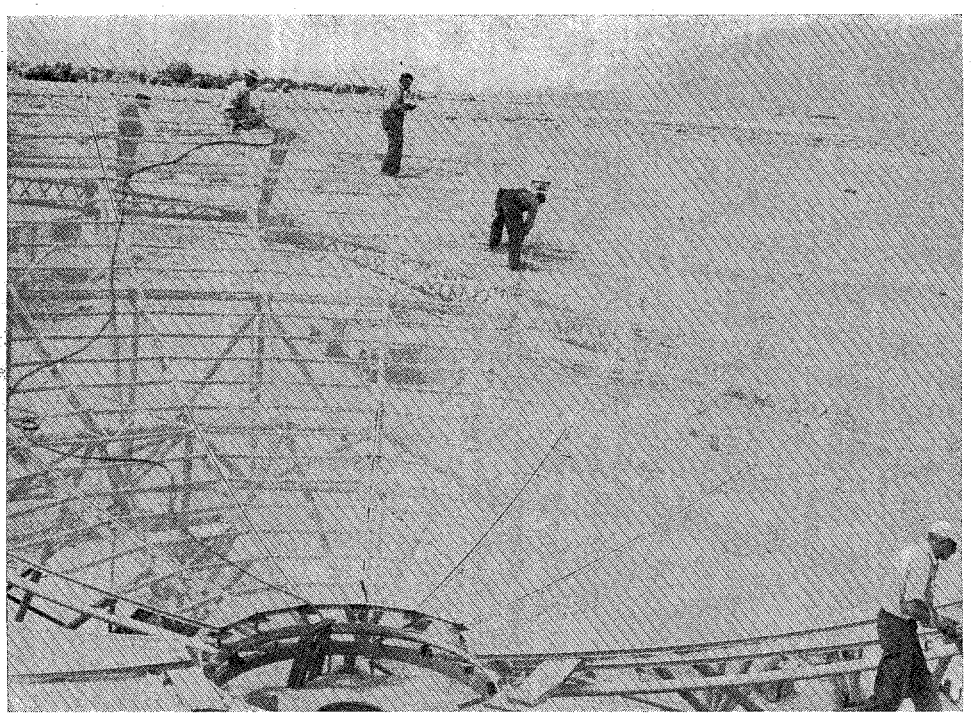
Caltech's research program in radio astronomy will include attempts to identify several hundred radio stars with visible objects and to study the mechanism responsible for generating the signals. So far, only about 50 of some 2,000 known radio stars have been identified.

Some of the radio stars are associated with grand catastrophes in nature—such as the remnants of an exploded star, or the collision of two galaxies near the limit of the visible universe. In fact, some of the objects detected by the Owens Valley telescopes may be beyond the range of the largest optical instruments.

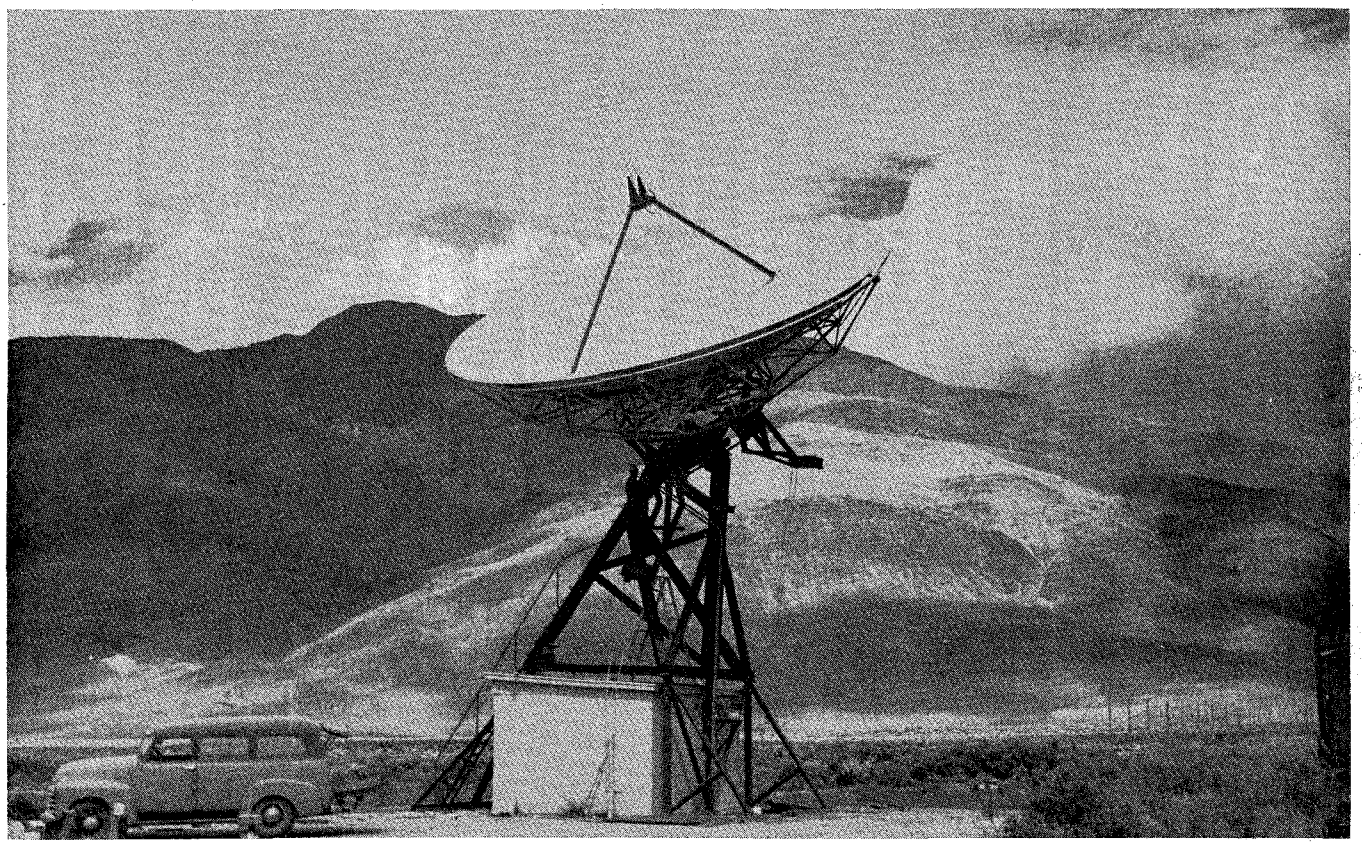
The research program will also include studying solar outbursts which are believed to be due to streams of ionized matter, or pieces of atoms, blasted into space from the sun, and responsible for the aurora borealis.

Though there are a number of other large radio telescopes in use throughout the world (including England's 250-foot dish—the largest of all), the Caltech instrument will be the most versatile because of its twin antennas. Stellar signal sources can be more accurately pinpointed by a team of two dishes operating as an interferometer. In order to detect very weak signals, the two antennas can be steered to follow a star. To measure the angular diameter of the faintest objects, each antenna is set on a wheeled mounting, riding on railroad tracks 1,600 feet long. The telescopes (each dish carries more than 6,000 square feet of steel as its reflector) are built to take winds of 80

John Bolton, professor of radio astronomy, is scientific director of the new Caltech radio observatory.



Workers adjust the expanded aluminum mesh which covers the 90-foot telescope. When accurately adjusted (at 324 different points) the mesh forms a reflecting surface that accurately focuses all rays coming in from space.



Auxiliary 32-foot telescope, with its highly accurate solid surface, is used mainly for experimental purposes.

mph, and Bruce Rule, Caltech's chief engineer, who designed them, admits that the structural problems were more severe than for Caltech's 200-inch optical telescope at Palomar.

In Caltech's twin telescope, radio signals are caught in the dish-shaped reflector antennas, which focus the radio waves to a point, just as telescope mirrors focus light. The incoming signals are funneled into a radio receiver that amplifies them. Then the signals are presented on pen recorders, oscilloscopes or magnetic tapes.

The 90-foot antennas will be used to study signal wavelengths ranging from about two inches to nearly forty inches long. A 32-foot dish for picking up short radio waves is already in operation at the observatory, as are two networks of wire antennas (called "arrays") for collecting the long ones. The 32-foot reflector, which used to operate at the Palomar Observatory, is used for waves two-fifths of an inch to two inches long. It will also be used to develop and test instruments. The arrays (one of which covers 2 acres, the other, 10) are used to investigate the earth's upper atmosphere. They have been studying broadcasts on wavelengths ranging up to 40 feet for about a year.

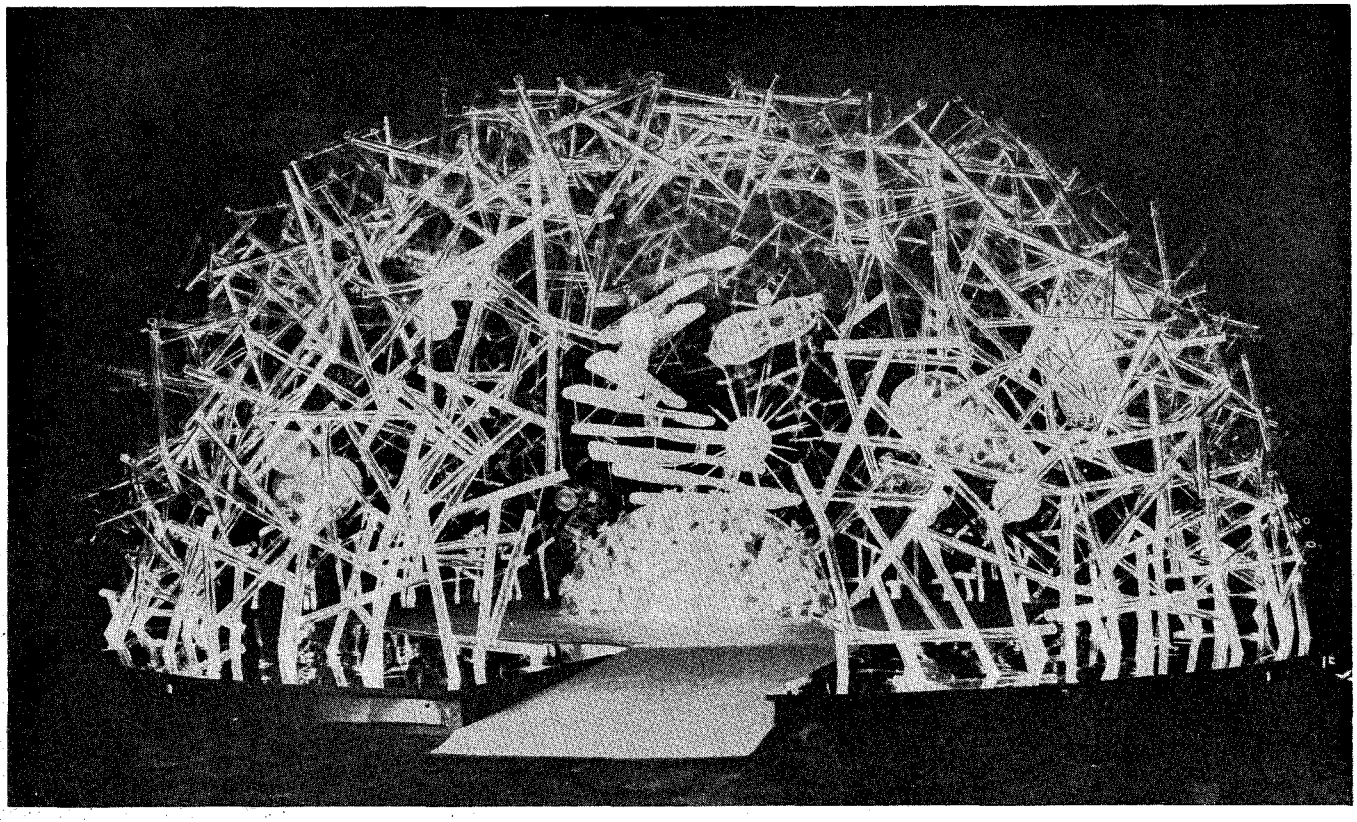
John G. Bolton, professor of radio astronomy, is scientific director of Caltech's radio observatory. Though he is only 36, Bolton was one of the pioneers in the field of radio astronomy. With Gordon J. Stanley, who is now also at Caltech, he discovered the first radio stars in 1947. Formerly principal research officer of Australia's Commonwealth Scientific and Industrial Organization, he came to Caltech in 1955 to help design the radio observatory and supervise its construction.

Gordon Stanley, senior research fellow, has been responsible for the design and construction of the sensitive receiving equipment to go with the big dishes at the observatory.

The research staff also includes Dr. J. A. Roberts, senior research fellow; Dr. T. A. Matthews, research fellow; and Dr. K. C. Westfold, visiting associate professor of astronomy.

The observatory includes a one-story concrete block building containing electronic receiving equipment, living quarters for four people, two offices and a workshop.

The Caltech observatory is one of several radio astronomy research projects being supported by the Navy. Aside from basic research, the Navy can expect some very practical applications to result from these studies. Research in this field will require advances in electronic techniques such as low-noise receivers and antennas, which may find future application in military equipment. The research will contribute to our knowledge of the propagation of radio waves through the ionosphere and the troposphere and so may be of value in achieving improved radio communication. And, in time, radio stars may be used for navigation of aircraft and ships, and for the tracking and guidance of missiles and space vehicles.



Upjohn Company's model of a human cell, 24 feet wide and 1,000,000,000 times larger than an actual cell.

The Biology of Microsomes

by James Bonner

These are stirring times in the world of biology. We are beginning to find out a little bit about how proteins are synthesized by living creatures.

In recent years we have come to know a great deal about the structure of proteins—as, for example, that proteins consist of amino acids linked into long peptide chains, and that these chains are wound in helical form.

Now we are beginning to understand why individual proteins are different from one another, and why they have different enzymatic activities—even though they are all composed of the same 20 amino acid building blocks. We know that the individuality of a protein resides in part in the sequence in which its amino acid units are put together to form the protein peptide chain. But until recently the mechanisms by which the cell makes its many different enzymatic proteins was totally obscure.

It appears today that proteins are synthesized upon the surfaces of a particular kind of subcellular entity —the microsome. The microsome, in turn appears to be made in the nucleus. The microsome is not only the engine of protein synthesis but also the device whereby the coded information of the chromosome is carried to and utilized by the protoplasm of the growing cell in the synthesis of its individual enzymes.

Our new knowledge of protein synthesis has been made possible by the development during the past 10 years of methods for separating the cell into its component parts. These methods have, in part, been devised at Caltech by Samuel G. Wildman (now professor of botany at UCLA); George Laties, senior research fellow at Caltech; and others.

The individual cellular components, whose structure and nature we know in some detail through electron microscopy, are in general separated from one

Our modest understanding of microsome biology is leading us to an understanding of the problems which lie at the very base of biology

another quantitatively by differential centrifugation. Thus, a plant tissue is first ground at low temperature to rupture the cellulosic material of the cell wall and release the protoplasm. The broken cell walls and other cellular debris are then removed by centrifugation at a few hundred times gravity for a few minutes. The supernatant for this centrifugation may now be spun briefly at higher speeds—perhaps 1,000 to 2,000 times gravity—in order to sediment the relatively large and heavy nuclei. Centrifugation of the supernatant at still higher forces—about 12,000 x g—for a few minutes, results in quantitative sedimentation of the mitochondria, which are rod-shaped particles about 1 micron long, and hence visible in the light microscope.

The supernatant, after removal of the mitochondria, contains still further particulate matter. It may contain lipoprotein membranes—the so-called endoplasmic reticulum—although this is absent in some tissues. It also contains small spherical particles, the microsomes, which are attached to the membranes of the reticulum if this is present. Centrifugation of the mitochondria-free supernatant at forces of 100,000 x g for 30 to 60 minutes results in sedimentation of membrane and microsomal particles together.

In the case of the pea stem (worked on at Caltech by Paul Ts'o, research fellow in biology; Jerome Vinograd, research associate in chemistry; and myself) membranes are absent, and it is possible to obtain the microsomal particles in relatively homogeneous condition. The supernatant which remains after removal of the microsomes contains still further material. It is in this residue that the individual soluble enzymes of the cell—the common everyday garden varieties of enzymes—are to be found.

The microsomal particles prepared by centrifugation are homogeneous in the ultracentrifuge. They appear in the electron microscope as oblate spheroids with a major diameter of 280 angstroms and a molecular weight of about 4 million. They are composed of 40 percent ribonucleic acid (RNA) and the balance of their mass is entirely protein.

Interestingly enough, microsomal particles appear to be much the same in size, shape and chemical composition throughout a wide spectrum of living creatures. For instance, the microsomes of the pea plant, which we have studied, are very similar to those of yeast, which have been studied at the University of California at Berkeley by Fu Chuan Chao, graduate student, and Howard Shachman, professor of biochemistry. They are also very similar to the microsomes of immature red blood cells (reticulocytes) studied at Caltech by Jerome Vinograd and Howard Dintzis, assistant professor of chemistry.

Even the amino acid compositions of the microsomes of these different forms are closely similar. All are characterized by high contents of the basic amino acids lysine and arginine, and by high contents of the acidic amino acids glutamate and aspartate.

Research at Caltech by Paul Ts'o and his collaborators has revealed that the microsomal particle is composed of subunits: The microsome contains magnesium ions, and these magnesium ions bind the subunits together to form the intact microsomal particle. If about half of the magnesium is removed by suitable means, the microsome reversibly comes to pieces to form two new particles of masses two-thirds and one-third of the original, respectively (shown on p. 22).

Further removal of magnesium results in further disaggregation of the microsome, each original particle yielding two subparticles with a mass one-third of the original and two subparticles with a mass one-sixth of the original. Each of these microsomal subunits contain ribonucleic acid and protein in the same proportion as the original microsome—that is, they are ribonucleoprotein subunits. Binding of RNA to protein does not concern magnesium but is apparently due to hydrogen bonds.

The microsome is then made up of ribonucleoprotein units, the smallest of which is one-sixth of the

James Bonner, professor of biology and acting chairman of the Division of Biology.

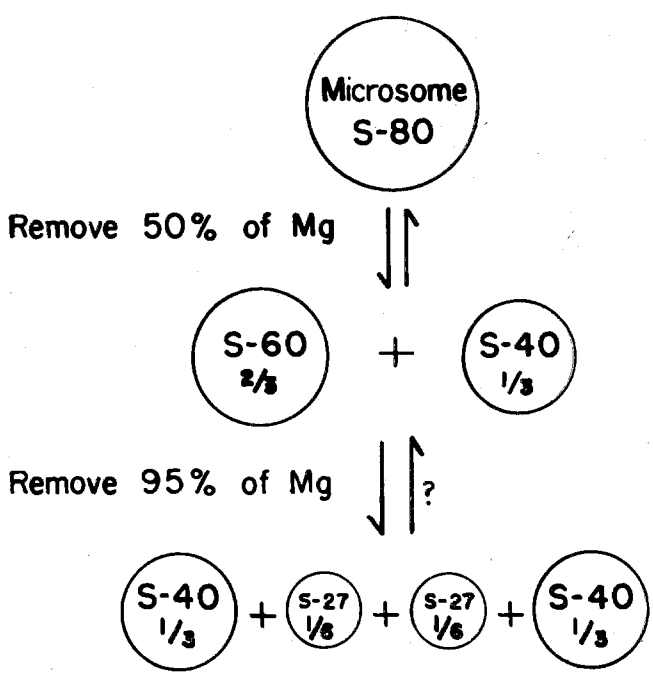
original microsomal particle. The molecular weight of the microsomal RNA appears to be close to that expected on the basis that the one-sixth particle contains but a single giant RNA molecule.

The molecular weight of this giant RNA molecule, approximately 280,000, may well place an upper limit on the amount of information which can be contained within the microsome. Thus, the elementary RNA chain of the microsome is about 900 nucleotide units in length. Current coding theories suggest that a sequence of at least 3 nucleotide residues are required to determine the position of each amino acid in a peptide chain—supposing, of course, that RNA does somehow determine amino acid sequence. Accordingly, an RNA chain 900 nucleotides in length could code in sequence no more than 300 or so amino acids. A protein 300 amino acids in length would have a molecular weight of about 30,000. This is indeed the average molecular weight of the mixture of cellular proteins. It is apparent then that each microsome contains information sufficient to make only one or, at most, a small number of kinds of proteins.

It was first suspected that the microsome has a role in protein synthesis because of the fact that when C^{14}-labeled radioactive amino acid is supplied to living tissues it appears most rapidly in the microsomal fraction—a fact first noted at Caltech by Henry Borsook, professor of biochemistry, and his group in 1950. Although the microsomes of living tissue become labeled very rapidly in the presence of labeled amino acid, they do not become highly labeled and they reach a plateau within a short period of time. At this plateau, or steady-state level of labeling, about one-tenth to one-half percent of the amino acid of the microsome has become labeled. This suggests immediately that some small portion of the total microsomal protein is capable of rapidly incorporating amino acid, the remainder of the microsomal structure being relatively inert.

In addition, the labeling of microsomes in the steady state is transitory. Labeled amino acid, once incorporated into the microsome, may be washed out again if the labeled amino acid is replaced by unlabeled. This is not true of the incorporation of labeled amino acid into the proteins of the soluble cytoplasm, for example. The kinetic evidence available is in agreement, then, with the hypothesis that microsomes somehow assemble amino acids into growing peptide chains and finally into protein molecules, which are then shed from the microsome to appear as soluble protein.

Where do little microsomes come from? Cellular particles such as nuclei, chloroplasts and mitochondria multiply by division but this does not appear to be



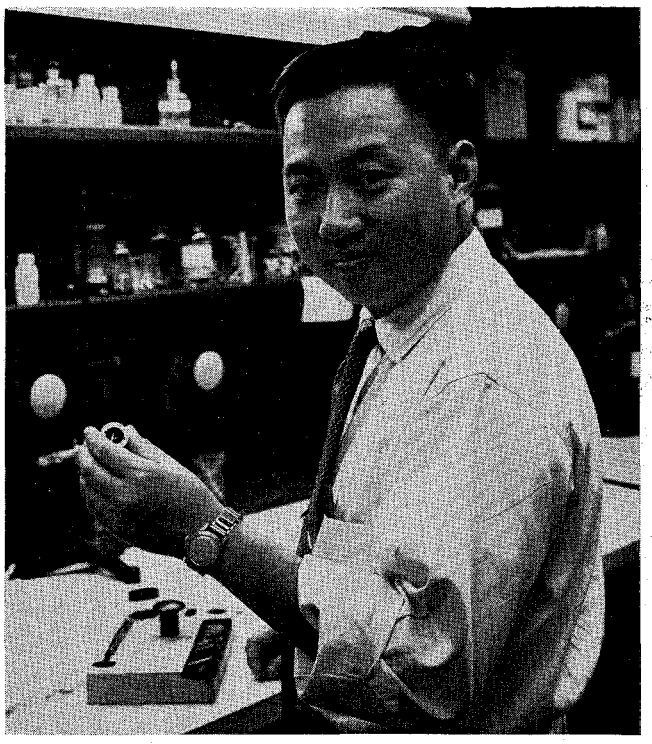
When microsomes are robbed of their magnesium they come apart into fragments. S is the unit for measuring the rate of sedimentation in the ultracentrifuge.

the case for microsomes. On the contrary, microsomes appear to be synthesized within the nucleus. Thus, with the electron microscope, objects resembling microsomes can be seen within the nucleus. In addition, it has been possible to isolate particles physically and chemically identical with microsomes directly from preparations of purified nuclei.

