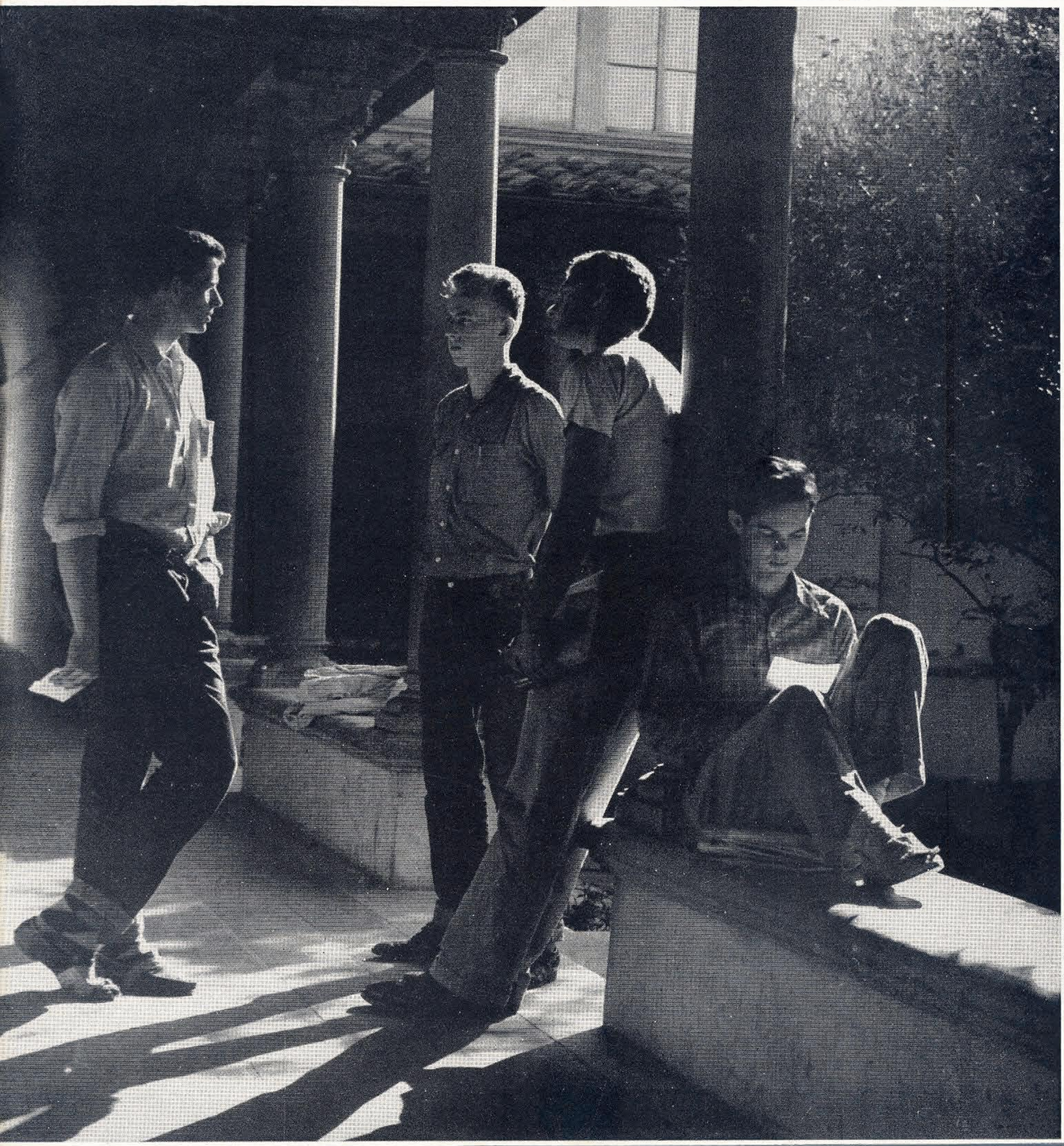