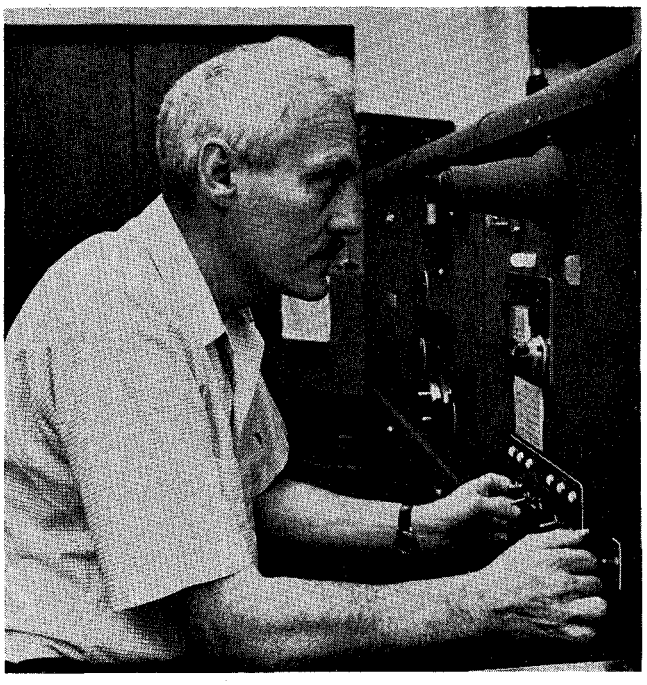
This has been done by Paul Ts'o and Clifford Sato at Caltech and also by Soyozo Osawa and his group at Nagoya University. Particles identical with the cytoplasmic microsomes in molecular weight, RNA content and other characteristics have been prepared from such isolated nuclei.

Microsomes are then contained in the nucleus. Are they in fact synthesized within the nucleus? It has been known for some years that the nucleus is the seat of active RNA synthesis and that much of the RNA of the cell is formed there. Cells which do not contain nuclei do not possess the ability to form RNA, or at least they form RNA sluggishly. Cells which contain nuclei possess the ability to form RNA abundantly. If tissues containing nuclei are supplied with labeled precursors of either RNA or protein, the label is recovered in the nuclear microsomes at relatively high levels of activity, as would be expected if microsomes are synthesized within the nucleus.

And, finally, the matter has been approached directly in the laboratory of Alfred E. Mirsky, a former Caltech research fellow who is now a member of the Rockefeller Institute. In the experiments of Mirsky, V. G. Allfrey and Syozo Osawa, the synthesis of RNA and of protein was studied in isolated nuclei from the thymus gland. In these experiments, it has been shown that ribonucleoprotein (material which we now believe to be in part nuclear microsomes) is formed in the nucleus, and that the formation of such material takes place only in nuclei containing intact DNA (deoxyribonucleic acid), intact chromosomal material. Treatment of the isolated nucleus with the enzyme DNAase, which destroys DNA, abolishes the ability of the nucleus to synthesize ribonucleoprotein.



Paul Ts'o, research fellow in biology and leader of the Caltech group studying microsome biology.



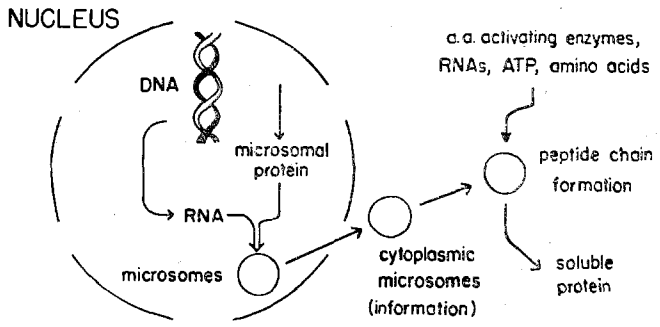
Jerome Vinograd, research associate in chemistry, at the analytical centrifuge.

How do the microsomal particles, once made in the nucleus, escape into the cytoplasm? Experiments with amoebae by L. Goldstein and Walter Plaut, research fellows at the University of California in Berkeley, have shown that such escape does take place.

In these experiments, nuclei containing labeled RNA were transplanted to unlabeled cytoplasm of a second amoeba. The RNA from the labeled nucleus escaped to and filled the cytoplasm of its host. No experiment has as yet been done, however, which directly shows the movement of microsomal particles from nucleus to cytoplasm. Such an experiment, difficult as it would be, is a logically essential one.

When tissues which are actively synthesizing RNA are supplied with labeled amino acid the microsomes may attain very high levels of labeling. In such microsomes, the structural protein of the particle itself becomes labeled.

We must distinguish therefore between two kinds of protein synthesis. We have, on the one hand, synthesis of the structural protein of the microsome. This apparently takes place within the nucleus and leads to high levels of microsomal labeling. Synthesis of protein by microsomes, on the other hand, occurs outside of the nucleus. This is a process in which microsomes



Microsomes are synthesized within the nucleus. They escape to cytoplasm. There they participate in protein formation.

become labeled rapidly, to be sure, but in which only a small proportion of the microsomal protein is labeled in the steady state.

The microsome then is a component of the protein synthesis mechanisms. But it is only one link in the chain. We now know that protein synthesis consists of a series of events. The nature of these events has been elucidated by work on animal tissues done by former Caltech research fellows Richard Schweet (now at the City of Hope), and Paul Zamecnik (now at the Massachusetts General Hospital) and his group —including Mahlon Hoagland, Elizabeth Keller and others; and by work on plant systems at Caltech done by George Webster (now associate professor of biochemistry at Ohio State University), John Clark, Jr. (now instructor of biochemistry at the University of Illinois), Paul Ts'o, and others.

In this sequence of events, amino acids are first converted into activated forms which we call AMP-acyl-amino acid complexes. This is the step of amino acid activation. It appears that both plant and animal tissues contain separate amino acid-activating enzymes for each of the 20 individual amino acids which compose proteins.

Amino acid, once activated, is next transferred to an acceptor which is soluble cytoplasmic RNA. This was first discovered at Caltech by Robert Holley (now of the Agricultural Research Service at Cornell University), and was studied in detail by Mahlon Hoagland, and by Richard Schweet and his group.

Richard Schweet's research also indicates that there are individual soluble acceptor ribonucleic acids, one for each of the individual activated amino acids. Transfer of RNA-acyl-amino acid complex to the microsomal surface appears to be the next event in this catenary sequence. Amino acid is somehow transferred to the microsomal surface, there to be incorporated into peptide bond linkage with other similarly activated and transferred amino acids.

It appears probable that the microsome contributes to this process by acting as the long-postulated template, and by ordering in proper sequence the amino acids which are being assembled in the growing peptide chain.

This is suggested by the experiments of Howard Dintzis, which show that microsomes of red blood cells, which manufacture hemoglobin, receive activated amino acids and assemble them in the relative abundances characteristic of hemoglobin. Then, too, the work of Richard Schweet, Hildegarde Lamfrom, and Esther Allen shows that immature red cell microsomes make hemoglobin even if wedded to activating enzymes and soluble RNA of liver. Clearly, it is the microsome which contributes information to the process of amino acid assembly into protein.

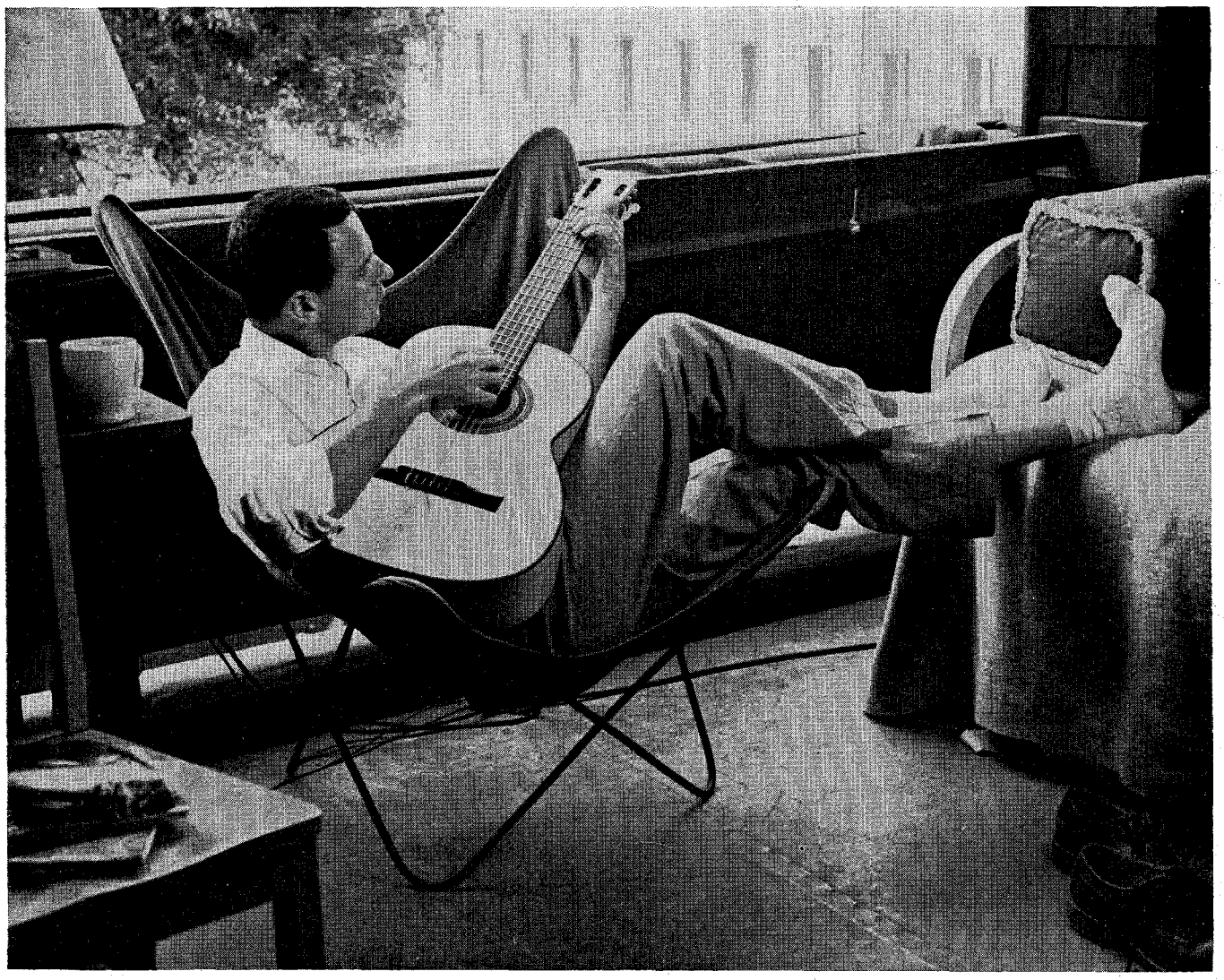
It has already been noted that the store of information as to the appropriate sequence which can be contained within one microsome is finite and in fact small. While a single microsomal particle may contain the information necessary to assemble a few hundred amino acids in proper sequence, it can hardly be imagined to contain the information necessary to assemble more than this small number. It appears quite probable, therefore, that the individual microsome is concerned with the synthesis of one individual kind of protein. Although they appear similar in structure, the microsomes actually seem to be different from one another—each containing, in RNA code, information appropriate to the synthesis of a particular kind of protein.

Genetic information

Interestingly enough, the number of nucleotides in the elementary RNA chain of a single microsome corresponds approximately to the number of nucleotides estimated by geneticists to be contained in the DNA of a single gene. The attractive possibility presents itself that each individual gene sends out its information to the rest of the cell in the form of a single species of microsome—that each microsome contains in RNA language the message contained in DNA language in a single gene. Indeed, the working hypothesis and rallying cry of the microsome biologist today is "one gene, one microsome, one enzyme."

We know today, at least, that the problem of how proteins are synthesized is a problem which can be solved. The mechanism by which energy is made available for peptide bond formation is known. Microsomes appear to be the engines of protein synthesis. Microsomes appear also to be the agency by which the information contained in the DNA of the chromosomes is transmitted to, and utilized in, the synthesis of soluble cytoplasmic enzymes.

An understanding of the complex processes of differentiation itself may ultimately flow from our increasing knowledge of microsome biology. Differentiation may well consist merely in enrichment or impoverishment of the cell in particular kinds of microsomes at the expense of others. Our modest understanding of microsome biology is giving us understanding of problems which lie at the very basis of all biology.



The summer sort of dribbles to an end . . . it's a lonely time.

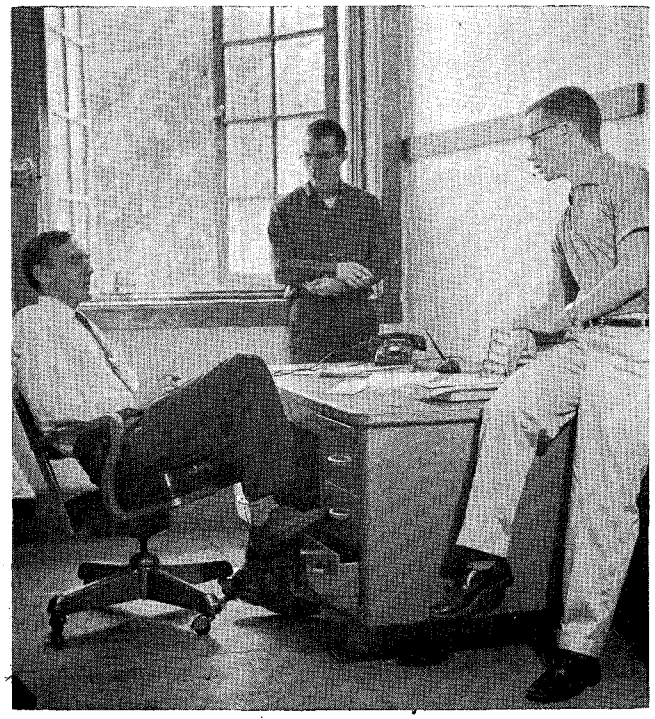
The Three-One Plan

Summer school — the easy way

This was my second summer spent at Caltech on the 3-1 plan—study three seasons and work one so you can come back for the next three. Since this was my *second* summer here, I was able to avoid many of the pitfalls and excesses of the first—thus opening up time for a whole new field of excesses.

With my family safely exiled in Minnesota, I was free to do as I pleased, with only my conscience and the law as a guide. Somehow, despite this freedom and the pent-up emotions of nine months' previous schooling, I managed to do surprisingly little. This is the usual way things go for me, though, so I'm practiced at salvaging pleasant overall memories from uneventful periods of my life.

One of the first pitfalls I avoided was the Old Dorm. Despite the best efforts of Mrs. Lyall and her



You get to meet the big and sometimes wonderful Caltech community.

crew, the Old Dorm remains slightly inferior to the dollar-a-day joints in East L.A. Four fellow undergrads and I moved into a nearby home rented from a vacationing faculty member. It was a large pleasant home, nice to live in after two years of dormitories. A private bedroom (which is not also a living room, study and bathroom) can seem quite a luxury.

Perhaps our little cooperative didn't keep the place too clean, but we didn't ruin it either, and we did have a lot of fun. The only real wear came during our parties, which were large and I fear sometimes boisterous. The best of these was our "Baby Party," so-called (quick explanation) because the accepted dress was baby-wear, and couples roamed the neighborhood drinking punch from baby bottles.

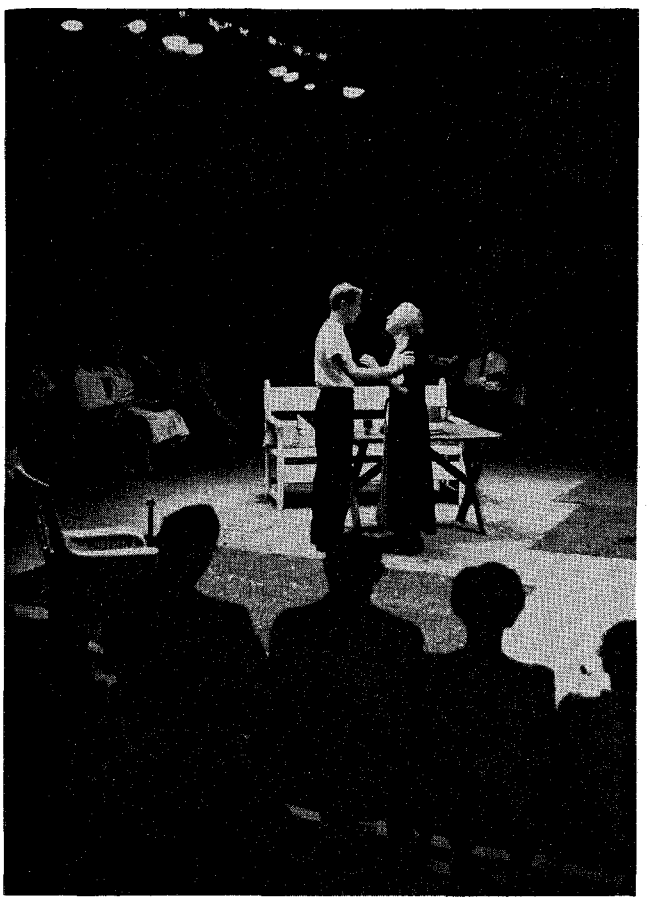
Tempting jobs

The house was only two blocks from school, very handy since three of us were working on campus. Campus jobs are one of the nicest things that happen to a Caltech undergrad, and though the pay's not sensational, it would take quite a bit more to tempt me away (nobody's doing any tempting, so I'm safe). I worked at the Synchrotron, which is just full of people worthy of spending half-hour coffee breaks with.

My group was involved in an important bit of basic research, as you could tell from our continual shouts of "More black tape!" I was assigned to build small devices for the big expensive device that was our project. Mostly I built coils of various sizes and designs. Sounds dull, but you can learn a lot between turns. Actually, the non-monetary values of a campus job are at least three-fold:

1. You get a lot of technical know-how. It doesn t do much good to learn Maxwell's equations if you don't know where the resistors are kept.
2. You learn what a scientist's life is really like. This can be discouraging for those raised on the notion of steely-eyed, white-smocked men running around yelling "Eureka!"
3. You get to meet the big and sometimes wonderful Caltech community of grad students, research fellows, senior research fellows, assistant professors, associate professors, full professors, secretaries, machinists, electricians, window-washers, and Ed Hutchings. Somehow, undergrads get left out of this convivial community during school—probably because of their own aloofness. They miss the fun of such community meetings as occurred at the performance of Kent Clark's musical comedy late in August. A good show in its own right, made more so because it was written by a neighbor.

I began this summer with a definite theme in mind —culture. No longer would I be the village slob, wallowing in rock 'n roll and the *Saturday Evening Post*. Instead, I would sample the intellectual nectar of the Greater Southern California area. Being a



Caltech's Arena Theatre—I came as a scoffer but left a humbler young man.

tourist at heart, I began my sampling at the Hollywood Bowl. Symphonies Under the Stars (and airplanes) proved to be somewhat of a disappointment. A Mack truck in low gear is pretty stiff competition even for Beethoven.

Much happier were my visits to the far-flung network of progressive jazz and Dixieland restaurants (bars). They're everywhere—Hollywood (Ben Pollack's, Jazz Cellar, Beverly Caverns); Hermosa Beach (Lighthouse); even Pasadena (Zucca's Cottage, The Track). I didn't become an expert on the music, but I did learn to tap my foot in accepted fashion.

All this, though, was just a prelude to my adventures with the little bohemian coffee shops that thrive in Hollywood. (Most famous: The Unicorn, which has the advantage of an avocado tree growing through the center of it.) Bad paintings, exotic coffees, and discussions of such things as Zen Buddhism and The Way of Yoga keep one on one's toes. For awhile I was on the verge of chucking my Caltech life entirely and joining an Ouspensky group. Then I found out that one of Ouspensky's chief tenets involves changing living quarters every two hours in order to avoid stagnation.

Despite my travels, the best thing I attended all summer was given in Culbertson Hall. Caltech's Arena Theatre's presentation of *All My Sons* by Arthur Miller was definitely a professional job. I came as a scoffer but I left a humbler and quieter young man.

There were three occurrences this summer that deserve special mention because of their heart-warming effect on loyal Caltechers. (Caltechites? Calticians? Caltacos? Let's have a contest to choose a better name.)

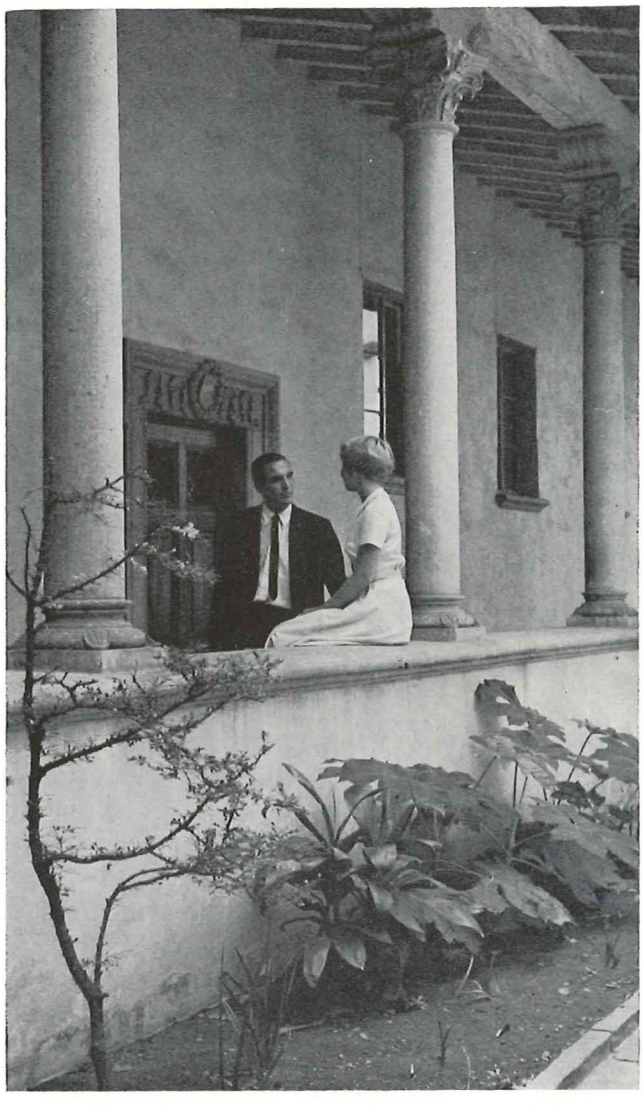
Dr. Beadle appeared suddenly on the cover of *Time*. It was a square-jawed, hard-eyed Dr. Beadle, who seemed a far cry from the pleasant gentleman who just laughed when he caught you taking a jar of fruit flies from Biology 1 lab. Still it was our Dr. Beadle and it was nice to write home that my biology teacher was on the cover of that week's *Time*.

Danger: empire builders

One day in late July, the homes on San Pasqual between Holliston and Chester suddenly sported "Danger, Keep Out" signs. Perhaps there was something sad about watching those homes be flattened out and hauled away in dump trucks, but they were going to make room for the new $16 million worth of Caltech. Just call us the empire builders.

A more humble event, but in my opinion even a happier one, took place just at the end of August. Some one in the administration, and my blessings on him, had wooden benches installed under the trees in front of Engineering. Tradition in the making as anyone could see.

I predict great things for those benches. At least five generations of secretaries and students will share



Goodbye Sue, Marylee, Lura, Nancy, Wendy, Karen, Joany, Binny.

lunches on them. Of course no freshmen will be allowed to sit there, with dire penalties for those who do. Perhaps a thousand girls will be kissed under the protection of those trees (not during the rainy season, though).