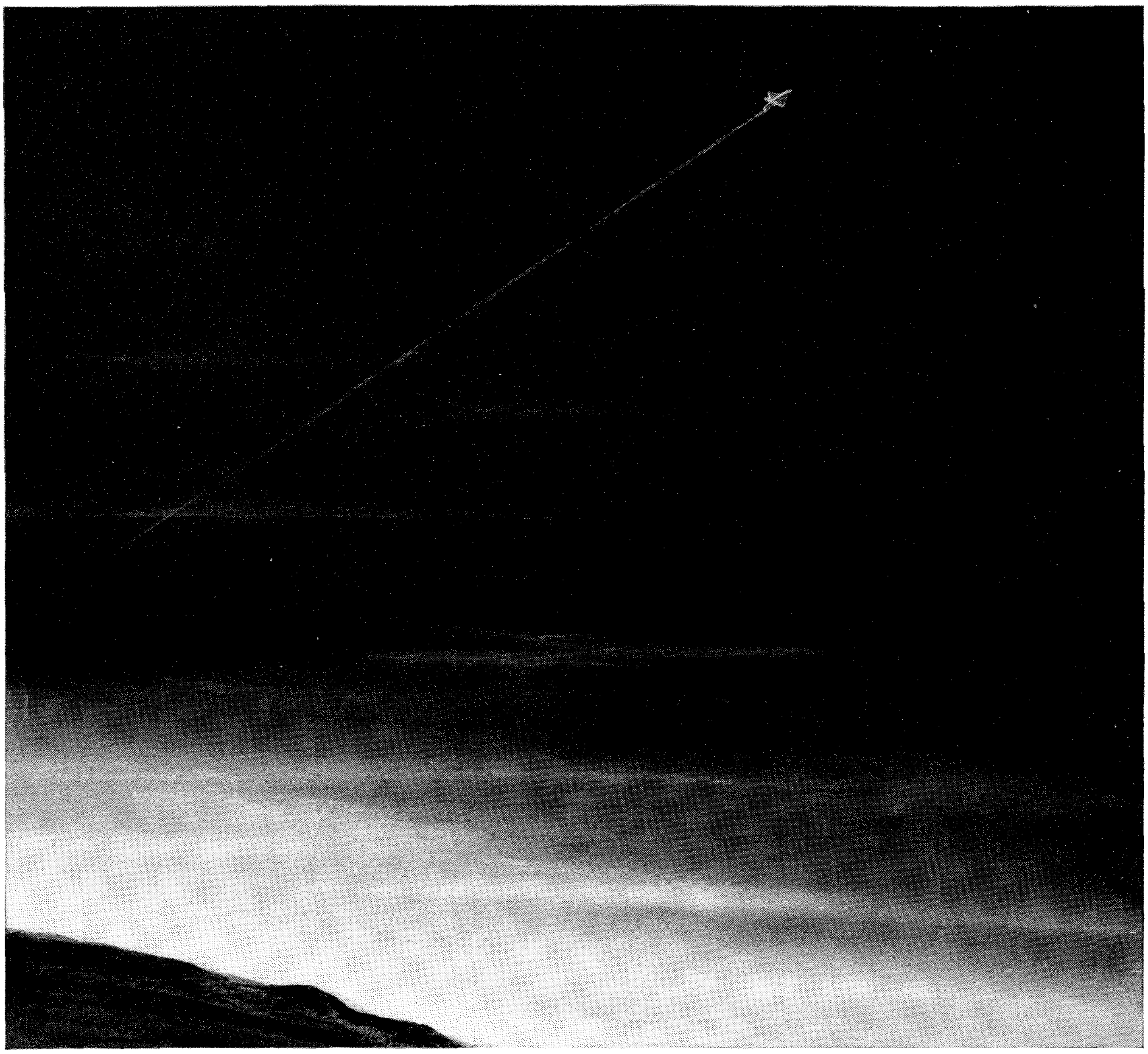
# ENGINEERING | AND | SCIENCE