I stood around while the workmen installed one set of the benches, and, as soon as they were finished, sat down. Me and Edmund Hillary.

The summer sort of dribbles to an end, and all the girls you and your buddies have been taking out go away to school. Goodbye Sue, Marylee, Lura, Nancy, Wendy, Karen, Joany, Binny. Have fun at Berkeley, Vassar, Smith, Arizona, Colorado. See you next year if you don't get pinned to some jerk.

Tech starts later than most schools, so there's about two weeks of meditating time for the summer student, with few earthly distractions to disturb the mind. It's a lonely time, and you miss the exiled family more than usual. But soon school starts again, and the only thing you have time to miss is sleep.

—Brad Efron '60

L. A. DuBridge and Arnold O. Beckman at Caltech groundbreaking.

The Month at Caltech

Groundbreaking

Caltech entered the construction phase of its $16,100,000 Development Program on September 16. Ground was broken for the first of 15 new buildings when a signal from Explorer IV activated a power shovel. The ceremony took place at the corner of San Pasqual Street and Holliston Avenue, the site of a new $600,000 physical plant building.

Although the Development Program has been under way only a few months, a total of $5,800,000 has already been contributed. Six of the 15 buildings being planned are now assured by specific gifts. The most recent contribution was a gift of $850,000 for the construction of a 1200-seat auditorium on campus by Dr. and Mrs. Arnold O. Beckman. Dr. Beckman is president of Beckman Instruments, Inc., of Fullerton, California, and a member of the Caltech board of trustees. He received his PhD from Caltech in 1928 and is serving as chairman of the Institute's Development Program.

Faculty Changes

New members of the Institute's staff of instruction and research for 1958-59 include:

Charles E. Crede, associate professor of mechanical engineering, from Barry Controls, Inc., in Watertown, Mass., where he was vice president of the engineering company. He is also a national vice president of the American Society of Mechanical Engineers.

Gordon K. Douglass, instructor in economics, from the Sylvania Electric Corporation in New York where he has been an economist for the past five years. Mr. Douglass received his BA from Pomona in 1950.

Daniel G. Dow, assistant professor of electrical engineering, from Stanford where he received his PhD in June.

Donald F. DuBois, instructor in mathematics, who will receive his PhD at Caltech in June, 1959.

I. S. Edelman, MD, senior research fellow in chemistry, from the University of California Medical Center in San Francisco, where he is chief of Medical Service. A graduate in medicine from Indiana State University in 1944, Dr. Edelman is on a leave of absence for one year to conduct research on proteins and nucleoproteins.

George S. Hammond, professor of organic chemistry, from Iowa State College where he has been professor of chemistry since 1955. Dr. Hammond, who received his PhD from Harvard in 1947, was a research associate in chemistry at Caltech in 1956.

Robert L. Harder, instructor of electrical engineering, is working for his PhD at Caltech. He received his BS and MS degrees from the Carnegie Institute of Technology.

Thomas E. Hull, visiting associate professor of mathematics, from the University of British Columbia in Vancouver, B.C., where he is associate professor of mathematics. He has been at UBC since 1949 when he received his PhD from the University of Toronto.

Robert A. Huttenback, master of student houses and lecturer in history, from a year in New Delhi, India, on a Ford Foundation Fellowship. He is a 1951 graduate of UCLA and served as soccer coach at Caltech for several years.

Robert Jahn, assistant professor of jet propulsion, from the physics department at Lehigh University. Dr. Jahn received his PhD from Princeton in 1955.

John L. Kerrebrock, senior research fellow in jet propulsion, from Oak Ridge National Laboratories where he has spent the past two years as a research scientist. He received his PhD from Caltech in 1956.

Harry A. Kirkpatrick, research associate in physics,

is professor of physics emeritus at Occidental College. He received his BS there in 1914 and his PhD at Caltech in 1931.

James K. Knowles, assistant professor of applied mechanics, from the department of mathematics at the Massachusetts Institute of Technology where he received his PhD in 1957.

W. A. J. Luxemburg, assistant professor of mathematics, from the University of Toronto where he has been assistant professor of mathematics since 1956. He received his PhD from the University of Leiden in the Netherlands in 1955.

Charles J. Mankin, assistant professor of geology, from the department of geology at the University of Texas in Austin. He received his PhD there in June.

Paul D. V. Manning, professor of chemical engineering, from the International Minerals & Chemicals Corporation in Chicago, where he was senior vice president for the past 15 years. He received his MS from Caltech in 1917.

Peter V. Mason, instructor in electrical engineering, received his BS in 1951 and his MS in 1952 from Caltech, and is now studying for his PhD.

Robert M. Mazo, assistant professor of physical chemistry, from the Enrico Fermi Institute of Nuclear Studies in Chicago where he was research associate.

Carver A. Mead, instructor in electrical engineering, received his BS in 1956 and his MS in 1957 at Caltech and is now studying for his PhD.

Dino Morelli, lecturer in mechanical engineering, from Strollee of California in Los Angeles where he has been a design engineer. He received his PhD here in 1946 and was assistant professor of mechanical engineering from 1949 to 1956.

Frances J. Mullin, assistant professor of electrical engineering, from the University of California in Berkeley where he received his PhD in June.

J. B. Oke, assistant professor of astronomy, from the University of Toronto in Canada where he has been assistant professor of astronomy since 1956. He received his PhD from Princeton University in 1953.

Ian Proudman, visiting associate professor of aeronautics, from the Cavendish Laboratory at Cambridge University. He is a Fellow of Trinity College where he holds a university lectureship in mathematics.

Martin A. Reif, instructor in history, has been a teaching assistant at UCLA since 1955 while working for his PhD and also was an instructor at L.A. State College during spring semester.

James A. Roberts, senior research fellow in radio astronomy, from the division of radiophysics of the Commonwealth Scientific and Industrial Research Organization in Australia. He is a senior research officer there.

Willard V. T. Rusch, instructor in electrical engineering, who is studying for his PhD at Caltech. He received his MS here in 1955.

William R. Samples, assistant professor of civil engineering, from Harvard University where he has been a research fellow since 1955 when he received his MS there.

David R. Smith, instructor in English, from Pomona and Fullerton Colleges where he has been an instructor. He received his BA from Pomona in 1944 and his MA from Claremont Colleges in 1950.

Gordon J. Stanley, senior research fellow in radio astronomy, who has been at Caltech as a research engineer since 1955.

Robert R. Stoll, senior research fellow in mathematics, from Oberlin College in Ohio where he has been professor of mathematics since 1952. He received his PhD from Yale in 1943.

Cecil E. Tilley, visiting professor of geology, from Cambridge University in England where he is professor of mineralogy and petrology. He received his PhD from Cambridge in 1923.

Richard M. Sutton, professor of physics and director of relations with secondary schools, from Case Institute of Technology in Cleveland where he taught science and technology to business executives. He got his PhD at Caltech in 1929 and did research here from 1925 to 1931.

Haruo Takeyama, senior research fellow in engineering, from Hiroshima University in Japan where he is professor of physics.

Jurg Waser, professor of chemistry, from Rice Institute in Houston, Texas, where he was professor of chemistry. He received his PhD here in 1944 and was instructor, research fellow and senior research fellow from 1942 to 1948.

Hatten S. Yoder, Jr., visiting professor of geochemistry, from the Geophysical Laboratory at the Carnegie Institution in Washington, D.C., where he has been a research geochemist since 1942.

H. J. Zassenhaus, visiting professor of mathematics, from McGill University in Montreal, Canada, where he is professor of mathematics.

PROMOTIONS:

To Professor:

John G. Bolton—Radio Astronomy

To Associate Professor:

Allan J. Acosta—Mechanical Engineering
Norman H. Brooks—Civil Engineering
Thomas K. Caughey—Applied Mechanics
Roy W. Gould—Electrical Engineering
Hardy C. Martel—Electrical Engineering
Robert D. Middlebrook—Electrical Engineering
Anatol Roshko—Aeronautics
Alvin V. Tollestrup—Physics
Thad Vreeland—Mechanical Engineering
Ward Whaling—Physics

To Assistant Professor:

Fred C. Anson—Analytical Chemistry
Matthew Meselson—Physical Chemistry
George N. Richter—Chemical Engineering
Winston Royce—Aeronautics

To Senior Research Fellow:
Yuen Chu Leung—Chemistry

On Leave of Absence:

George W. Beadle, chairman of the division of biological sciences, to the University of Oxford in England, as Eastman Visiting Professor for 1958-59.

Felix Boehm, senior research fellow in physics, to Heidelberg University in Germany for one year as visiting professor of physics.

Richard Feynman, professor of theoretical physics, to Cornell University in Ithaca, N.Y., as visiting professor for the 1958 fall term.

Robert Finn, associate professor of mathematics, for a year of teaching and research at the Technische Universität in Berlin.

Yuan-Cheng Fung, associate professor of aeronautics, to Europe for one year on a Guggenheim Fellowship.

Guido Munch, associate professor of astronomy and staff member of the Mount Wilson and Palomar Observatories, to the Max Planck Institute of Physics in Goettingen, Germany, for a year of research.

John D. Roberts, professor of organic chemistry, to Harvard for six months as visiting professor of chemistry.

Allan Sandage, staff member of the Mount Wilson and Palomar Observatories, to South Africa for research at Radcliffe Observatory in Pretoria and the Royal Observatory in Capetown for five months and to the Royal Greenwich Observatory in England for one month.

Frits Went, in charge of Caltech's Earhart Laboratory, to the Missouri Botanical Gardens in St. Louis as director for one year.

Calvin Wilcox, assistant professor of mathematics, to the U.S. Army Research Center at the University of Wisconsin for one year.

David S. Wood, associate professor of mechanical engineering, to the Massachusetts Institute of Technology for six months as visiting associate professor of mechanical engineering.

Departures:

Gunnar Bergman, assistant professor of chemistry and mechanical engineering, to Hughes Aircraft.

Arthur Code, associate professor of astronomy, to the Washburn Observatory in Madison, Wisconsin, as director.

Howard M. Dintzis, assistant professor of chemistry, to the Massachusetts Institute of Technology in Cambridge, as a senior research associate in the biology department.

Donald E. Osterbrock, assistant professor of astronomy and staff member of the Mount Wilson and Palomar Observatories, to an appointment in the department of astronomy at the University of Wisconsin.

Robert S. Richardson, staff member of the Mount Wilson and Palomar Observatories, to the Griffith Observatory in Los Angeles, as associate director.

Harry Rubin, senior research fellow in biology, to the Virus Laboratory at the University of California at Berkeley, as associate professor.

Verner Schomaker, professor of chemistry, to the Union Carbide and Carbon Corporation in New York.

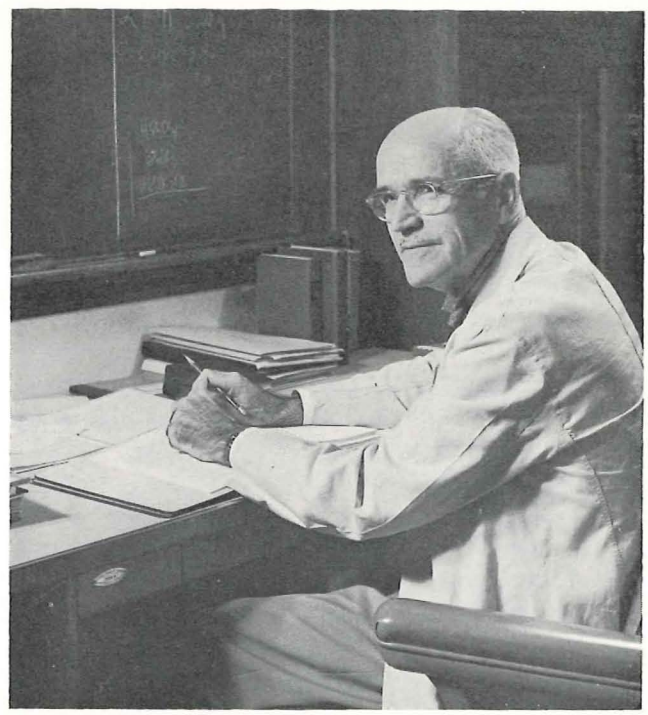
Ronald Shreve, instructor in geology, to the Swiss Federal Institute of Technology in Zurich for one year, on a National Science Foundation Fellowship.

Chemistry Chairman

Ernest H. Swift, professor of analytical chemistry, was named chairman of Caltech's Division of Chemistry and Chemical Engineering this summer. He replaces Linus Pauling, who has resigned to devote full time to his teaching and research, which is currently concerned with the molecular chemistry of mental disease.

Dr. Swift was graduated from the University of Virginia in 1918, then received his MS and PhD degrees at Caltech, and has been a member of the faculty here ever since. During World War II Dr. Swift was an official investigator for the Office of Scientific Research and Development, working on problems related to the identification of chemical warfare agents and their detection in the field.

His most recent pioneering research has been in the development of coulometric analysis—the use of an electric current to measure chemical elements quantitatively. In 1955 he won the annual $1,000 Fisher Award, given for "outstanding contributions to the science of analytical chemistry."



Ernest H. Swift, chairman of the Division of Chemistry and Chemical Engineering.

The Need for College Scholarships

by L. Winchester Jones
Dean of Admissions

If anyone were to ask me for a justification for spending large sums of money on educational scholarships I would point first to what has been happening to the personnel requirements of industry in this country in roughly the last 30 years.

In the first quarter of this century there were few jobs in business or industry that required much more than the ability to read and write as far as a strictly formal education was concerned. Many a successful enterprise was founded, operated and controlled by men who had not had the opportunity to study beyond the twelfth grade, if that far, and who chose even their most important executives on the basis of such qualities as industry, shrewdness, ambition and common sense without much regard to the quantity of schooling involved.

Even in such a technical field as engineering the man with experience, a little knowledge of trigonometry, and a genius for tinkering with gears and levers still managed to hold his own. The scientist in industry was a rare bird indeed. Except in a few far-sighted corporations, he was simply ignored and classed with Dr. Johnson's lexicographer as a harmless drudge.

I do not think that I need to enlarge on the contrast between this situation and the one that exists today—when a man without at least a bachelor's degree can hardly hope to rise above the rank of laborer or clerk—when each year it becomes more necessary for the engineer to go even beyond the bachelor's degree in order to rise in his profession—when industry is begging the scientist for more basic ideas to keep the wheels turning, or at least greased to the point at which the turning will result in profits—and when an ever-increasing number of those in the most important positions are entitled to write PhD after their names.

This extraordinary change does not mean that we have any less respect for industry, shrewdness, ambition or common sense. It means simply that our society has grown so bewilderingly complex that these qualities by themselves are no longer sufficient. We must have men and women trained well beyond the scope of a high school education to attack the problems with which modern society is faced, and to make the kind of decisions which—if improperly made, without a complete grasp of the complexities involved—could result in the disintegration of our society. Furthermore we must have these trained people in very large numbers, not only in industry, but in government, in the professions, and—if we are to continue to turn them out at all—in education. They are no longer a luxury, a frill or a small elite group. They are essential to our survival and they are a fair-sized army.

There is no longer any question of the value of a college education either to the individual or to the society in which he lives. There is only the question of how we can educate enough people to care for our great need with the facilities we now have, or are likely to be able to create in time to do much good.

This brings us to the question of who should be educated beyond the high school level. I am not going to attempt to answer that one, but it seems clear that we cannot afford to carry everyone through four years of college—nor would this be desirable if we could. Selecting those who will most profit from a college education and afterward yield the biggest return on the investment is something on which, according to my official title, I am supposed to be an

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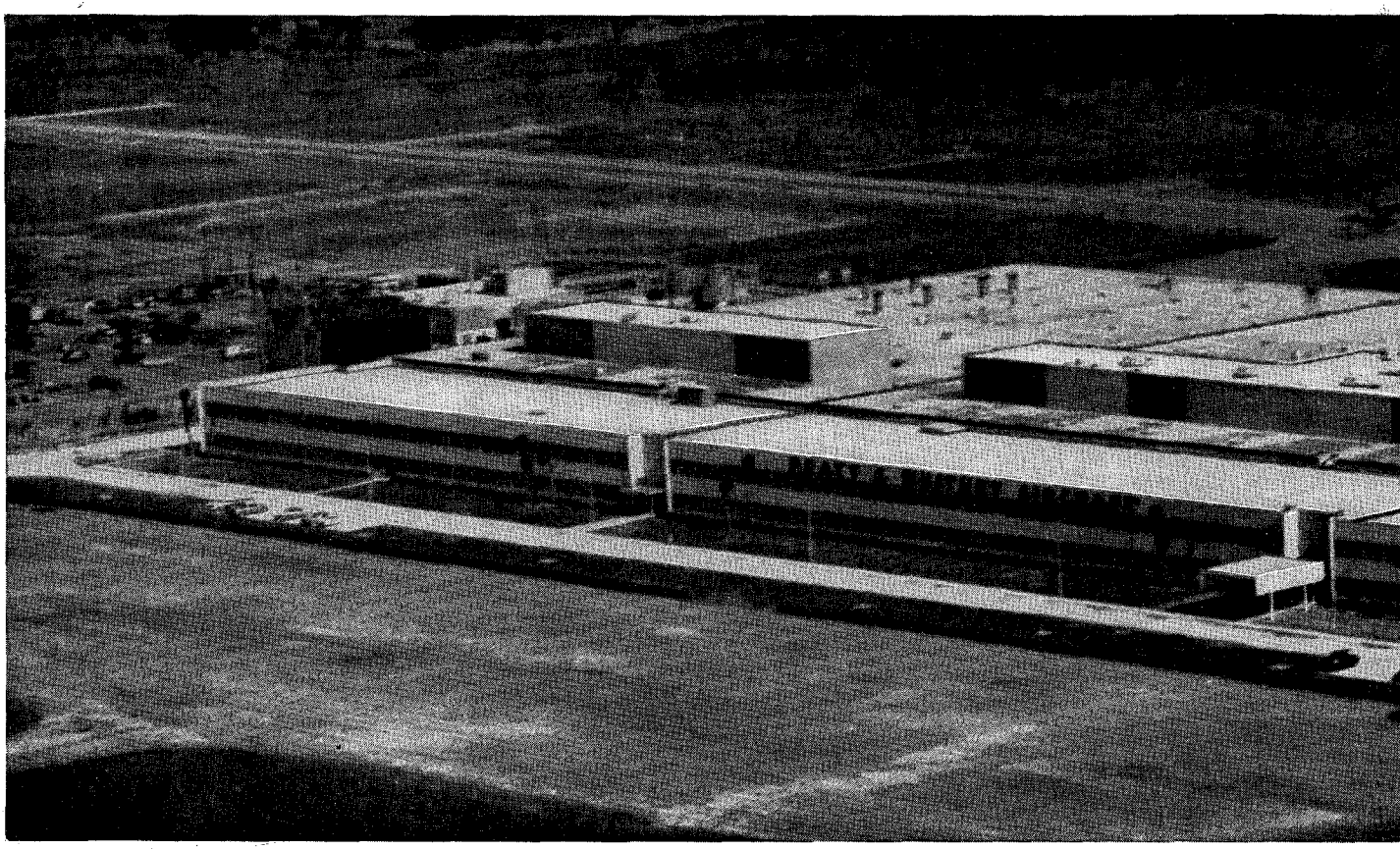
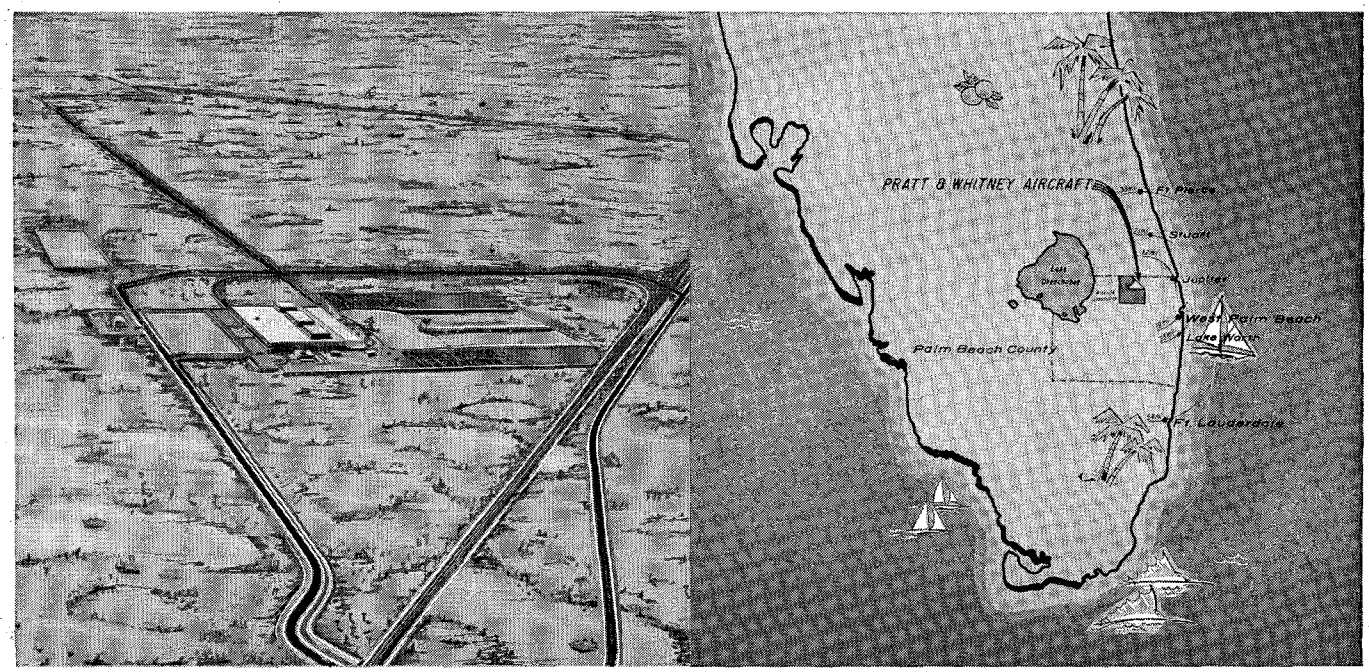
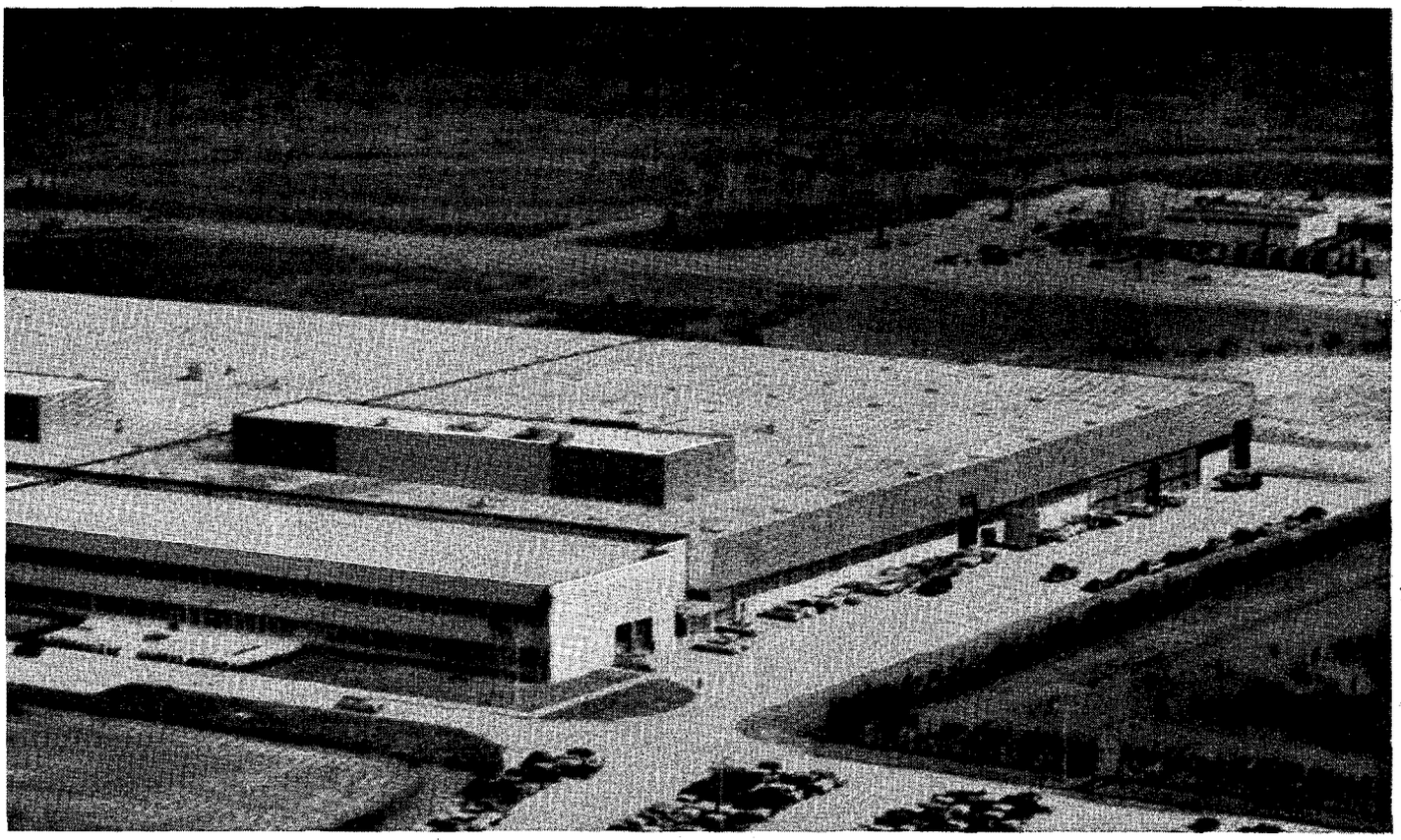


FLORIDA RESEARCH AND



ISOLATION—Ten square miles comprise the site of Pratt & Whitney Aircraft's new Florida Research and Development Center. Experimental shops and offices covering some 17 acres are in the foreground, while the tests areas, barely visible in upper left, lie four miles in the background.