APRIL/1953



*The Caltech Student . . . page 20*

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



# Tight reins in the stratosphere

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# "True-or-False" Quiz on Business

| Question | What Most People Believe | The Fact |
|---|---|---|
| How big are corporations' profits? | 25% (or 25¢ out of each $1 of sales). | 7%. In most years actually *less* than 7 cents of each sales dollar. |
| Who gets the largest share of the income of corporations? | Most people say the owners do. | Actually the workers—they get 86%. |
| Does war increase corporation profits? | Many people think so. | The facts are—NO. Compared to a good peace year, corporation profits on the sales dollar went down from 6.4¢ to 4.3¢ in the last war. |
| Do machines put men out of work? | Most people say yes. | NO. In the automobile industry, for example, one man and a machine do the former work of 5 men, yet 20 times as many men are employed. Machines well used reduce costs and prices which broadens markets and so provides more jobs. |
| Do top executives make too much? | Too many workers think, "If their salaries were divided among workers, our wages could be much higher." | If *all* the salaries of the three top men in the country's biggest company were divided among that company's workers, it would take each worker in that company about three weeks to buy one pack of cigarettes with his increase. |
| Should taxes on corporations be increased? | "Yes," say many. "Soak the rich." | Truth is that high taxes already take so much money which should be spent in keeping machines modern, that 43% of America's machines are too old to protect tomorrow's jobs. |

So much falsehood has been spread about business by communists that workers in their own interest should promote the truth. The best interest of workers, business and all the people is the same.

* * *

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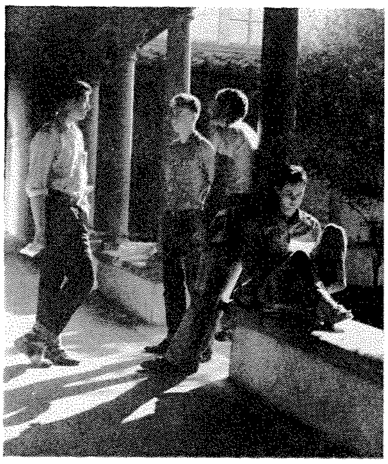
**GENERAL MOTORS CORPORATION**

**Personnel Staff, Detroit 2, Michigan**

““# ENGINEERING AND SCIENCE

## IN THIS ISSUE



**The Caltech student** (sample shown on cover) comes up for discussion on page 20 this month, in an article called "The Caltech Student—His Aptitudes and Limitations." The author of the article, Hunter Mead, is Professor of Philosophy and Psychology at Caltech, and has had some six years' experience in observing the aptitudes and limitations of students around these parts. Though Dr. Mead is the first to admit that his analysis may be a minority report, he is nevertheless ready to defend it against all comers. Complaints may be addressed directly to Dr. Mead or to this publication; we'll print all printable comments in our letters column.

**The statement on Communism** and the colleges on page 10 is the result of six-months' work by a five-man committee of the Association of American Universities, representing 37 U.S. and Canadian colleges and universities—including Caltech. As the first comprehensive statement on this vital and ticklish subject, it should be of interest to anyone interested in the future of our colleges.

PICTURE CREDITS

| | |
|---|---|
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| p. 30 | Mike Boughton '54 |
| p. 36 | Frank Crandall |

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# BOOKS

**ELIZABETHAN POETRY: A Study in Conventions, Meaning, and Expression**
**by Hallett Smith**
**Harvard University Press, 1952**

*Reviewed by Charles M. Coffin*
*Ford Foundation Fellow,*
*Huntington Library*

If Hallet Smith were not a member of the faculty of the California Institute of Technology, his book *Elizabethan Poetry* possibly would go unnoticed in *Engineering and Science*. But Hallett Smith *is* a member of that faculty, and there is the big, important fact. In ordinary comparative terms, it means that a professor of English in a great technical institution easily competes for distinction with the scholars in the graduate schools of letters wherever they may be.