LOCATION—The new Center is located at United, Florida, midway between West Palm Beach and Lake Okeechobee, in the upper Everglades area. It is almost surrounded by a wildlife sanctuary. Most employees live in the cities and towns along the east coast of Florida, driving to the Center on excellent new highways.



DEVELOPMENT CENTER...

Another Unmatched Engineering Facility to Advance Propulsion Systems of the Future

Future aircraft and missiles may require propulsion systems far different from those in wide use today — different in size, power output, appearance, and perhaps even in the basic method of utilizing energy.

To probe the propulsion future . . . and to build and test greatly advanced propulsion systems for coming generations of flight vehicles, Pratt & Whitney Aircraft is now operating its new Florida Research and Development Center. This facility supplements Pratt & Whitney's main research and development installations in Connecticut.

The new Florida Center, financed and built by Pratt & Whitney Aircraft, is unique in America's air industry. Here a completely air-conditioned plant with 17 acres under roof is specially designed and equipped for the development of new power plants of virtually any type. Testing is handled in special isolated areas; the nearest is four miles from the plant and many miles from any inhabited area. The new Center can be greatly expanded on its 10-square-mile site. Continued isolation is insured by a vast wildlife sanctuary in which the Center is located.

Of the many people employed at the Center today, about half are scientists, engineers and highly trained technicians. By late next year, the total number is expected to be almost doubled.

The new Florida Research and Development Center is one more reason why Pratt & Whitney Aircraft is able to continue producing the world's best aircraft propulsion systems . . . in whatever form they take.

For further information regarding an engineering career at Pratt & Whitney Aircraft, contact your college placement officer.

PRATT & WHITNEY AIRCRAFT

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FLORIDA RESEARCH AND DEVELOPMENT CENTER — United, Florida

expert, and I can assure you that I—and all the other experts – have as yet found no satisfactory answer.

There is only one point on which I think we would all agree. The selection cannot be made wisely on the basis of the ability of the candidate or his family to pay the freight. History records the ruins of many a civilization which confined the special culture on which that civilization depended to a privileged few who became so self-protective and rigid that, like the dinosaur, they failed to adapt to changing conditions. One never knows from what kind of a background or environment—rich or poor, luxurious or squalid—the right combination of genes will develop into a mind which, if given the proper training, will be able to solve some problem that cries out for solution. In making our selections we must, therefore, leave ourselves the widest possible field of choice, and this means at least the elimination of the size of the family bank account as a limiting factor.

Who then is going to pay the bill? A college education is expensive and it must become more so as time goes on or it must deteriorate in quality. There are very few colleges in this country today whose tuitions cover even half the cost of the education of a student. Thus every student, whether on scholarship or not, essentially costs the college money. It is in recognition of this fact that many scholarship donors have with each scholarship made an additional donation in some amount to the college's general funds.

Tuition goes up

In the past the difference between the tuition fee and the actual cost has been made up from the interest from endowment funds given by farsighted and generous people who, thanks to a more favorable tax structure, were able to accumulate fortunes to be given away. Because of these endowment funds colleges have been able to carry those highly desirable students who could pay their own way only partially or not at all. But the income from endowment funds is largely a fixed one. As a rule colleges cannot afford to indulge in the kind of investment that will yield enough to keep pace with inflation.

Five years ago the tuition at the California Institute was $600 a year. Today it is $900 and in 1959 it must go to $1275. Thus in 1959 we will have to take over twice as much from our endowment funds to give the same relative amount of scholarship support as we did in 1953, and this does not take into account those who must have more than full tuition in order to eat and have a place to rest their weary heads.

Additional endowment funds large enough to yield significant amounts in interest are rare in these days when individual initiative must more and more content itself with being its own reward, and colleges must rely more and more on annual gifts received in one year and spent in the next—if indeed they have not already been spent in anticipation.

Individuals, foundations and corporations have been and are being extraordinarily generous. The colleges are most certainly grateful. I hope I do not appear to detract from this gratitude when I say that it behooves these individuals, foundations and corporations to be even more generous in the future. If one hundred and sixty million people in these United States are to exist together in reasonable harmony with themselves and the nations around them, are to be supplied with the goods and services that make for a decent standard of living, and are not to fall into chaos, we will need all of the wise leadership at every level and in every line of endeavor that all of the colleges of this country can possibly select and train—and in our selection we cannot afford to pass over the leadership potential that may happen to develop from an economic environment that cannot pay for the training.

If, by now, I have made clear the reasons why we must strive to discover and to educate at the college level every promising boy and girl, regardless of economic background, and why the colleges can no longer hope to do this on their present resources—why, because of rising costs and increased demand, they must have additional scholarship funds—I have done what I set out to do. But if I were asked to help in this essential endeavor I would want to know something more. I would want to know whether there were not other and even better ways of taking care of this problem than adding one more worthy cause to the dozens already clamoring for my attention. I would—before anything else—want to look at the alternatives.

Neglected money

For example, what about the rumor that there are thousands of dollars of scholarship money lying around unused? Personally I have never run across any of this sadly neglected money nor have I met any other scholarship officer who has unless—and this I think may be largely responsible for this rumor—the donor so restricted the conditions of his gift that only once in 20 years can a candidate be found who meets the qualifications. Any college that itself possesses unrestricted idle funds must either be unable to attract students or fail to encourage applications from those who cannot pay their way.

What about loan funds? A number of colleges report surpluses in these funds so why not cut down on the free rides? There are two answers to this question. First there is the reluctance on the part of parents to commit a 17-year-old freshman to several thousand dollars worth of indebtedness to be paid off after graduation, especially in fields like engineering and

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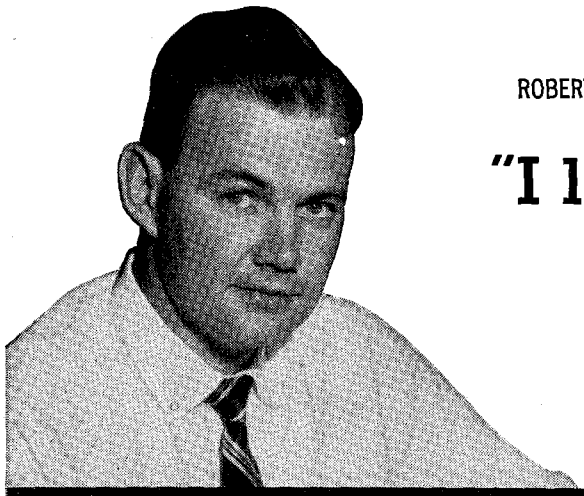
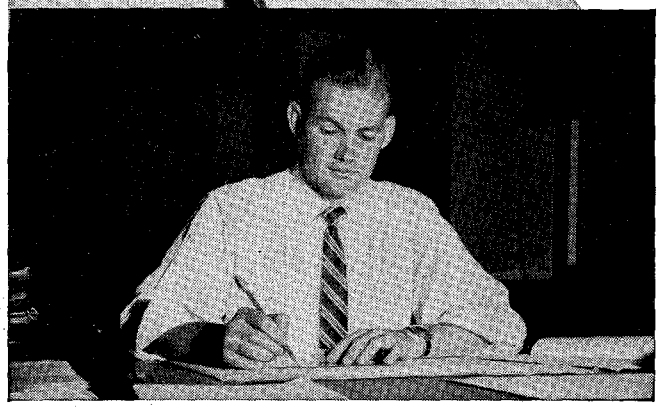


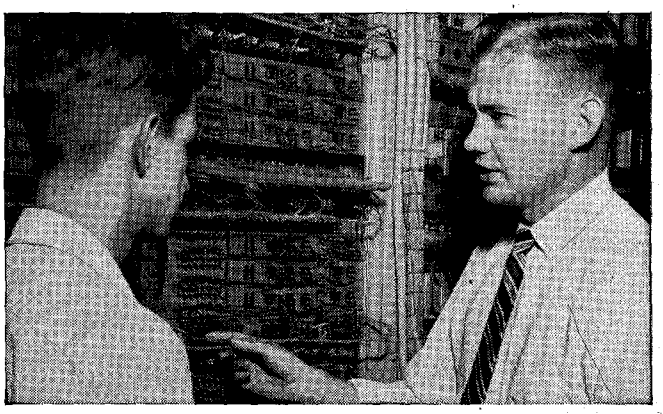
ROBERT H. SWISHER, B.S.E.E., GROVE CITY COLLEGE, '54, SAYS:

"I like my job. Here's why."

"I'm a radio transmission engineer for Bell Telephone Company of Pennsylvania. My work is interesting and full of variety, and I get all the responsibility I can handle. Have a look at today's assignment, for example —and see for yourself."



"8:30 a.m. I'm at my desk applying a new method for overcoming interference on Pittsburgh's mobile radio channels. It involves operating inactive channels on reduced power."



"10:45 a.m. Before any modifications can be made, it's important that I check apparatus and wiring options. That's what I'm doing here at the Remote Control Terminal equipment."

"1:30 p.m. After lunch, I take a company car out to the transmitter tower site. Here I check wiring and explain our plan to one of our mobile radio maintenance men."

"3:15 p.m. I review my proposed modifications of auxiliary control circuits with Supervisor Sid Graul. Now I'll prepare work orders, and next week we'll make operational tests."

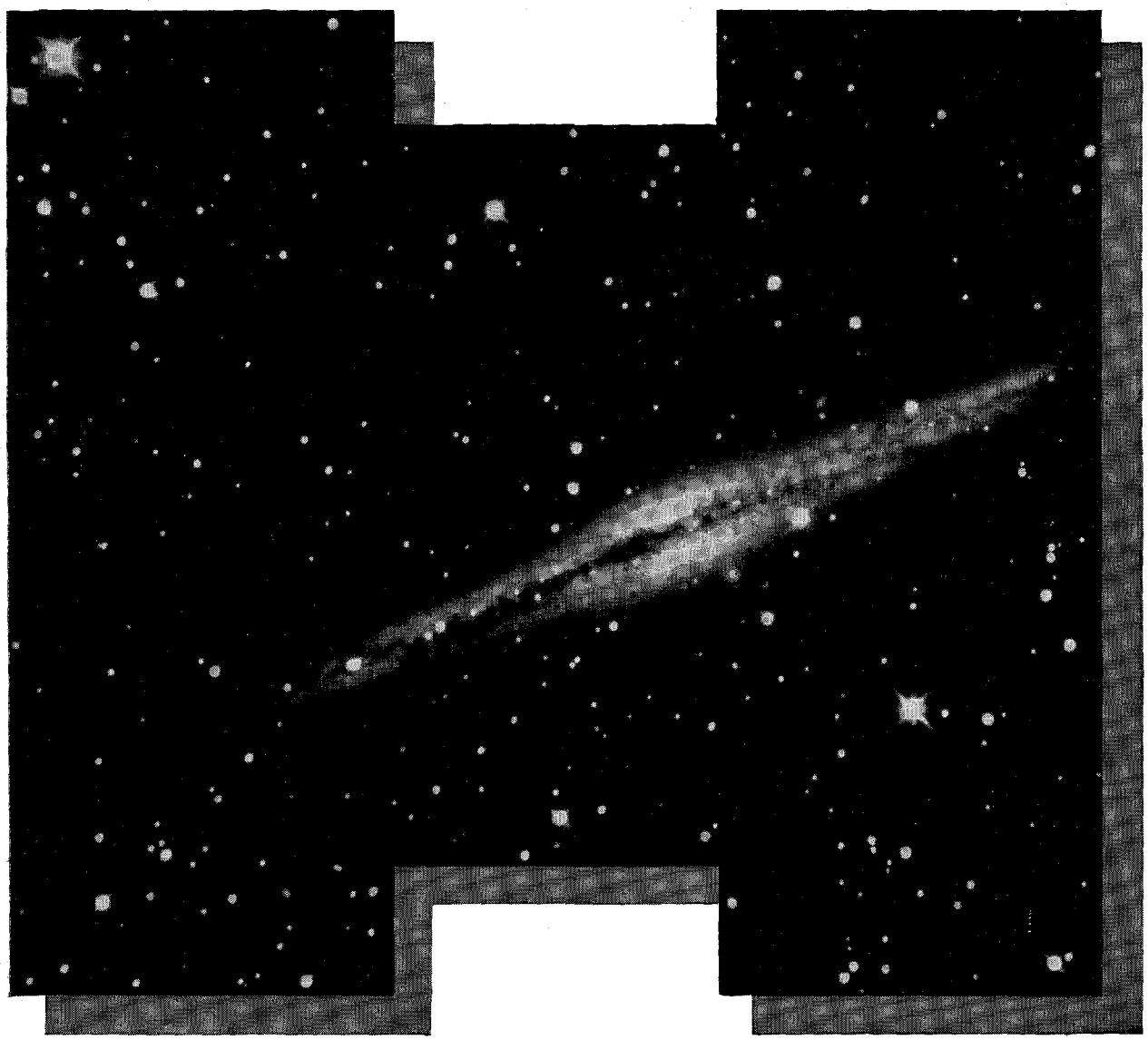
"Final phase. The operational test is made from an actual mobile radio unit. I'll make test calls and monitor the channels from various points within the Pittsburgh area."

"See what I mean? I really get to 'carry the ball.' Soon I'll be taking a special course in advanced electronics at Bell Labs—a great opportunity. As I said —I like my job."

Like Bob Swisher, *you* may find a bright engineering future with the Bell Telephone Companies. 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

GROOMING ELECTRONICS



FOR THE SPACE AGE

Systems in the Air

The march of electronics into the Space Age is being quickened as a result of Hughes work in airborne electronics systems.

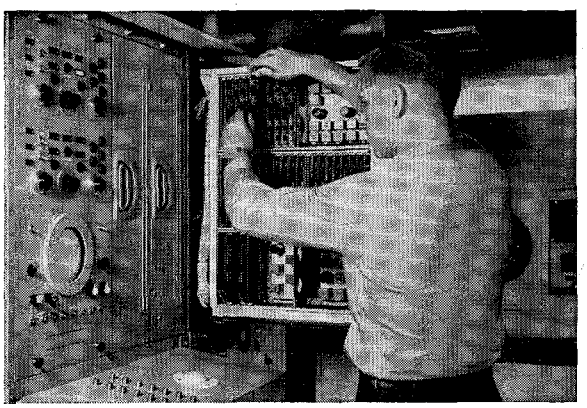
One such development is the Hughes Electronic Armament System, which pilots high-speed jet interceptors to enemy targets, launching Hughes air-to-air guided missiles, and flies the plane home. Even more sophisticated Electronic Armament Systems completely outstrip those presently released for publication.

Working on space satellites, Hughes engineers are active in the preliminary design of guidance and control systems, communication and telemetry systems, sensing devices using infrared, optical and radar techniques.

Information resulting from Hughes study in the fields of air-to-air and ballistic guided missiles is presently paying dividends into the fund of space knowledge.

Hughes engineers have developed space hardware using high-reliability wire wrapping to replace soldered connections and miniaturized "cordwood" circuit modules to allow high component density.

The advanced nature of Hughes electronic systems—in the air, on the ground, and for industry—provides an ideal growth environment for the graduating or experienced engineer interested in building rewarding, long-range professional stature.



Data Processors, which monitor hundreds of aircraft and store the information for high-speed assignment of defense weapons, comprise one part of an advanced Hughes ground defense system.

Capacitors which provide for electrical, rather than mechanical tuning of circuits, are being produced by Hughes Products, the commercial activity of Hughes.

Members of our staff will conduct

CAMPUS INTERVIEWS

on November 24 and 25. For interview appointment or informational literature consult your College Placement Director.

the West's leader in advanced electronics

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

science, in which a very large proportion will want to go on to several years of graduate work.

Even in the unlikely event that we can hold to the present rate for room and board, it will, commencing in 1959, cost a student living in our dormitories $2500 a year to cover everything including a small amount for clothing and personal expenses. Even a moderately well-to-do family with two or three other children in or about to enter college will find it difficult to meet this charge, and there are many hundreds of worthy applicants whose families could not contribute a half or even a quarter of this amount. To borrow the remainder would, by the time a student's formal education had ceased, create a really heavy burden of indebtedness.

Deferred payment plans

The second answer to this question is that, in the face of rapidly rising costs, colleges already are more and more resorting to a system of part loan and part scholarship in attempting to cover financial need. Caltech in 1959 will offer a choice of several deferred-tuition payment plans, whereby about one-third of the tuition is paid in the usual way and the remainder plus a small amount of interest is paid in monthly installments spread over a period of as much as ten years from the date of matriculation. For years we have required all seniors who ask for scholarship aid to take one half of their need in loans, whether or not they intend to go on for graduate work, and for the past three years we have in a number of cases offered loans in place of scholarships to entering freshmen.

The fact remains, however, that few applicants without fairly strong family resources will commit themselves to a large indebtedness at graduation. Rightly or wrongly most of them will rather forego the kind of education that they want and deserve, and either accept one not as suited to their abilities or give up the idea of college altogether. Loans are an important factor in the problem and will become more so, but they can never be a major solution.

To what extent should a student be required to earn his own way? This will, of course, depend on the other demands made on his time by the particular college he is attending. His most important task is to get the most out of the educational opportunities that are offered him. Many colleges now offer a kind of package deal consisting of some scholarship, some loan, and a part-time job. Caltech requires that every scholarship student beyond the freshman year earn at least $600 a year, including term time and vacation periods. If he fails to do so without very good reason his scholarship is reduced by the amount which he falls short of the $600.

Most colleges will agree that a student should not try to earn money during his freshman year. The average student will then in a four-year period earn a total of about $2,000, to be applied against bills amounting to $10,000.

It is true that a very few fortunate individuals may earn nearly $2,000 in one year. If they do we have consistently refused to penalize them and have considered their need as we do the others on the basis of the $600 minimum. It is our hope that additional scholarships will enable us to continue to reward the industrious and the self-reliant by not confiscating the savings which they themselves have earned.

And now, finally, what about the government—state or national? Why not pass the burden to the taxpayers? The state of California is starting its third year of a state scholarship program. It is a good program and well administered, but the maximum amount of aid which an individual can receive from it is $600 a year, and while this amount may some day be increased it is unlikely that those who meet in Sacramento will ever feel that the voters will stand for an increase sufficient to keep up with rising costs. Furthermore, these scholarships are, of course, available only to California residents and must be used at California colleges. Where similar programs develop in other states they follow the same pattern. To a college which for excellent reasons wishes to maintain a fair degree of geographical distribution among its students, and one at which the tuition alone is nearly twice the maximum award, such scholarships are certainly a help but are hardly the whole answer.

Federal scholarships

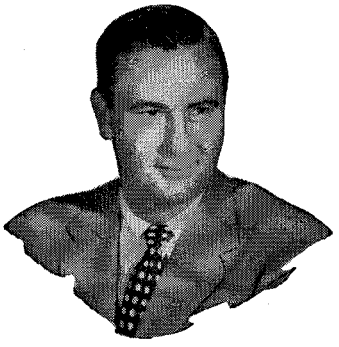
Well, then, what about the Great White Father in Washington? We hear that he was recently frightened by a bear and is about to give out millions to train thousands of bright little Daniel Boones to clear the woods of varmints. It is true that the men on Capitol Hill got a scare—or at least an abrupt awakening—and as a result a number of Federal Scholarship bills have been presented in Congress. The one which has received the most publicity provides for 25,000 scholarships a year—or a total of 100,000 in all four undergraduate years when the plan shall be in full operation. Each scholarship carries a stipend of $1000 a year.

There is now a college population of somewhat over 3,000,000, which the best estimates indicate will increase to 6,000,000 in 1970. Of the 3,000,000 presently in college probably at least 2,000,000 now need —or will need in the near future—scholarship aid in some amount. The ratio of Federal scholarships to those in need is therefore 1 in 20 and by 1970 it will be 1 in 40. It is true that as long as the varmints are in the woods there may be occasional increases in the

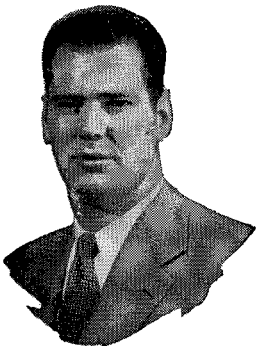
continued on page 42

Allis-Chalmers offers training course

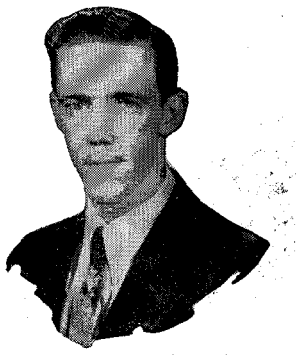
In nucleonics, Andrew Selep, Brooklyn Polytechnic Institute, BME '53, is working on the problem of reactor safeguards.



Special engineering by Paul W. Clark, Iowa State College, EE '49, is of large job involving combined electrical equipment.



Sales manager, Robert Horn, Marquette University, EE '51, heads sales of voltage regulators used on power lines.