Of more immediate and local concern, where comparison is inept, it means that the California Institute of Technology encourages and promotes the excellence of mind, also whereever that may be, and provides brilliant instruction in a many-dimensioned experience—as, for example, the dimension which words in their richest complication give to experience, as well as the dimension given by "number," employed in all of its imaginative and practical ways. The situation is notable. It is a right cause for pride, and for considerably more.

*Elizabethan Poetry*, as the author notes, is not a history of the poetry of late sixteenth-century England (though *it* goes a long way towards satisfying our need for such a history), but a "historical study," attempting to elucidate "the nature of the creative process" working in this period. "To understand the creative process," he goes on, "you must have before your eyes the things created." This is unimpeachable doctrine wherever the mind is acting—perhaps more steadily honored by the men of science than by literary scholars, though it is applicable to the one as to the other, and throughout his book Professor Smith has stuck to the application.

The "things created" in words in late Elizabethan England are not exactly countless, but they are uncountable, and their variety is a function of their multiplicity. In our civilization, it is the period of greatest verbal excitement, comparable only, as Matthew Arnold thought, to the age of Sophocles and Pindar. The ages are different, however, in this one fact, at least: the fifth century B. C. had no printing presses; the Elizabethans were great printers, and they have left Bodleians, British Museums, Folgers, and Huntingtons of testimony to the baffling enormousness of their achievement.

### The value of the totality

Yet Professor Smith is neither baffled by this enormousness, nor baffling to his readers as he gracefully comments upon literally hundreds of poems (exclusive of the dramatic work), ranging from the brevity of epigram and song to the more than 30,000 lines of Spenser's *Faerie Queene*. He paraphrases, analyzes, and relates many particular texts; and he is able to name the value of the totality. In short, he sees both the trees and the forest. Further, he reckons with much of the medieval, classical and continental renaissance literature which prepared the way for the Elizabethan expression; and he takes into critical account the context subsequently accumulating from the scholars who have written in many languages about this period.