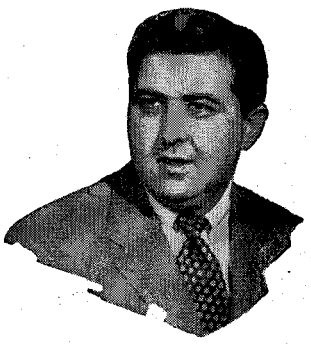
Electronics man, William E. Martin, Alabama Polytechnic Institute, BSEE '53, engineers applications of induction heaters.

plus wide choice of type and fields of

Design of generators for steam turbines is directed by G. W. Staats, Illinois Institute of Technology, Ph. D. '56.

Field sales of America's widest range of industrial equipment is career of Carl E. Hellerich, U. of Nebraska, ME '49.

Promotion man, Robert I. Carlson, Worcester Polytechnic Institute, ME '50, directs promotion of switchgear, and substations.



Application and sales of steam condensers for power plants are handled by William E. Ellingen, U. of Wisconsin, ChE '49.

work on equipment for many industries

THE outstanding training course started by Allis-Chalmers has proved a springboard to many worthwhile careers. In fact, most of the A-C management team has stemmed from its ranks.

Up to two years of theoretical and practical training are offered. This experience leads to jobs in research, design, manufacturing, application and sales.

Even though you may not know exactly what you wish to do, the Allis-Chalmers training course is designed to help you find the type of work and the field to which you are best suited.

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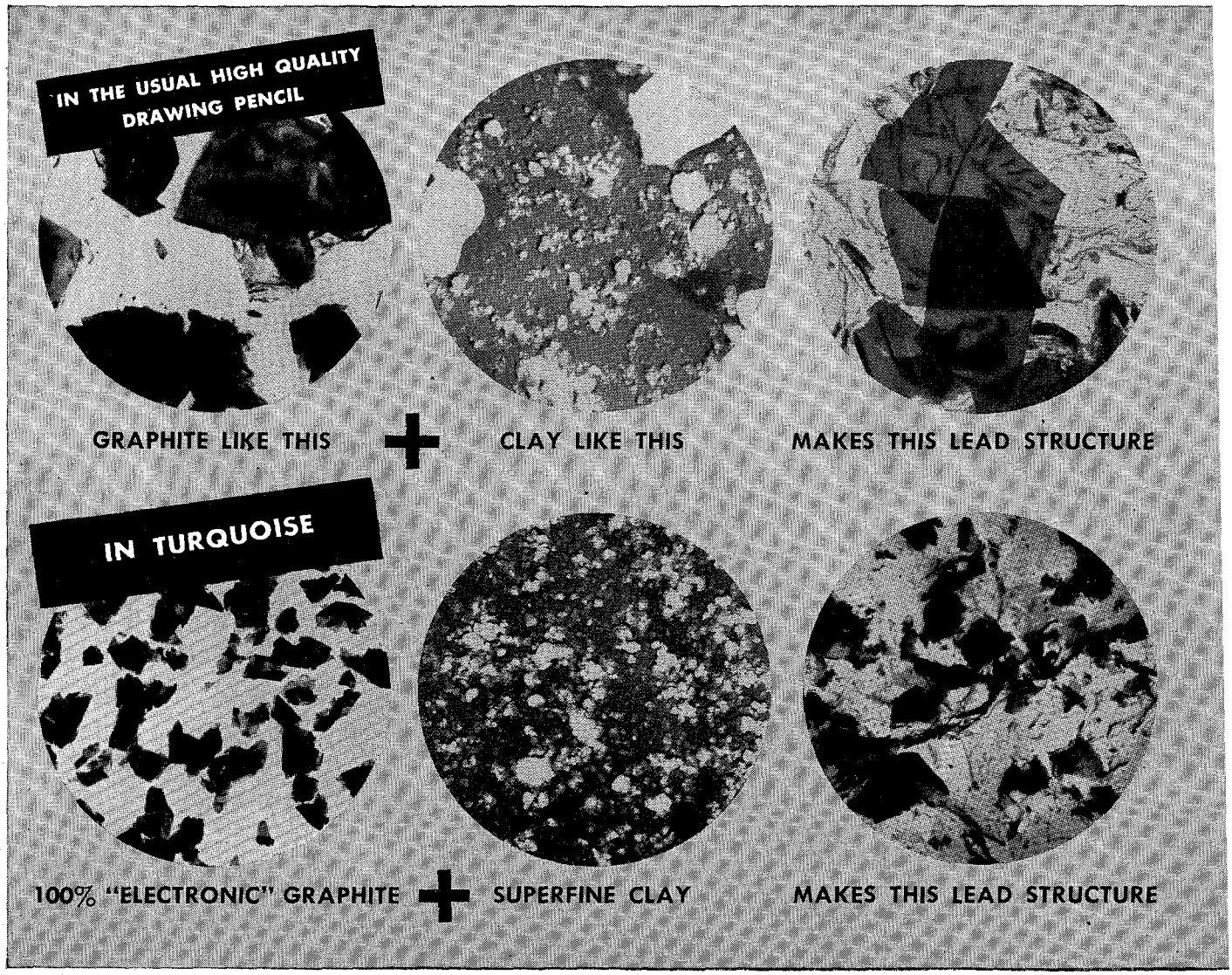

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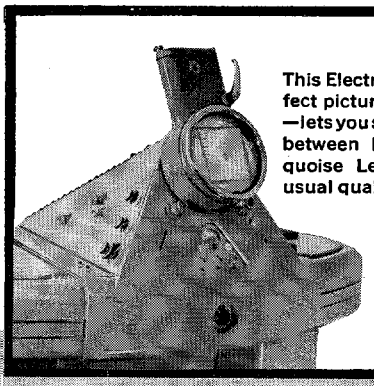
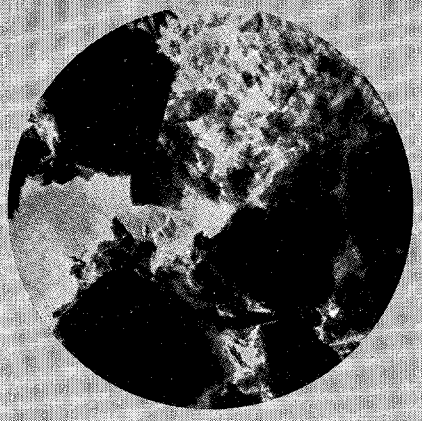
Eagle Turquoise sharp drawings



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

Photographs courtesy of Ladd Research Industries, Inc.



. . . AND MARKS LIKE THIS

Relatively large, irregular particles of graphite make a rough-edged line. Drawings will be inferior.

. . . AND MARKS LIKE THIS

Tiny, more uniform particles deposit as a clean-edged, solid line. Drawings will be perfectly sharp, clearly defined.

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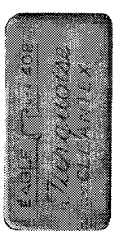
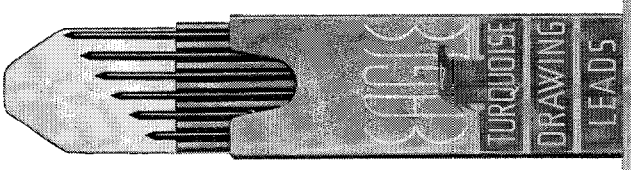
(including Turquoise wood pencil, Turquoise lead, and Turquoise "skeleton" lead) naming this magazine. Eagle Pencil Company, 703 East 13th Street, New York, N. Y.

● **TURQUOISE DRAWING PENCILS:** ®"Electronic" graphite. 17 grades, 6B through 9H.



● **TURQUOIS CLEANTEX ERASER:** Super-soft, non-abrasive rubber.



● **TURQUOISE DRAWING LEADS:** Fit any standard lead holder. Grades 5B through 9H.

● **TURQUOISE LEAD HOLDERS:** Hold any grade of Turquoise lead.

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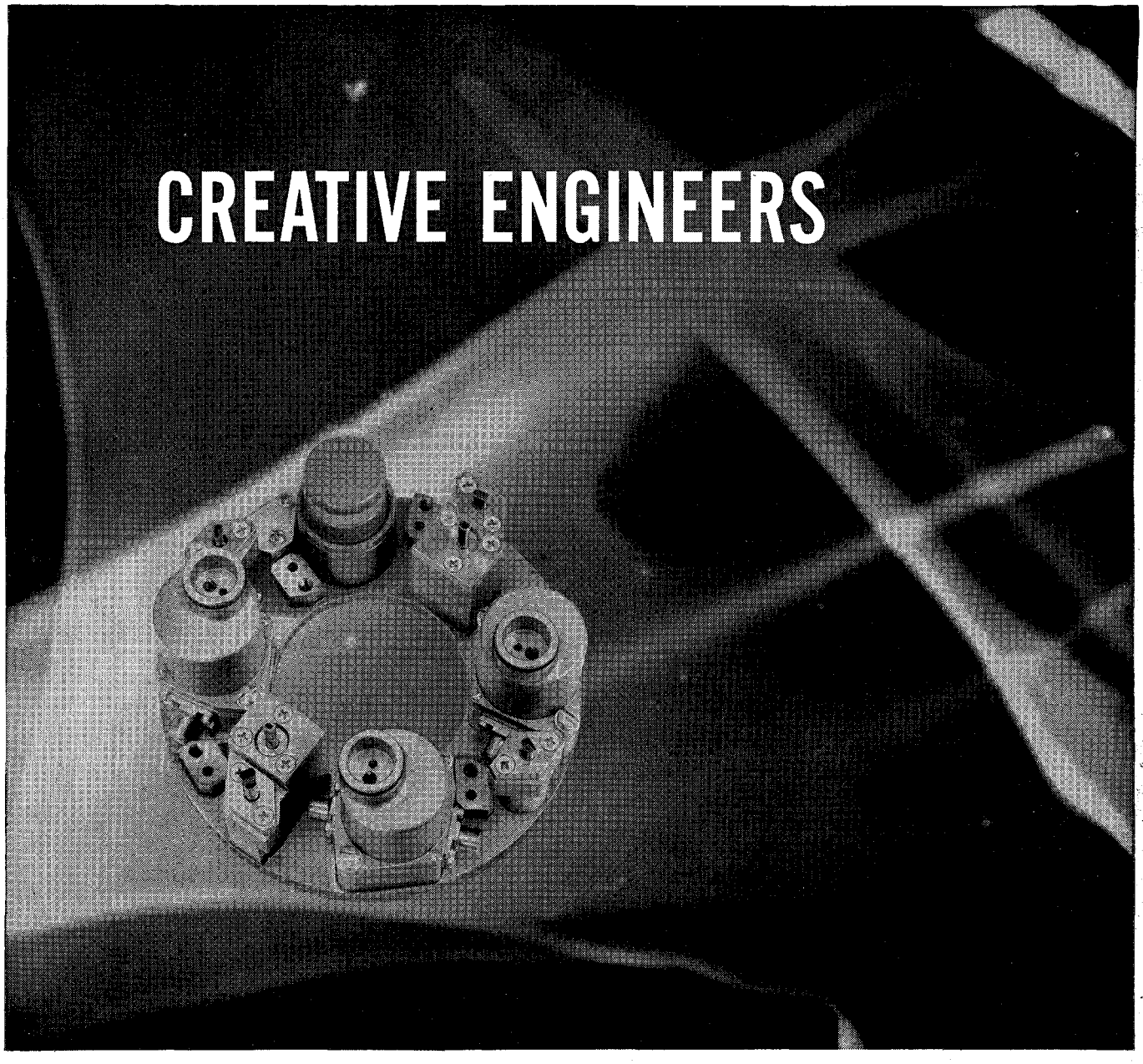
number and even in the amounts of the awards, but again I would be willing to gamble that those increases will not keep pace with the need.

But there is an additional and a very compelling reason why I do not want to rely on Federal scholarships. If I were asked by a man from Mars to state the basic difference between a democracy and a dictatorship I would reply that in the former the citizens are free to discriminate and some of them are taught to do so; whereas in the latter the people are permitted only to believe. The ability to discriminate is the basic requirement for reaching sound conclusions. It can be acquired only under conditions in which people are free to examine ideas. It can be taught only if the colleges and universities are uninhibited in their efforts to investigate, to weigh and to evaluate. To attempt to teach discrimination in an atmosphere in which in any area of human endeavor only one side of a question may be considered is a contradiction in terms. It is the most mentally emasculating experience to which any citizen can be subjected and can result only in flabby minds existing within a protective shell of authority.

I am not suggesting that the proponents of government scholarships are plotting to seize control of education. I am not even objecting to Federal scholarships in the modest proportion now being proposed. I am trying to point out that if private citizens, private foundations, private corporations decline to support scholarship programs and leave this field entirely to the government, the colleges and those who attend them must sooner or later became government dependencies to some important degree. No matter how good the intention may be in the beginning, eventually the man who pays the piper calls the tune.

If this tune can be changed from day to day by public hysteria, public whims, enthusiasms and prejudices which cannot help affecting legislative bodies the colleges will not long be free. That is why I do not think that private citizens and private enterprise can afford to delegate their responsibilities in the field of education to the authorities in Washington, and it is why we in the colleges feel justified in turning to private sources for help in discovering and educating those to whom we must some day turn for leadership. That these people shall be ready when we need them is certainly to our mutual advantage.



AiResearch engineered and produced this electro-hydraulic servo system—the most reliable and responsive steering control system for missiles yet produced. Extremely lightweight, it consists of three control valves and six actuators.

This unique system represents but a part of the challenging, important work under way 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 and turbine and air motors; cryogenic and nuclear systems; pneumatic valves; industrial turbochargers; air conditioning and pressurization; and heat transfer, including electronic cooling and nuclear applications.

Intensified engineering is conducted by small groups where individual effort and accomplishment are quickly recognized, providing opportunity for rapid growth and advancement. An eight-month orientation program is offered prior to permanent assignment to help determine your placement from a variety of analytical or development projects.

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Alumni News

Robert W. Alcock

On the morning of July 14, 1958, Robert W. Alcock was having breakfast in the new Hotel Baghdad in Iraq. He was there to confer with Mr. M. M. Hadid of the Vegetable Oil Extraction Company on a proposal for a new detergent plant to be built in that country. Bob was there as chief engineer of Industrial Engineers, Inc., of Los Angeles. He had flown to Baghdad the night before from Kuwait where he had been helping the Aminoil Company with process problems. It was the very morning that the revolution in Iraq exploded. Bob and two other Americans, Mr. George S. Colley, senior vice-president of the Bechtel Corporation, and Mr. Eugene Burns, a newspaperman, were forced by the revolutionary mob to leave the hotel. Apparently these Americans were chosen at random from the hotel guest list and shortly thereafter all three were killed in the streets of Baghdad.

Robert was born in Iowa City, Iowa, and was an honor student at University High there. He graduated from CIT in 1940 and received an MS in ME in 1941. He was well known and well liked, having been elected president of Dabney House in 1940, vice president of the ASME, and was a member of the Photo Club and the Dabney Hunt Club. He was also an ardent skier and was very active in the social life of the campus. He trekked regularly to the Scripps College campus in Claremont where he met his wife-to-be.

After Caltech, he went to Lockheed Aircraft as an engineering trainee. He soon returned to the Institute to work on the OSRD rocket project and was instrumental in devising pressure-time measuring equipment, high-capacity hydraulic extrusion presses for propellants and special machine tools. He then went with Industrial Engineers, Inc., and became their chief engineer. He supervised the design and installation of a number of important process plants, including a detergent plant in Tokyo and one in Mexico City.

Robert is survived by his wife Erminia (Nina) Aguirre Alcock, Scripps '41, and eight children ranging in age from 1 to 16. The family lives at 126 East Palm in Altadena.

Great assistance has been given to Mrs. Alcock by the Alumni Association and members of the CIT faculty. Dr. DuBridge has been in contact with Dr. Wallace Brode, the science advisor to the U.S. Department of State, for the purpose of pressing claims for reparations against the Iraqui government. The Alumni president, Edward Fleisher, and other alumni have been writing their representatives in Washington to encourage the State Department to press for reparations. Congressman Edgar W. Heistand has done an outstanding job. He has been in constant contact with Mrs. Alcock and the State Department. He introduced a resolution in Congress asking that the new Iraqui government not be recognized until reparations were made. The new Iraqui government indicated that it would pay any valid claims and was subsequently recognized by the United States.

All of Bob's friends are shocked and grieved over his untimely death and feel a sense of frustration over this tragic occurrence. Some have questioned the wisdom of exporting our technical talents and wealth to underprivileged countries which have such unstable governments as to pose a threat to the lives and property of American citizens who are there to help. However, if we are to encourage such countries in the development of their own resources we have no choice but to continue to share our technical knowledge in spite of these tragic accidents. Robert will stand as a symbol of this American point of view.

Bob's two eldest sons have been given full scholarships to the Webb School in Claremont by the Henry J. Kaiser Foundation.

A Robert W. Alcock fund has been started for Mrs. Alcock and the children. Contributions may be sent to Mrs. Ynte Posthuma, 2210 Midlothian Drive, Altadena.

—Gardner P. Wilson, '38

Fall Dinner Meeting

Nothing is more subject to criticism than the technical accuracy of a blockbuster movie—and the major studios maintain extensive research staffs to circumvent this criticism.

The Caltech Alumni Association is fortunate in having one of the most distinguished of these research men as speaker at its Fall Dinner Meeting on October 16 at Eaton's Santa Anita Restaurant in Pasadena.

Henry Noerdlinger, research consultant to Cecil B. DeMille and Paramount Pictures, has worked with writers, producers and technical staffs in the filming of such epics as *Samson and Delilah*, *The Greatest Show on Earth*, and *The Ten Commandments*. His work has required research on every conceivable subject from costuming to contemporary slang.

At the Fall Dinner Meeting Mr. Noerdlinger will discuss some of the techniques involved in film documentation—illustrating these techniques with observations based on his experiences while working in Egypt on *The Ten Commandments*.

—James C. Crosby, Chairman, Fall Dinner Meeting

continued on page 46

You're on the right road...

The biggest construction job in history is under way. It's the building of a vast new network of Interstate Highways. Miles and miles of highway. For trucking. For travel. For defense. Some 41,000 miles in all. In addition, many thousands of miles of primary and secondary roads are being built in a greatly expanded "ABC" Highway Program.

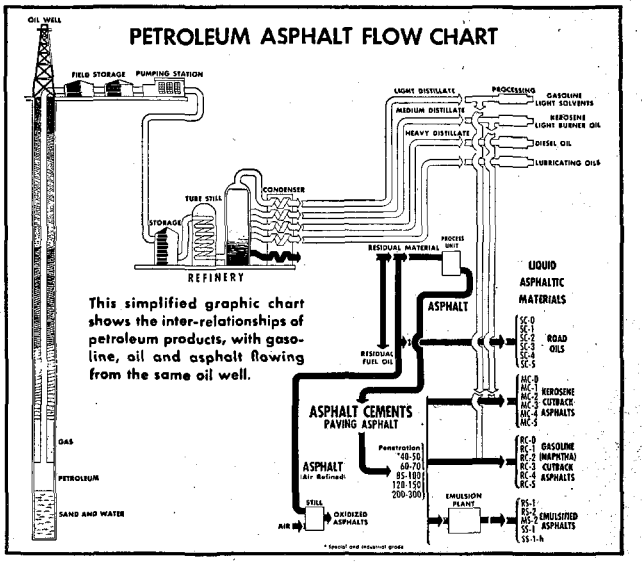
With these new highways will come new industries ... new communities ... a greater share in national life for everyone.

It's a big job ... an important job!

And you're on the right road when you study asphalt technology ... asphalt's characteristics and its applications in pavement construction.

Asphalt pavement is playing a leading role in the construction of the Interstate System.

It now surfaces 81% of State Primary and Municipal Extensions – the nation's most heavily traveled



roads—and 85% of all paved roads and streets in the country.

Your contribution – and reward – will depend in part on how much you know about it.

Do you know, for example, how Asphalt fits into the over-all petroleum family? This chart illustrates the inter-relationship of Asphalt with other refined petroleum products.

The semi-solid form – Asphalt cement – is the basic paving material. It is used in hot-mix Asphaltic pavements for roads, airfields, parking lots and thousands of construction and industrial applications.

Liquid Asphalt materials – road oils, emulsions and cutbacks – are used extensively for a variety of construction and specialty applications.

Special Student Kit on Asphalt Technology Free!

Literature included gives you a broad concept of Asphalt products—its sources, production, characteristics and uses. Put yourself on the right road by sending for your kit today. A postcard will do.

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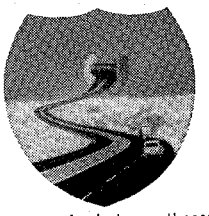
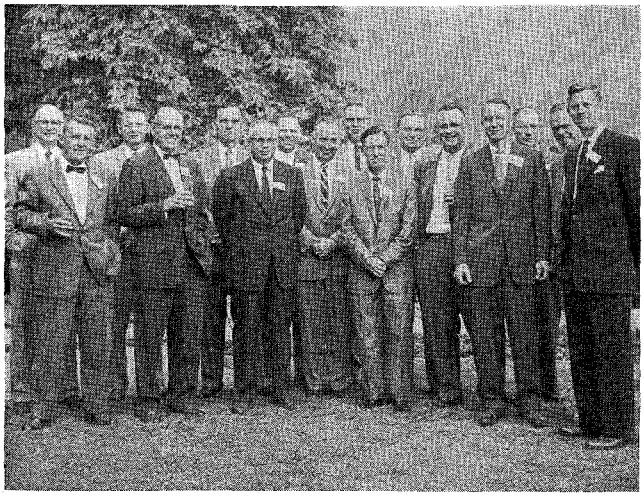


Ribbons of velvet smoothness...
ASPHALT-paved Interstate Highways



Class Reunion

Sixteen members of the Class of 1933 had a reunion at the home of J. Stanley Johnson in Altadena on June 11. Pictured above: (front row) Art Mathewson, Bob Smallman, Walter Scholtz, Bill Moore, Doug Marlow, Sam Johnson, George Pickett and Lee Carleton. (Back row) Fred Detmers, Bob Grossman, John Meskell, John Monning, Bill Wheeler, Trent Dames, Jack Sparling and Stan Johnson.

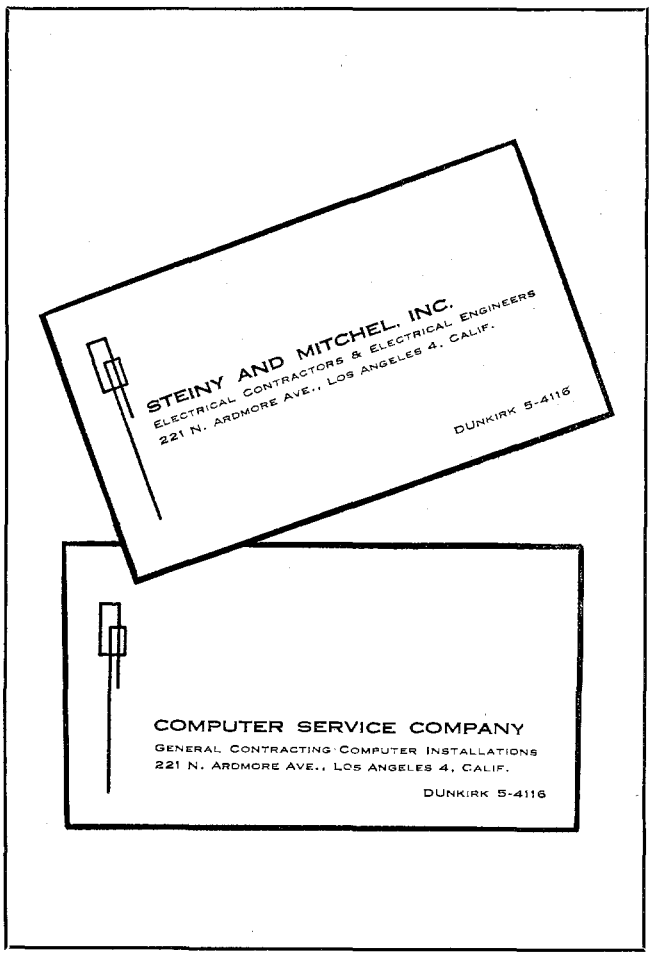
Alumni Development Campaign

A coast-to-coast telephone conversation with alumni by President L. A. DuBridge launched the Caltech alumni campaign in the Institute's $16,100,000 Development Program on October 7. Through a telephonic public address system, Dr. DuBridge talked with alumni meeting in 33 cities and briefed them on their task of reaching a goal of $1,100,000. The alumni campaign has already received over $150,000 in advance gifts, about 13 percent of the ultimate goal.