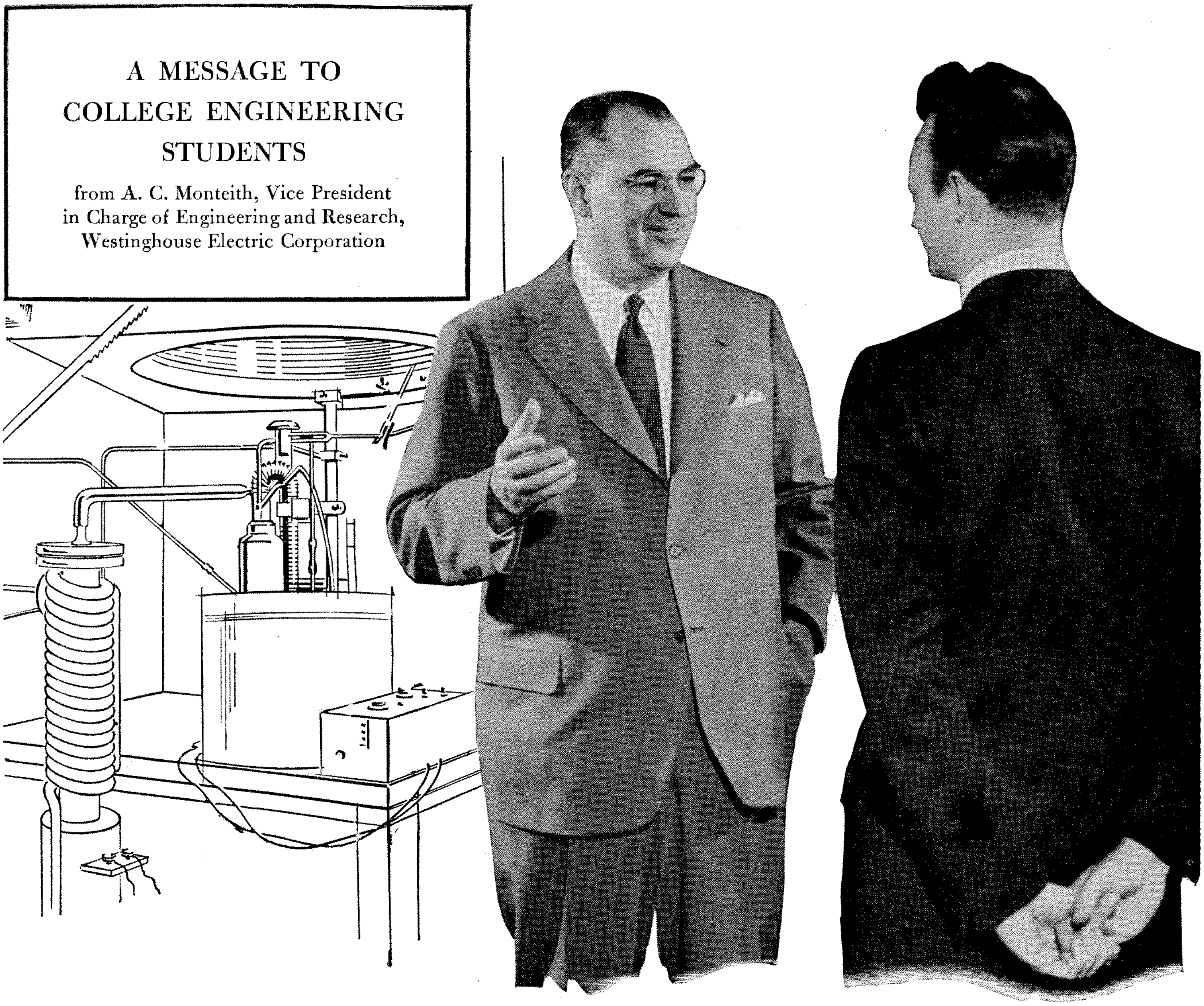
Precisely how Professor Smith manages his materials, to get them before us in a way where we can see them for what they are worth and as evidence of the vast creative energy of the period, is, in my judgment, even more noteworthy than his bibliography. He gives us much more than skilful classification of items, though the divisions he uses, of "pastoral," "Ovidian verse," "the sonnet," "satire," and "heroic poetry," may seem superficially to be little more than a concession to the customarily recognized generic groupings. The *genres*, after all, do exist and are not to be put by; but it is in the treatment of the constituent poems in a way to show how they exhibit the primary configurations of the sensibility of the Elizabethan Age that he is remarkably important.

As to the "configurations of sensi-

CONTINUED ON PAGE 48

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from A. C. Monteith, Vice President
in Charge of Engineering and Research,
Westinghouse Electric Corporation



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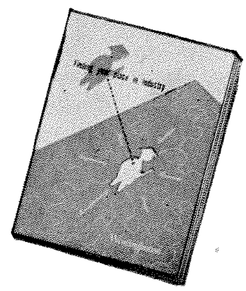