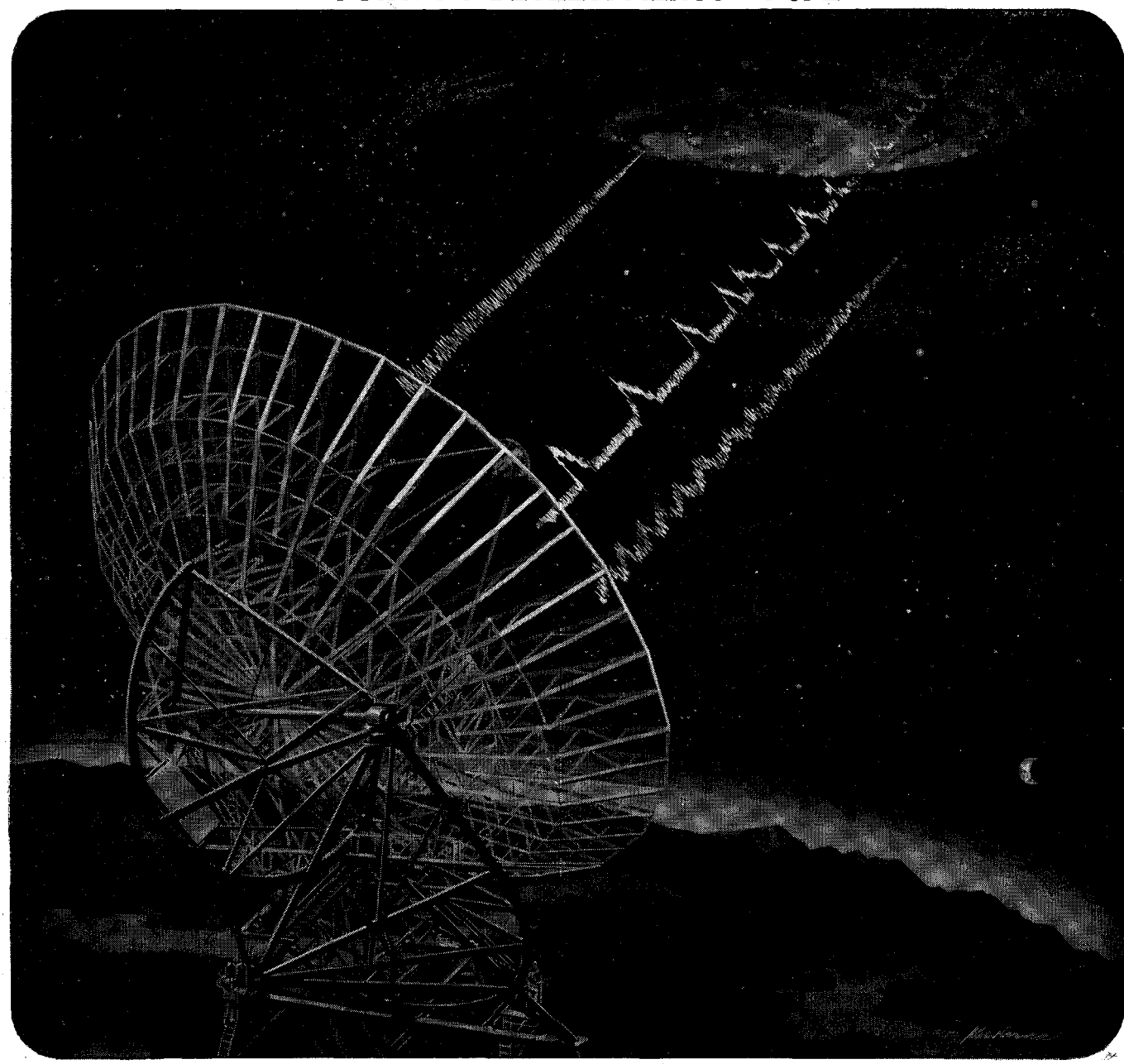
For Your Calendar

The Caltech Student Body will present a Pasadena Jazz Festival on October 18 at the Civic Auditorium, featuring Louis Armstrong and his All Stars, the Firehouse Five Plus Two and singers Jackie Cain and Roy Kral. Tickets are available at any Mutual ticket agency or at the Caltech News Bureau on campus.

The first of a Caltech TV series called "The Next Hundred Years" will be shown on Channel 4 at 6:30 p.m. on Saturday, November 1. The opening show will feature Harrison Brown, professor of geochemistry, who presents "The Story of the Irish Potato."



IMPORTANT DEVELOPMENTS AT JPL



PIONEERS IN EARTH-SPACE COMMUNICATIONS

The exploration of outer space will take a new step forward with the completion of the new giant radio antenna being installed by JPL near Barstow, California. This huge "dish," 85 ft. in diameter, will enable the Laboratory scientists to probe still farther into space problems.

Information thus obtained and combined with lessons still being learned from the successful Army "Explorer" satellites, will provide invaluable basic data for the development of communication systems to serve space exploration programs. Long range communication will begin as a one-way link from space to earth, developing later into tracking and communicating with lunar vehicles at far greater ranges.

This activity will be part of a great research and development program to be operated jointly by JPL and the United States Army Missile Command.

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JOB OPPORTUNITIES NOW OPEN IN THESE FIELDS ▶ SYSTEMS ANALYSIS • INERTIAL GUIDANCE • COMPUTER EQUIPMENT • INSTRUMENTATION • TELEMETERING
FLUID MECHANICS • HEAT TRANSFER • AERODYNAMICS • APPLIED PHYSICS • PROPELLANTS • MATERIALS RESEARCH

Personals

1917

A. R. Kemp, MS '18, is now research associate at the University of Southern California in Los Angeles. He is doing fundamental research in the field of rubber and organic polymers under the auspices of the Tlargi Rubber Technology Foundation. Since leaving Bell Labs in New York in 1948, Archie has been actively engaged in consulting work. For the record: Archie was the first man to get an MS in chemistry at Caltech (which was still Throop in those days).

1918

Eugene H. Imler died of a heart attack on July 30 in Brawley, California. He had been city engineer for the cities of Brawley, Seeley and Westmoreland. Gene was a member of the Alumni Association's board of directors from 1934-36 and served as secretary-treasurer from 1923 to 1924. He is survived by his wife, Hazel.

1922

Robert J. Crissman, general traffic superintendent of the Pacific Telephone and Telegraph Company, died at his home in San Marino after a heart attack on July 7. Bob had been with the telephone company for 36 years. He is survived by his wife, a son and two grandsons.

Hallan N. Marsh and *George N. Ramseyer* (BS '23) are both celebrating their 35th year with the General Petroleum Corporation this year. Hallan is manager of the company's production engineering and equipment section, with headquarters at Vernon. A former director of the Caltech Alumni Association, he has also been national chairman of several petroleum industry committees.

George is manager of operations in the company's marketing department in Los Angeles.

1924

F. Douglas Tellwright has been appointed executive vice president and director of the Pacific Telephone and Telegraph Company in San Francisco. He had been vice president of the public relations department there.

Joseph E. Mayer, professor of chemistry at the University of Chicago's Enrico Fermi Institute for Nuclear Studies, was the winner of this year's Gilbert N. Lewis Award, given by the California Section of the American Chemical Society. He received it for his contributions to statistical mechanics of fluids and solutions, his successful theoretical and experimental investigations of critical

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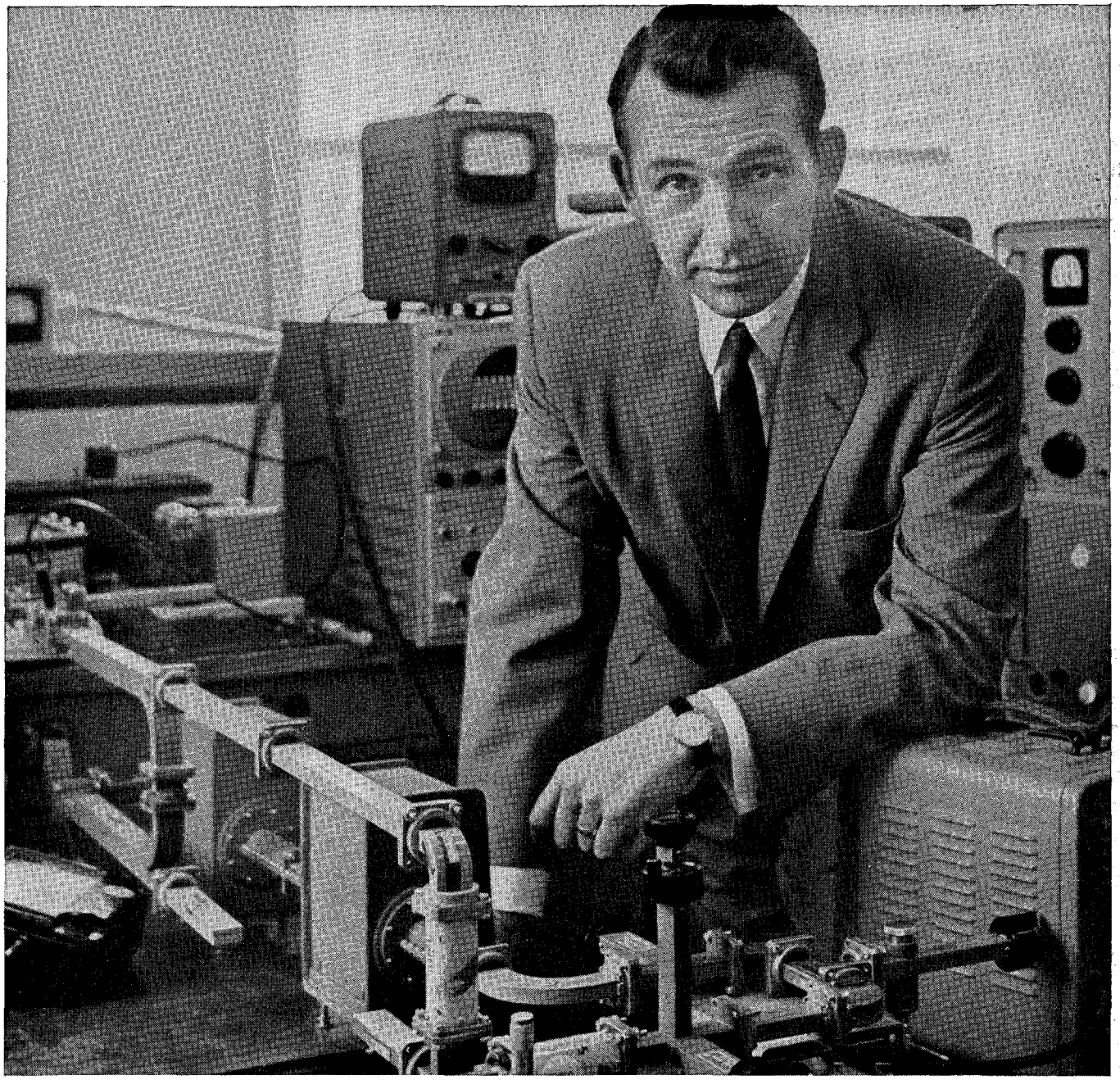


STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

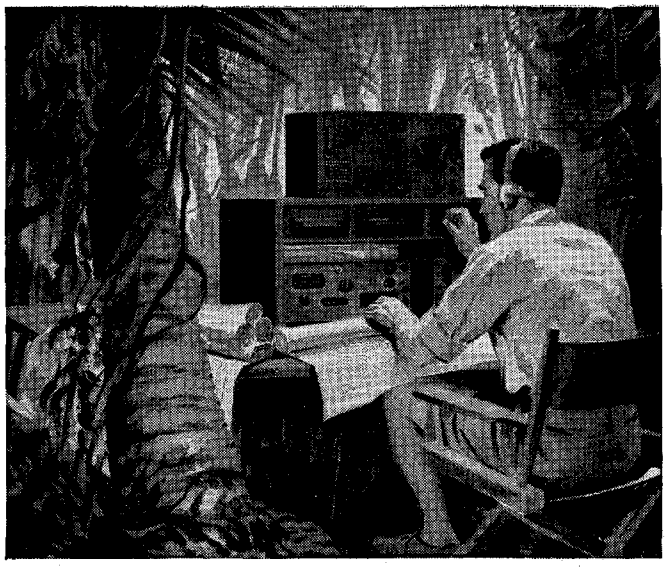
In your field, as most of you well know, it's easy to be complicated . . . it's hard to be simple. At Douglas, I'm happy to say, we do things the "hard" way. This matter of simplicity is vitally important. We work intensive hours, days and months to achieve it.

Why this extra effort? Well, simple things work easier, last longer, are more easily maintained and are lots more reliable. We are rewarded for our greater engineering effort with a product that performs better for our various customers.

We know that good engineers, working in an atmosphere which stimulates them to do their best, have been largely responsible for our success. If you enjoy solving challenging problems in the simplest manner, we'd like to talk with you about joining us.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 6101-F
Santa Monica, California

Specially-compounded coatings and housings enable IRC resistors to withstand a higher degree of impact, shock and vibration than any other resistors of their type.

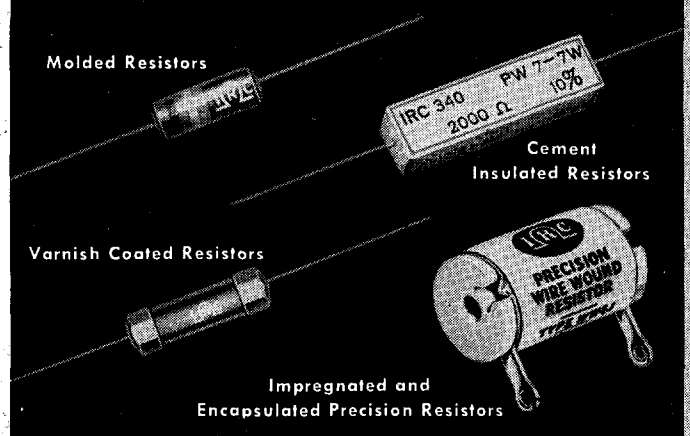


The skillful combination of protective coatings and resistive elements assures superior moisture resistance and heat dissipation, as well as protection from severe humidity or temperature conditions.

Exactly how important are resistor insulations?

In a sense, a resistor is simply a mechanical device for packaging ohms. So it is easy to see why the materials making up the mechanical package greatly determine resistor performance. In fact, insulation is so important that more than one-third of the 200 technicians at IRC are engaged in developing custom-tailored insulating coatings and housings for IRC resistors. That's why every IRC resistor is better protected from damage and ambient conditions than any other of its type. And at no extra cost.

Types of IRC® Insulated Resistors



ENGINEERING POSITIONS

IRC, leader in resistor engineering, offers excellent opportunities in engineering positions covering many professional fields. New developments in electronics, miniaturization and automation constantly present new creative challenges. For information, write today to: ENGINEERING EMPLOYMENT, INTERNATIONAL RESISTANCE COMPANY, 401 N. Broad St., Philadelphia 8, Pa.

INTERNATIONAL RESISTANCE CO.

401 N. Broad St., Philadelphia 8, Pa.

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Wherever the Circuit Says IRC®

phenomena and his work on the theory of electrolytes.

Rolland Thomas writes that he is starting his 29th year as instructor and head of the industrial arts department of the Woodrow Wilson High School in Long Beach. For about 10 years he has also been operating engineer and president of the board of directors of a mutual water company in Garden Grove.

Tommy has a daughter now living in Hayward, California, who is the mother of three children. His oldest son is the production engineer for the reactor unit of the new *U.S.S. Long Beach* and works for the Westinghouse Corporation in Pittsburgh, Pa. He is the father of two children. And Tommy's youngest son is a senior at Long Beach State College, majoring in physics.

1925

William F. Aggeler has been promoted to full professor of French at the University of California in Santa Barbara. He has taught there since 1940. He has also had a book published recently—*Learning French Is Fun,* written in collaboration wtih Mme. Yvonne Bardet of Berkeley.

1926

Theodore C. Coleman, president of the Coleman Engineering Corporation in Torrance, has been elected president and board chairman of the Strategic Industries Association, a national trade group of independent defense producers.

1927

Robert Creveling, staff member of the Sandia Corporation in Albuquerque, New Mexico since 1950, writes that both of his daughters are married now; Letitia in 1953 and Mary Patricia last June.

Alan E. Capon, assistant general manager and chief engineer of the Public Service Department of the City of Burbank, was recently elected chairman of the Burbank Chapter of the American Red Cross and is also serving on the 1958-59 board of directors of the Los Angeles Section of the American Institute of Electrical Engineers. His son, Alan, is taking business administration at the University of California in Berkeley.

1928

Richard G. Folsom, MS '29, PhD '32, was formally installed as president of Rensselaer Polytechnic Institute in Troy, N.Y., early this month. He had been head of the University of Michigan's Engineering Research Institute since 1953.

1930

Franklin M. Murphy, consulting geologist, died of a heart attack on March 10, 1957, in Las Vegas, Nevada. He is survived by his mother, Mrs. Estelle Murphy.

1931

A. Carl Tutschulte is now divisional petroleum engineer for the Tidewater Oil Company's western division, with headquarters in San Francisco. Carl has been with Tidewater since 1936.

1933

G. Merrill Berkley, owner of the Berkley Engineers and Equipment Company in Los Angeles, with a home office in Honolulu, spent some time in Europe during the summer on business. He visited Brussels, Paris, Geneva, Zurich, Frankfurt and Copenhagen.

John S. Warfel, manager of the Avionics Division of Aerojet-General in Azusa, was elected a vice president of Avionics in July. This branch of the company is one of the largest infrared research and development activities in the country. John has been with Aerojet since 1946.

1934

John T. Cortelyou, standards engineer for the Southern California Gas Company, writes that his daughter, Dorothy, was married on August 23 in Inglewood. Jack thinks he is probably the first member of the class of '34 to have a married child.

James W. McRae, MS, PhD '37, is now a vice president of the American Telephone and Telegraph Company. He had been vice president of the Western Electric Company and president of the Sandia Corporation, a western subsidiary. He will now serve as coordinator of defense activities for the Bell System.

1935

Alfred Romer, PhD, was promoted to the rank of professor of physics at St. Lawrence University in Canton, New York, this summer. He has been at the university since 1946.

Alan Beerbower, chemical engineer at Esso Standard Oil's Baltimore refinery, has rejoined the staff of Esso Research and Engineering in Linden, N.J. He is continuing research on lubricants and applications of radio isotopes—as he has been doing for various sections of Esso for the past 22 years.

He writes that he will be vice chairman of the Process and Industries Sec-

tion of the Nuclear Engineering and Science Congress next April—and that he has just received his 23rd patent and had his 6th article published. His daughter, Marjory, attends Goucher College in Baltimore.

1937

Walter H. Albach, MS, died of a heart attack on October 15, 1956, according to a recent note from his widow. Walt was a lecturer at the University of Southern California in Los Angeles.

John R. Austen is now assistant superintendent of the compressor division of Ingersoll-Rand in Phillipsburg, Pa. He had formerly been superintendent of the forge division. The Austens, who live in Palmer Township, have two sons—John, 13, and Stephen, 11.

Martin J. Poggi writes that "this year I started my own business as a manufacturer's representative, covering Washington, Oregon and Alaska. I represent five companies and am concentrating on products used in the aircraft, guided missile and nuclear industries in these areas. We built a home in Bellevue on the Lake Washington waterfront last year and hope to stay permanently now."

1938

Saul Winstein, PhD, professor of chemistry at UCLA, presented the annual Edward Mack, Jr., Memorial Lecture at Ohio State University last summer. The lecture is sponsored by the Ohio State chemistry department and by Phi Lambda Upsilon.

Charles F. Robinson, MS, PhD '49, has been appointed chief research physicist at Consolidated Electrodynamics Corporation in Pasadena. He has been with CEC since 1947.

Duane W. Farnham, MS, has moved from Tulsa to the New York offices of Pan American International as operating superintendent in the company's production department. His work in Tulsa had been associated with exploration, drilling and production activities of the company's subsidiaries operating in the Caribbean area.

Frederic H. Moore, senior project engineer at The Texas Company in Wilmington, California, was recently installed as governor of Toastmasters International District 51 for 1958-59. This district comprises the southeastern section of L.A. County from Redondo Beach to Seal Beach and Fred has 40 clubs under his supervision and the assistance of seven area governors.

1939

Andrew A. Fejer, MS, PhD '45, is now director of the department of mechanical engineering at the Illinois Institute of Technology in Chicago. He had been at the University of Toledo, as professor of aeronautical engineering, since 1949. He is also a member of the research division of the Curtiss-Wright Corporation. Andy used to work as a research engineer in Caltech's JPL, and he was also a member of the committee responsible for the design and construction of the Southern California Cooperative Wind Tunnel.

1940

G. R. Brown, division petroleum engineer for The Texas Company in Fort Worth, has been transferred to New York as staff petroleum engineer to the vice president of domestic production. His wife and their son, Reynolds, will join him in their new home in New Canaan, Conn.

1941

James T. Harlan, Jr., senior technologist at the Shell Chemical Corporation in Torrance, writes: "My family (3 children and 1 wife) are glad to be back in Southern California again after a long absence. In recent years I have been studying various aspects of the nuclear field for my employer—a very challenging assignment—and am now engrossed in work chiefly in the field of radiation chemistry research. One particularly interesting experience was a one-year association with AEC's Argonne National Laboratory. Part of the time was spent with an international group representing some 30 different countries—quite an effective way to gain an international viewpoint."

1942

George P. Sutton, manager of the advance design section at Rocketdyne in Canoga Park, has been named Hunsaker Professor of Aeronautical Engineering at MIT for 1958-59. He is the first man from industry to be selected for the endowed visiting professorship and will conduct a course on rocket engine propulsion at MIT and will also engage in research on the design and development of rocket engines. During the year he will deliver the Minta Martin lecture to scientific audiences throughout the nation.

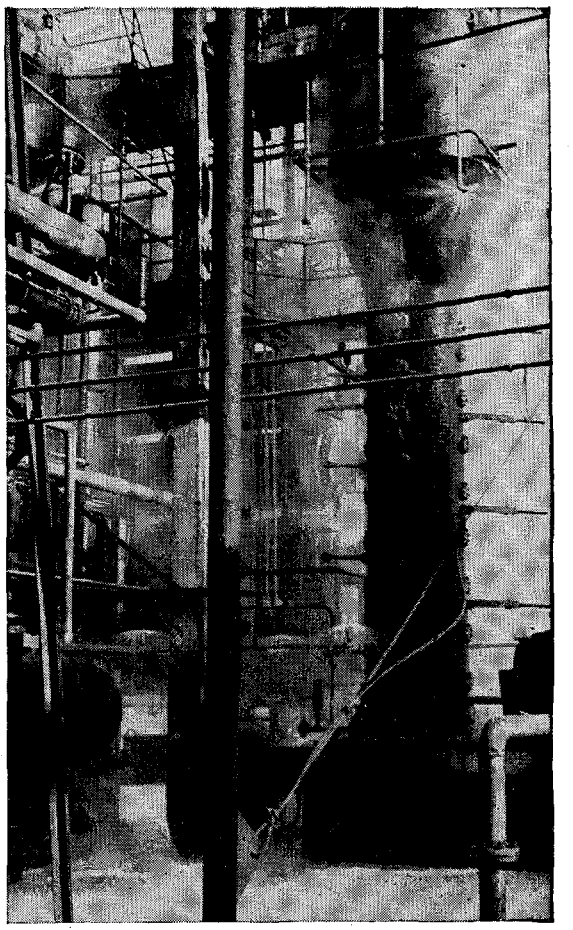
George joined North American Aviation in 1946 and has been active on all phases of the Navaho, Redstone, Thor, Jupiter and Atlas engine development work conducted at the company's Rocketdyne division. His wife and two daughters, Christine, 13, and Marilyn, 11, are moving with him to Boston.

1943

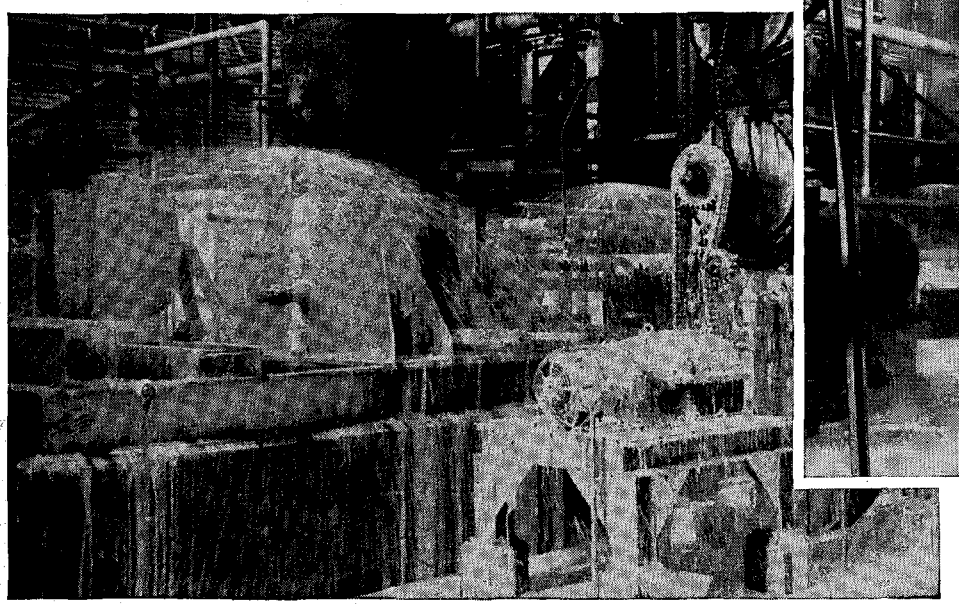
David M. Mason, MS '47, PhD '49, has been promoted to full professor of chemi-

continued on page 56

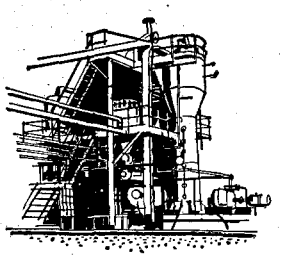
Tough Fire Protection Problem Solved by GRINNELL



▲ Grinnell ProtectoSpray on upper part of unit cools equipment and washes burning oil and solvent into area protected by foam blanket below.



▲ Grinnell ProtectoFoam safeguards the lower section of hexane solvent extraction unit with a blanket of foam, to prevent formation of explosive mixtures.



At Canadian Vegetable Oil Processing Ltd., Hamilton, Ontario, hexane solvent is used in extracting vegetable oil from soybeans. Because of the highly flammable nature of the solvent, Grinnell designed a special system for this unit, consisting of 162 ProtectoSpray nozzles — to drench the superstructure with fine water spray; and 24 ProtectoFoam spray heads — to blanket the diked area with foam. This water-foam combination protects the lives of personnel, as well as shielding equipment from costly damage.

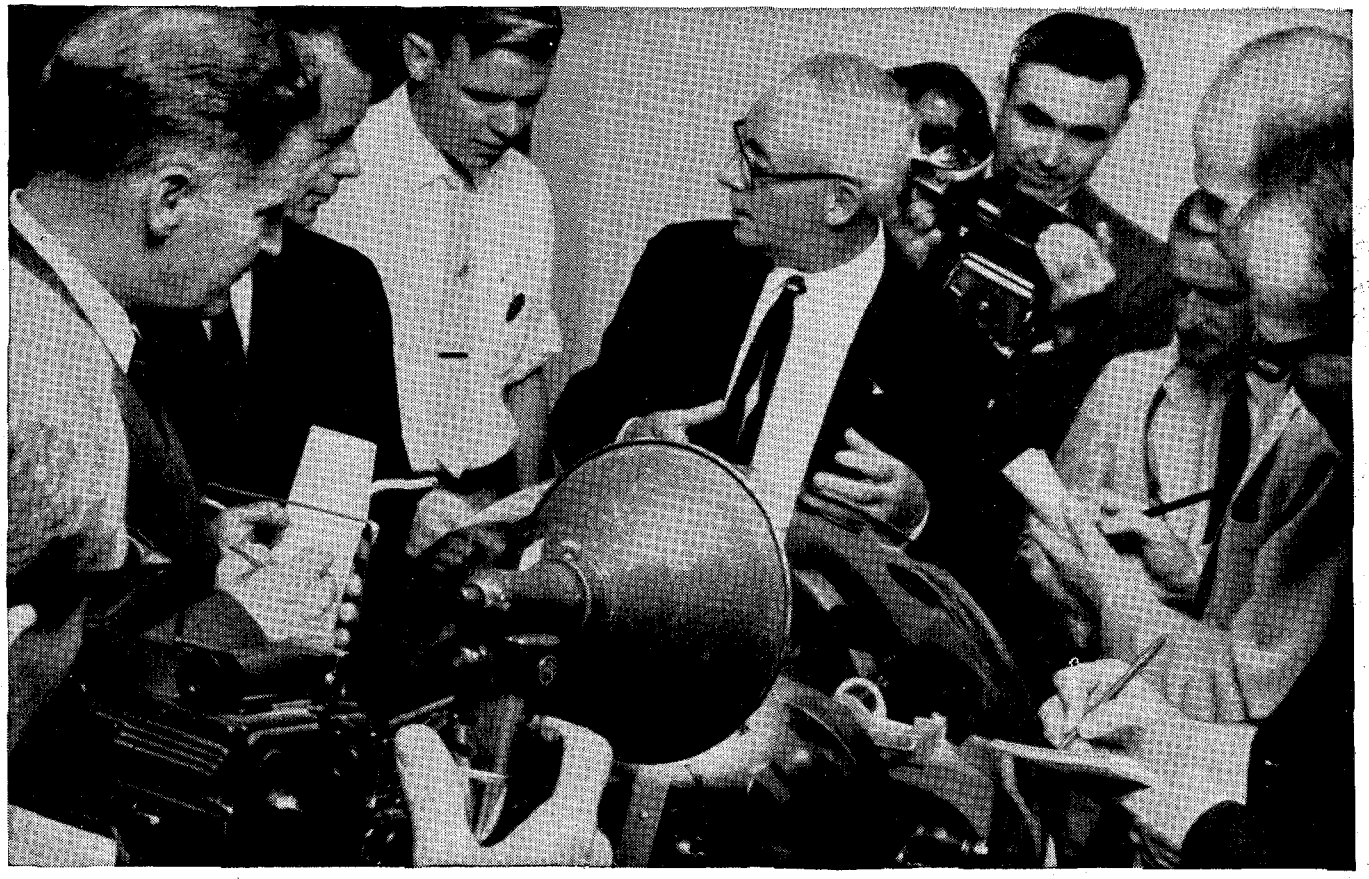
Solving tough fire problems like this with installations engineered to the hazard, tailored to the need, built of highest quality materials is something Grinnell has been doing successfully for more than 85 years.

Grinnell Fire Protection Systems include:

- Automatic spray sprinklers — wet pipe, dry pipe, Simplex, and deluge systems
- Emulsion and vapor dilution extinguishment with water sprays — Mulsifyre and ProtectoSpray systems
- Cooling, insulation and controlled burning with water sprays — ProtectoSpray systems
- Mechanical foam blanket — ProtectoFoam systems
- Carbon dioxide systems
- Dry chemical systems

Manufacturing, Engineering and Installation of Fire Protection Systems since 1870

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL



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Pioneers in celestial and inertial guidance. At Hawthorne: exploring infrared applications, airborne digital computers and interplanetary navigation. At Anaheim: developing ground support, optical and electro-mechanical equipment, and data processing devices.

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or: 500 East Orangethorpe Ave., Anaheim, Calif.

NORTHROP DIVISION

Creators of the USAF Snark SM-62, now operational with SAC. Currently active in programs for the ballistic recovery of orbiting man; readying the USAF-Northrop T-38 supersonic twin-jet trainer and the Northrop N-156F counterair fighter for flight tests.

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Creator of the world's first drone family; has produced and delivered tens of thousands of drones for all the U.S. Armed Forces. Now developing ultra-advanced target drone systems for weapon evaluation, surveillance drone systems, and guided missile systems.

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...NEWS IS HAPPENING AT NORTHROP

NORTHROP AIRCRAFT, INC., Beverly Hills, California

Personals . . . *continued*

cal engineering at Stanford University. From 1949 to 1955 he was an instructor and later a research group supervisor at JPL.

1944

Jay R. Borden, MS '47, is now senior instrumentation engineer of Waste King Corporation's Technical Products Division in Los Angeles. He was formerly chief engineer at the Clary Dynamics Corporation in San Gabriel, and before that was senior development engineer at JPL. The Bordens live in Pasadena and have two children—Thomas, 7, and Patricia, 5.

1946

William N. Lipscomb, Jr., PhD, head of the division of physical chemistry at the University of Minnesota, received the 14th annual Harrison Howe Award from the American Chemical Society's Rochester Section. The award, which consists of a citation and a $500 cash prize, is given annually to recognize achievement in chemistry and to promote discussion of problems likely to be important in the future of chemistry. The first award, made in 1946, went to *Linus Pauling,* PhD '25, Caltech professor of chemistry.

John W. Sease, PhD, received a promotion to full professor of chemistry this summer at Wesleyan University in Middletown, Conn. Now studying at UCLA under a National Science Foundation Fellowship, John was a research assistant with the National Defense Research Council before joining the Wesleyan faculty in 1946.

Earnest H. Clark, MS '47, has been appointed vice president and assistant general manager of Baker Oil Tools, Inc., in Los Angeles. He has been with the company for 11 years, serving most recently as head of new product research.

1947

Richard C. Gerke, MS, contracting engineer at the Bethlehem Pacific Coast Steel Corporation in Los Angeles, announced the arrival of the fifth addition to the family last spring—a second son, Carl Alexander.

George B. Melrose, Jr., MS, chief of aeromechanics with the space flight and missiles division of the Bell Aircraft Corporation in Buffalo, N.Y., has been appointed president of the Technical Societies Council of the Niagara Frontier—comprised of the local chapters of 40 national professional societies with a total membership of about 8,000. He has also been elected to the advisory board of the Institute of the Aeronautical Sciences. The Melroses, who live in Kenmore, have two children—Mark, 5, and Diane, 2.

1950

Vern Allan Edwards, process engineer at Fibreboard Paper Products, Inc., in Los Angeles, reports that two-year-old Jeanne now has a sister, Amy, born on June 27.

Edsel A. Worrell writes that "I am a senior engineer for Westinghouse Electronics Division in Baltimore, Md., and my major duties consist of mathematical analysis of electronic systems, mostly radar. Since coming to Baltimore in 1953 I have acquired a wife, Louise, (in April, 1955) and 2-year-old Frank Henry. Currently we are buying a house and will move early in the fall."

1951

Leo L. Baggerly, MS '52, PhD '56, formerly senior research engineer at JPL, has been granted an award under the State Department's international educational exchange program to enable him to serve as a visiting professor in mathematical physics at the University of Ceylon in Colombo. He has been serving at the University of Ceylon for the past year on a Fulbright Lectureship.

1952

Randolph G. Moore received his MS in electrical engineering from the University of Arizona in Tucson last May.

Robert E. Stanaway is now manager of the spectron department of the transducer division of the Consolidated Electrodynamics Corporation in Pasadena. Spectron designs, develops and manufactures precision optical assemblies and components for geophysical, industrial and aeronautical needs of companies in the instrumentation field. Bob has been with the company since 1956 and was formerly a development project engineer.

Michel Bader, PhD '55, writes that he and his wife have infectious cases of inflated ego—the probable cause being a new daughter, Annette, born in August. Michel is an aeronautical research engineer at the National Advisory Committee for Aeronautics at Moffett Field, California.

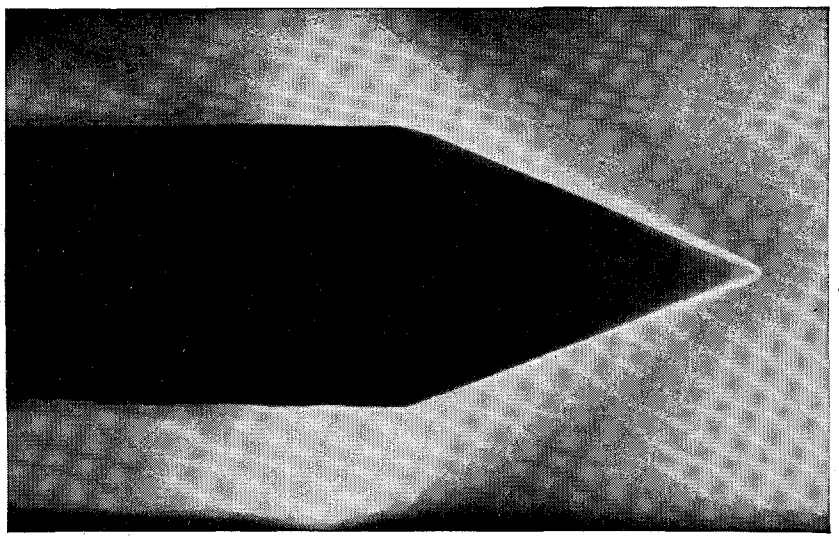
Robert W. Zwanzig, PhD, has joined the staff of the National Bureau of Standards and will be working on the Bureau's free radical research program. Prior to this appointment, he was assistant professor of chemistry at Johns Hopkins University.

1953

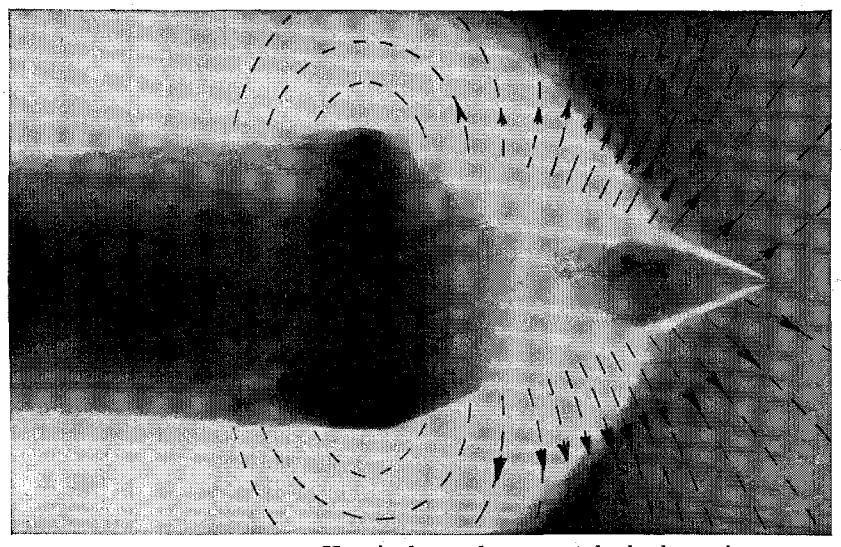
George W. Sutton, MS, PhD '55, research engineer in aerophysics at General Electric's Aerosciences Laboratory in Philadelphia, is currently working on projects associated with outer space conditions and space flight, undertaken by

continued on page 60

NEW LIGHT ON MHD*



NO MAGNETIC FIELD. This shock tube photograph, taken by emitted light only, shows the typical shock wave configuration formed by high-velocity gas flowing around a pointed cone.



WITH MAGNETIC FIELD. Here is shown the magnetohydrodynamic displacement of the shock wave. The magnetic field is caused by electric current flowing through a coil of wire within the cone. This experiment qualitatively demonstrates the interaction of a high-temperature gas with a magnetic field. This effect would be expected to produce drag and reduce heat transfer to the body.

Avco RESEARCH LABORATORY

A Division of Avco Manufacturing Corporation/Everett, Mass.

The Avco Research Laboratory was founded a little more than three years ago for the purpose of examining high-temperature gas problems associated with ICBM re-entry. The success of this research led to the birth of a new corporate enterprise, Avco's Research and Advanced Development Division.

The Research Laboratory, now established as a separate Avco division, has expanded to embrace all aspects of physical gas dynamics. We are currently gravid with several embryonic projects which we anticipate will likewise grow into new corporate enterprises. Our work in the physics, aerodynamics and chemistry of high-temperature gases is growing in the following areas:

Magnetohydrodynamics—
Flight and industrial power-generation applications

Space flight—
Manned satellites
Electromagnetic propulsion

These developments have created a number of openings for physicists, aerodynamicists and physical chemists. If your background qualifies you to work in any of these areas, we would be pleased to hear from you.

Arthur Kantrowitz

Dr. Arthur Kantrowitz, Director
Avco Research Laboratory

P. S. A listing of laboratory research reports indicative of the scope and depth of our activities is available. Address your request: *Attention: Librarian, Avco Research Laboratory, 2385 Revere Beach Parkway, Everett, Massachusetts.*

***Magnetohydrodynamics,** the study of the dynamics of electrically conducting fluids interacting with magnetic fields.

Other divisions and subsidiaries are:

AK Division
Crosley Division
Ezee Flow Division
Lycoming Division
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Moffats Limited
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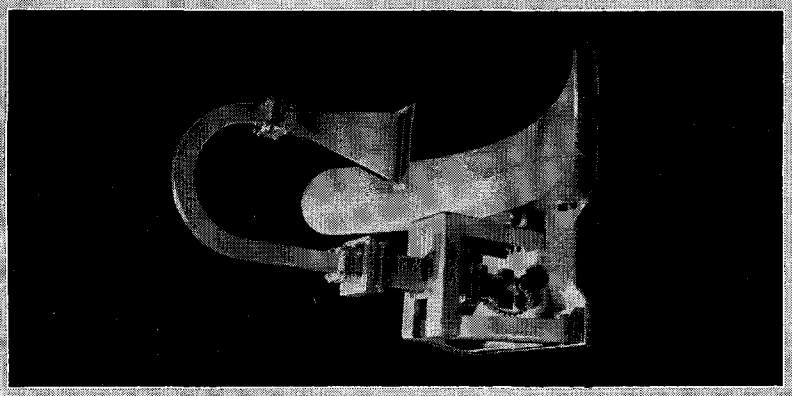
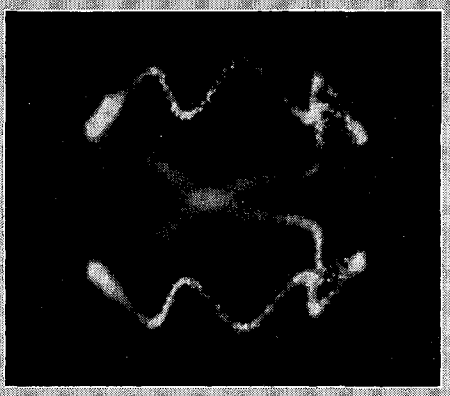
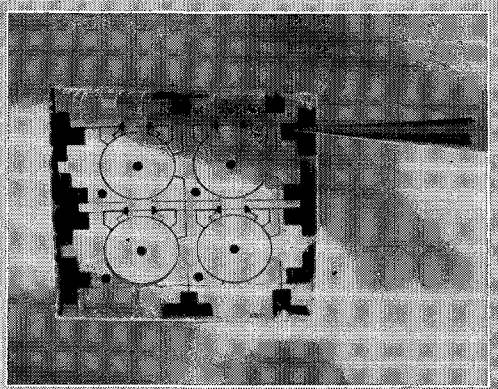


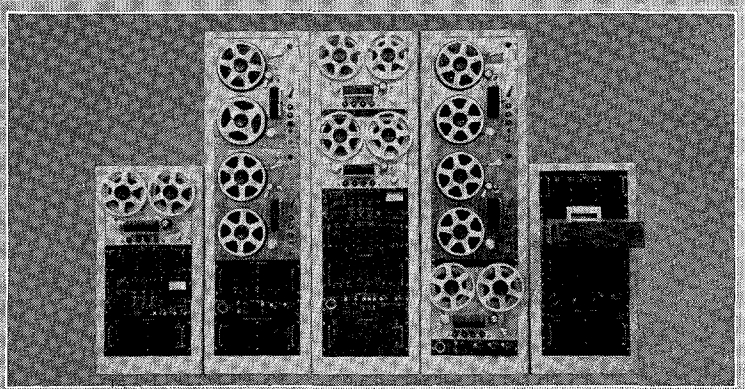
Horn fed parabolic reflector antenna for airborne applications.



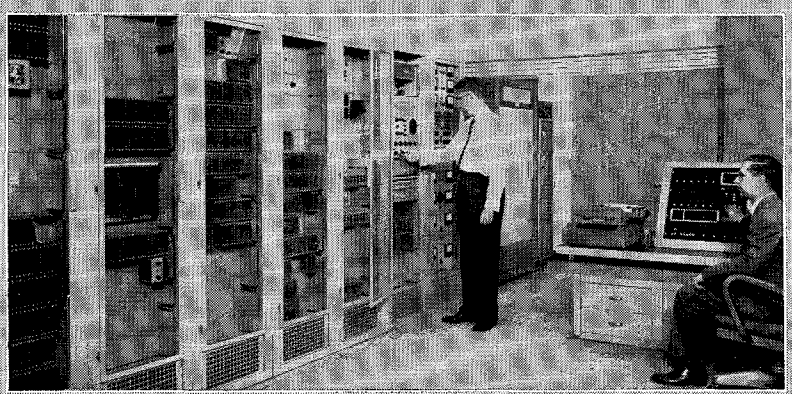
Charged aluminum particle suspended and controlled in a vacuum chamber by an oscillating electric field.



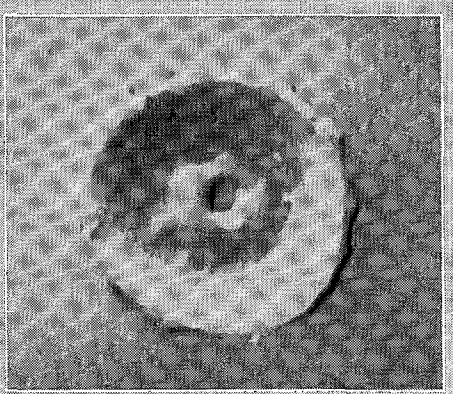
The Persistor gives promise of cryogenic computer memories with a capacity of 1,000,000 bits per cubic foot and access times of 1/30 microsecond.