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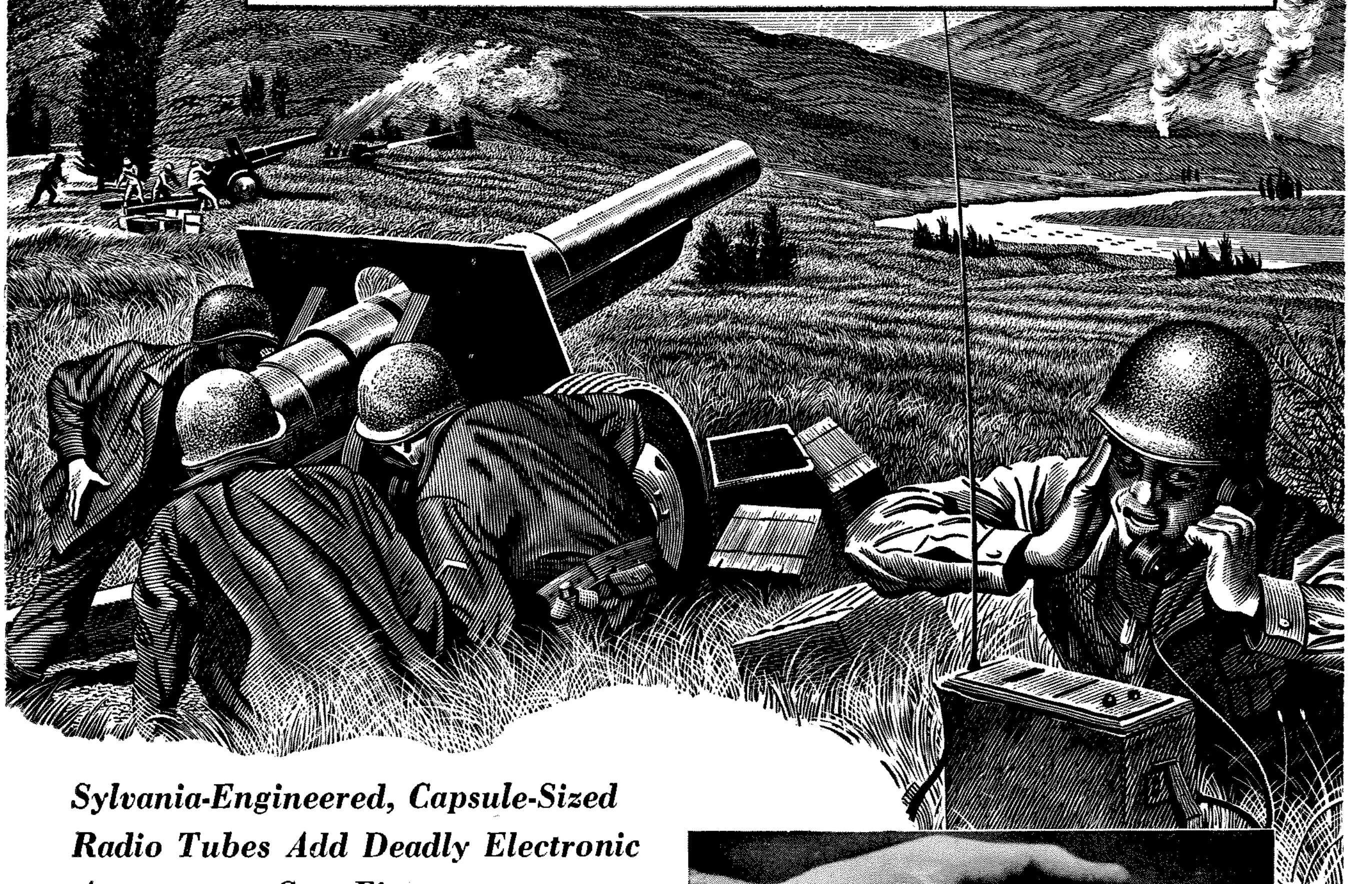
# Assignment: Accuracy
# Solution: Subminiaturization



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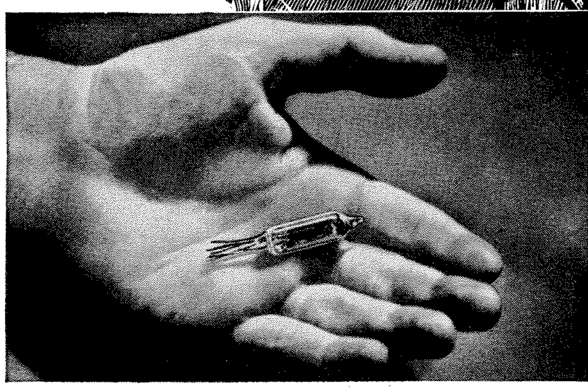