Ground based data handling equipment for processing analog and digital reconnaissance information.



Data conversion system for digitizing and processing telemetered missile test data.



Electron micrograph of impact produced on aluminum coated glass by a 1 micron diameter particle traveling at 7,000 feet per second.

Pictorial **PROGRESS REPORT**

The photographs above illustrate some of the recent research, development, and manufacturing activities at Ramo-Wooldridge. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields:

- Digital Computers and Control Systems
- Communications and Navigation Systems
- Guided Missile Research and Development
- Infrared Systems
- Electronic Countermeasures
- Electronic Instrumentation and Test Equipment
- Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

LOS ANGELES 45, CALIFORNIA

the company's missile and ordnance systems department. The most recent research has been directed toward the design and development of a nose cone for the Air Force's Atlas and Thor ballistic missiles. The Suttons and their two children live in Ambler, Pa.

1955

Armin D. Kaiser, PhD, has received a promotion to assistant professor of microbiology at Washington University in St. Louis, Mo.

Stephen L. Stamm, MS, was graduated from the General Electric Company's advanced engineering program in June. The program was established more than 30 years ago to make advanced study in applied physics and mathematics available to young engineers of exceptional promise. Steve joined the company in 1955.

Allen E. Fuhs, MS, is now an assistant professor of mechanical engineering at Northwestern University in Evanston, Ill. He was formerly a lecturer at Caltech's Jet Propulsion Laboratory.

Vincenzo M. Cestari, BS '55, MS '55, writes that he is still working for Consolidated Electrodynamics in Pasadena as a development engineer. "I have been here for the past two years," Vincenzo writes, "and have worked in many projects, all related to D.C. amplifiers of high sensitivity and stability. In August I start on a leave of absence of two years to study at the Harvard Business School. If all goes well, I will have an MBA in 1960."

1957

Thomas C. Hays, MS '58, writes that "after receiving my MS in electrical engineering in June, I married the former Mary Ann Jergens of Los Angeles. I am now serving with the Air Force as a 2nd Lt. at the Wright Air Development Center at Wright-Patterson AFB in Ohio."

Victor Evtuhov, MS, is one of ten outstanding postgraduate students who will attend Caltech this semester under Howard Hughes Fellowships in Science and Engineering. Three other Caltech alumni will be here as Hughes Fellows: *John P. Andelin,* '55; *Donald C. Forster,* MS '57; and *John J. Merrill,* '55, MS '56.

Edwin X. Berry, student in the education department of Sacramento State College, announced the arrival of a son, Kim, on July 21.

1958

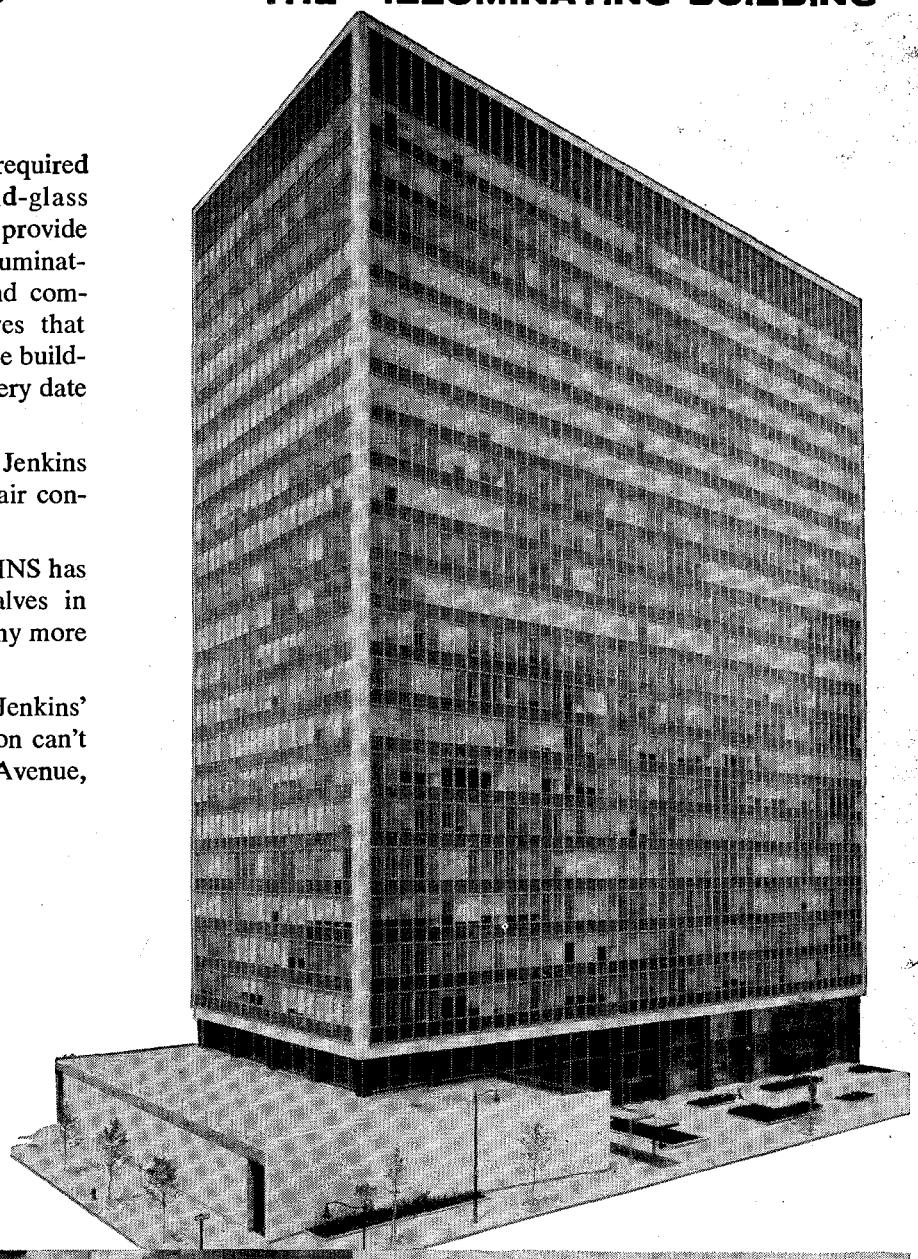
Donald B. Chesnut, PhD, is now on the research staff of Du Pont's Central Research Department as a physical chemist at the Experimental Station near Wilmington, Del.

Anthony Demetriades, PhD, research fellow in aeronautics at Caltech, now has a son, Anthony, born in August.

New Beauty on Cleveland's Skyline

Got lifetime service valves and got them fast by choosing JENKINS

THE ILLUMINATING BUILDING



More than top quality in valves was required for this $17,000,000 aluminum-and-glass building, completed in April 1958 to provide offices for the Cleveland Electric Illuminating Company and other industrial and commercial tenants. In addition to valves that would last for the building's lifetime, the builders sought assurance that a close delivery date would be met.

Both were assured by the choice of Jenkins Valves for all plumbing, heating and air conditioning lines.

For almost a century the name JENKINS has meant enduring quality. Jenkins Valves in service for fifty years and good for many more are often reported.

And, when valves are needed quickly, Jenkins' efficient, national system of distribution can't be surpassed. Jenkins Bros., 100 Park Avenue, New York 17.

Architects:
Carson and Lundin, New York

Consulting Engineers:
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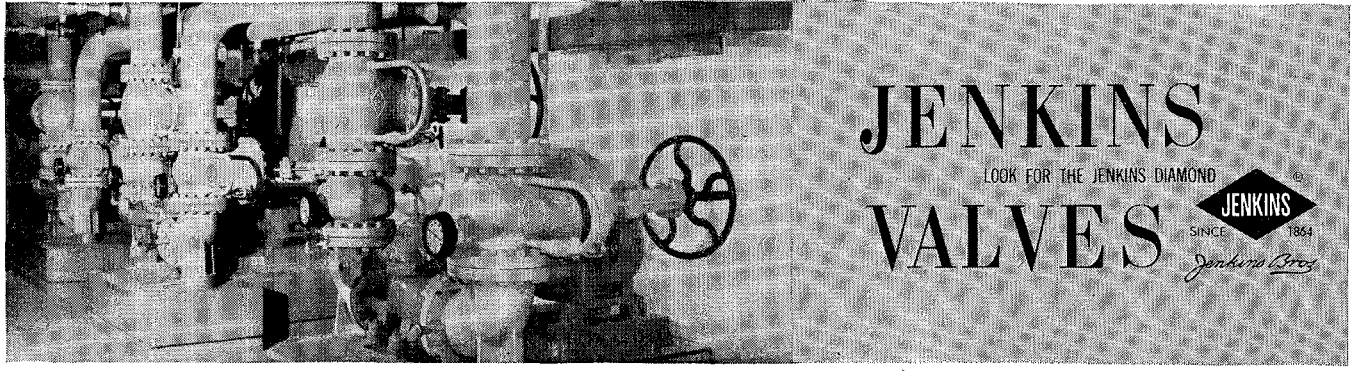
General Contractor:
George A. Fuller Company, New York

Heating-Air Conditioning Contractors:
Kerby Saunders Company, New York;
Feldman Brothers Company, Cleveland

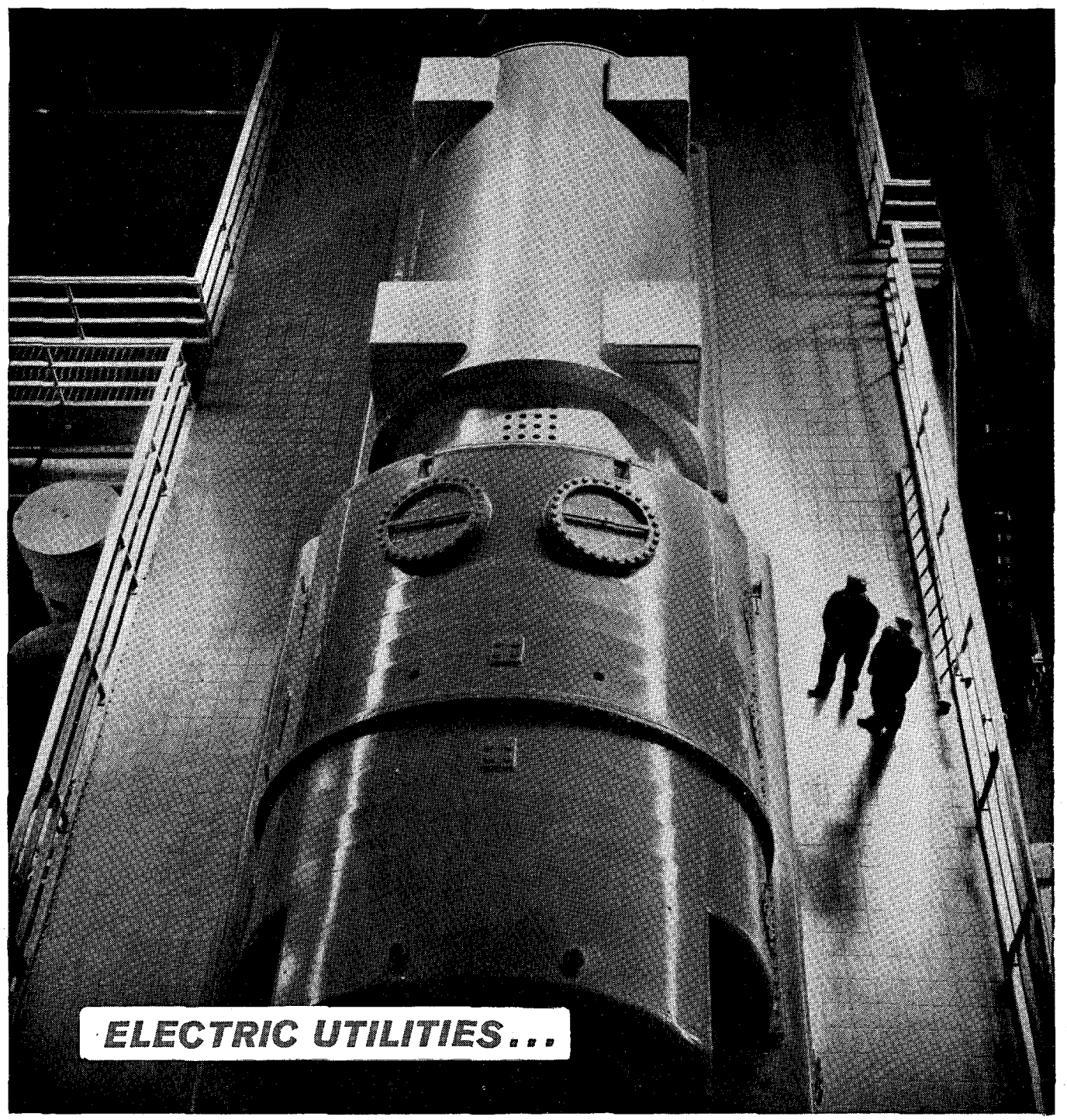
Plumbing Contractors:
Kerby Saunders Company, New York;
Gorman Lavelle Plumbing-Heating Co., Cleveland

Managing Agents:
Ostendorf-Morris Company, Cleveland



Typical of more than 4,000 Jenkins Valves of bronze, iron and cast steel serving this building owned by the 55 Public Square Corp., Cleveland.

Sold Through Leading Distributors Everywhere



Where the Engineer Designs His Own Career

Here's an industry that started big after the war . . . surged ahead in every direction . . . keeps on growing today when others are tapering off . . . and still has its biggest years ahead. The electric utilities business is basically an engineering business. Many of its top executives come from engineering ranks; from systems planning, design, operations, research, or sales; and with backgrounds ranging from electronics and nucleonics to older branches of scientific learning. If you want a career in an *expanding* industry that is based on engineering look to our electric public utilities. We know you'll like working with them. We have been doing it for many years in supplying this great industry with Kerite quality insulated wire and cable. See your placement officer, or write us at 30 Church Street, New York 7, N. Y.

KERITE CABLE

it's the **KERITE** *that makes the difference*

TALENT PROSPERS AT BENDIX

Talent prospers at Bendix. And proof of this is the vast number of Bendix engineers filling positions of executive responsibility in the world's largest and most diversified creative engineering and manufacturing company. Many are men who only a few years back faced the same problems and decisions now confronting you as a graduate engineer.

Bendix—producer of more than a thousand products for many basic industries—operates twenty-four separate manufacturing divisions; nine of them created or acquired since 1950. All are staffed by key men from within the company.

At Bendix you will enjoy the advantages of being with a big company, plus the opportunities for self-development and personal recognition inherent in small companies.

Bendix needs young men of talent —graduate engineers wanting to build solid careers with a solidly established, growing organization offering challenging tasks, opportunities for self-advancement, good compensation and a liberal program of personal benefits.

Bendix has special need for graduate engineers in these and related fields: Electronics, Electromechanics, Ultrasonics, Systems Analysis, Computers, Automation and Controls, Nucleonics, Hydraulics, Aerophysics, Instrumentation, Solid State Physics, Combustion, Heat Transfer, Propulsion, Metallurgy, Communications, Carburetion, Ignition, Radar, Sonar, Structures.

See your placement director or write to Dr. Gerald A. Rosselot, Director of University and Scientific Relations, Bendix Aviation Corporation, Fisher Building, Detroit 2, Mich.

A thousand products **Bendix** AVIATION CORPORATION Fisher Bldg., Detroit 2, Mich. *a million ideas*

ALUMNI EVENTS

October 16	Fall Dinner Meeting
November 14	Homecoming Game and Dance
January 15	Winter Dinner Meeting
March 7	Annual Dinner Dance
April 11	Annual Seminar
June 10	Annual Meeting
June 27	Annual Picnic

ATHLETIC SCHEDULE

WATER POLO

October 10
Caltech at Santa Barbara

October 11
Caltech Alumni at Caltech

October 14
L.A. State at Caltech

October 17
Whittier at Caltech

October 21
Caltech at Long Beach State

October 24
Caltech at Pomona

October 28
Claremont-Harvey Mudd at Caltech

October 31
Caltech at Occidental

FOOTBALL

October 10
Redlands at Rose Bowl

October 17
Pomona at Rose Bowl

October 25
Caltech at U.C., Riverside

November 1
Caltech at Whittier

November 8
Cal Western at Caltech

ALUMNI ASSOCIATION
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

BALANCE SHEET — As of June 30, 1958

ASSETS		
Cash in Bank		$ 452.91
Postage Deposit		38.20
Accounts Receivable		6.10
Investments:		
Share in Consolidated Endowment Asset Portfolio of C.I.T. 6-30-58	$53,870.45	
Share in Savings Accounts	13,972.79	
Total Investment		67,843.24
Furniture & Fixtures (at nominal amount)		1.00
Total Assets		$68,341.45
LIABILITIES		
Accounts Payable	$ 290.91	
1958-59 Membership Dues Paid in Advance	6,979.00	
Total Liabilities		$ 7,269.91
RESERVES		
Life Membership Reserves:		
Fully paid life memberships	$51,700.00	
Total Reserves		$51,700.00
SURPLUS		
Surplus, June 30, 1958	$ 8,005.46	
Provisions for Supplement to Directory	1,366.08	9,371.54
Total Liabilities, Life Memberships, Reserves, and Surplus		$68,341.45

STATEMENT OF INCOME
For the Year Ended June 30, 1958

INCOME		
Dues		$12,407.53
Less: Subscriptions to Engineering and Science Monthly for Annual Members		7,755.00
Net Income from Dues		$ 4,652.53
Income from Consolidated Endowment Asset Portfolio of C.I.T.	$ 2,358.32	
Investment Interest Income	472.69	2,831.01
Program and Social Functions:		
Income	$ 4,263.11	
Expense	4,227.81	35.30
Annual Seminar:		
Income	$ 4,407.00	
Expense	4,002.67	404.33
Sundry Income		41.14
Net Receipts		$ 7,964.31
EXPENSES		
Engineering and Science Subscriptions—Life Members		$ 1,727.50
Administration:		
Directors' Expense	$ 173.90	
Postage & Miscellaneous	1,043.43	
Supplies & Printing	1,070.65	
Total Administration Costs		$ 2,287.98
Alumni Membership Solicitation		370.20
Fund Solicitation		1,000.00
Program Committee		11.14
Total Expenses		$ 5,396.82
Net Income		2,567.49
Less: Directory & Supplement Appropriation		1,500.00
Net Income to Surplus		1,067.49

AUDITOR'S REPORT

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

I have examined the Balance Sheet of the Alumni Association, California Institute of Technology as of June 30, 1958, and the related Statement of Income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

In my opinion, the accompanying Balance Sheet and Statement of Income present fairly the financial position of the Alumni Association, California Institute of Technology at June 30, 1958, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

September 9, 1958

DALE J. STEPHENS, Public Accountant
3491 Cahuenga Blvd., Los Angeles 28, Calif.

PHOTOGRAPHY AT WORK—No. 34 in a Kodak Series

"Tree Rubber" made in U.S.A. for tires of tomorrow

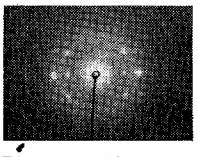
Photography and x-rays pointed the way for Goodrich-Gulf Chemicals Inc. to achieve a synthetic that matches natural rubber.

Heavy-duty truck and airplane tires always had to have tree rubber to assure acceptable performance. Usual man-made rubber didn't quite fill the bill. Its molecules didn't hang together like natural rubber.

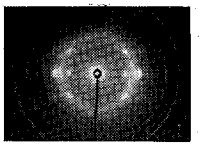
But now Goodrich-Gulf scientists, using x-ray diffraction photographs to check molecular structure, have produced Ameripol SN, a man-made rubber with the same physical properties as crude rubber even to tack and stickiness. It's an achievement that can mean a source of supply for the nation's new-rubber needs.

Playing a part in research like this is only one of the many ways photography is working for business and industry today. In addition, it also delves into problems of product design, production, and quality control. It trains employees, dealers and salesmen—does a selling job right to the consumer.

Photography is saving time and cutting costs for all kinds of businesses, large and small alike. It works for you in whatever occupation you choose.



Photographic negative showing the x-ray diffraction pattern produced by a molecule of natural, tree-grown rubber.



The x-ray diffraction pattern of a molecule of Ameripol SN rubber shows the scientist that this rubber is identical to natural rubber.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Kodak
TRADE MARK

One of a series*

Interview with General Electric's Earl G. Abbott Manager—Sales Training

Advancement in a Large Company: How it Works

Where do you find better advancement opportunities—in a large company or a small one? To help you, the college student, resolve that problem, Mr. Abbott answers the following questions concerning advancement opportunities in engineering, manufacturing and technical marketing at General Electric.

Q. In a large Company such as General Electric, how can you assure that every man deserving of recognition will get it? Don't some capable people become lost?

A. No, they don't. And it's because of the way G.E. has been organized. By decentralizing into more than a hundred smaller operating departments, we've been able to pinpoint both authority and responsibility. Our products are engineered, manufactured and marketed by many departments comparable to small companies. Since each is completely responsible for its success and profitability, each individual within the department has a defined share of that responsibility. Therefore, outstanding performance is readily recognized.

Q. If that's the case, are opportunities for advancement limited to openings within the department?

A. Not at all. That's one of the advantages of our decentralized organization. It creates small operations that individuals can "get their arms around", and still reserves and enhances the inherent advantages of a large company. Widely diverse opportunities and promotions are available on a Company-wide basis.

Q. But how does a department find the best man, Company-wide?

A. We've developed personnel registers to assure that the best qualified men for the job are not overlooked. The registers contain complete appraisals of professional employees. They enable a manager to make a thorough and objective search of the entire General Electric Company and come up with the man best qualified for the job.

Q. How do advancement opportunities for technical graduates stack-up with those of other graduates?

A. Very well. General Electric is recognized as a Company with outstanding technical skills and facilities. One out of every thirteen employees is a scientist or engineer. And approximately 50 per cent of our Department General Managers have technical backgrounds.

Q. How about speed of advancement? Is G.E. a "young man's Company"?

A. Definitely. A majority of all supervisors, managers and outstanding individual contributors working in the engineering function are below the age of forty. We believe that a job should be one for which you are qualified, but above all it should be one that challenges your ability. As you master one job we feel that consideration should be given to moving you to a position of greater responsibility. This is working, for in the professional field, one out of four of our people are in positions of greater responsibility today than they were a year ago.

Q. Some men want to remain in a specialized technical job rather than go into managerial work. How does this affect their advancement?

A. At G.E. there are many paths which lead to higher positions of recognition and prestige. Every man is essentially free to select the course which best fits both his abilities and interests. Furthermore, he may modify that course if his interests change as his career progresses. Along any of these paths he may advance within the Company to very high levels of recognition and salary.

Q. What aids to advancement does General Electric provide?

A. We believe that it's just sound business policy to provide a stimulating climate for personal development. As the individual develops, through his own efforts, the Company benefits from his contributions. General Electric has done much to provide the right kind of opportunity for its employees. Outstanding college graduates are given graduate study aid through the G-E Honors Program and Tuition Refund Program. Technical graduates entering the Engineering, Manufacturing, or Technical Marketing Programs start with on-the-job training and related study as preparation for more responsible positions. Throughout their G-E careers they receive frequent appraisals as a guide for self development. Company-conducted courses are offered again at all levels of the organization. These help professionals gain the increasingly higher levels of education demanded by the complexities of modern business. Our goal is to see every man advance to the full limits of his capabilities.

If you have other questions or want information on our programs for technical graduates, write to E. G. Abbott, Section 959-9, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR other interviews discussing: • Qualities We Look For in Young Engineers • Personal Development • Salary.**

GENERAL ELECTRIC