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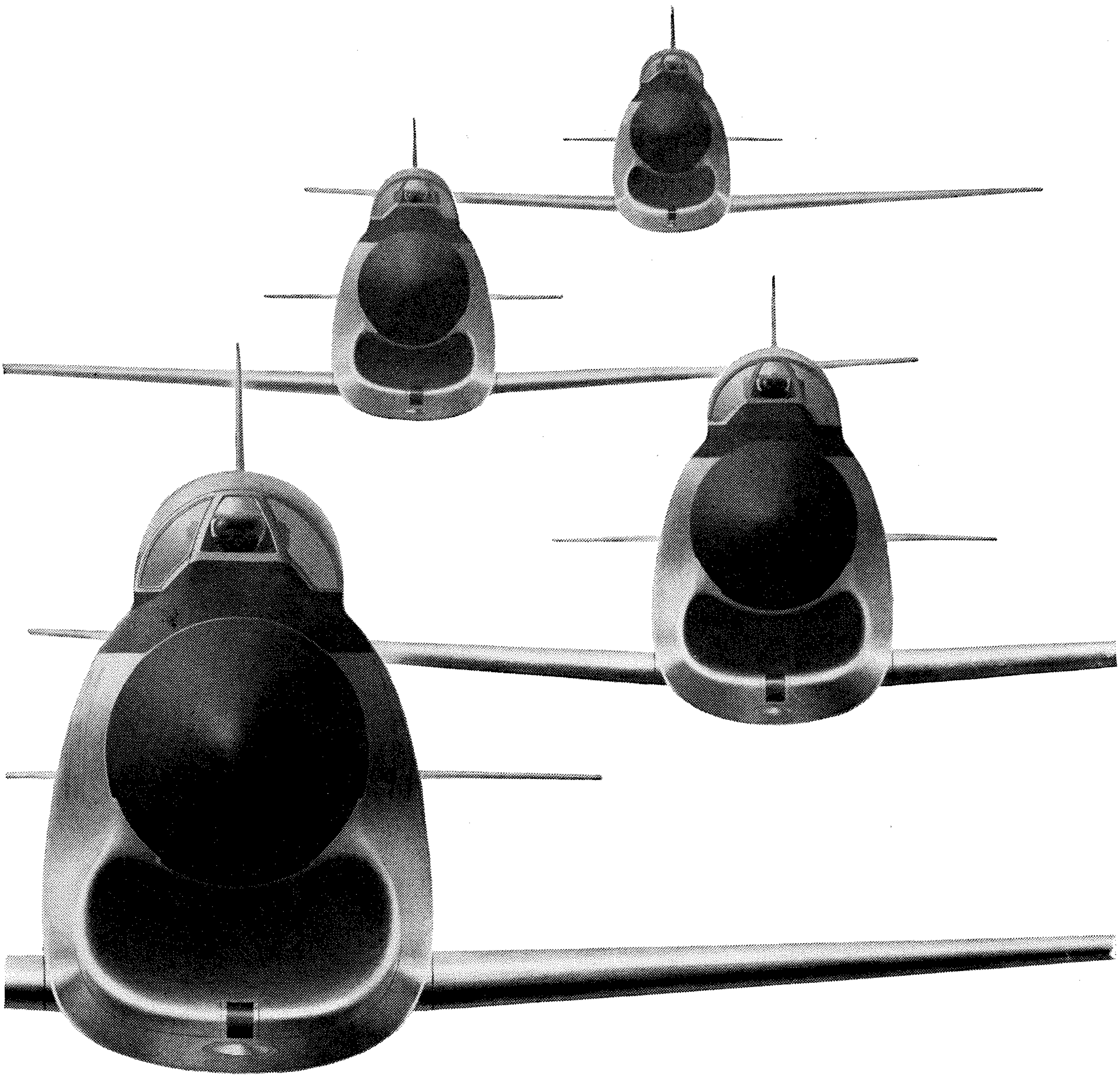

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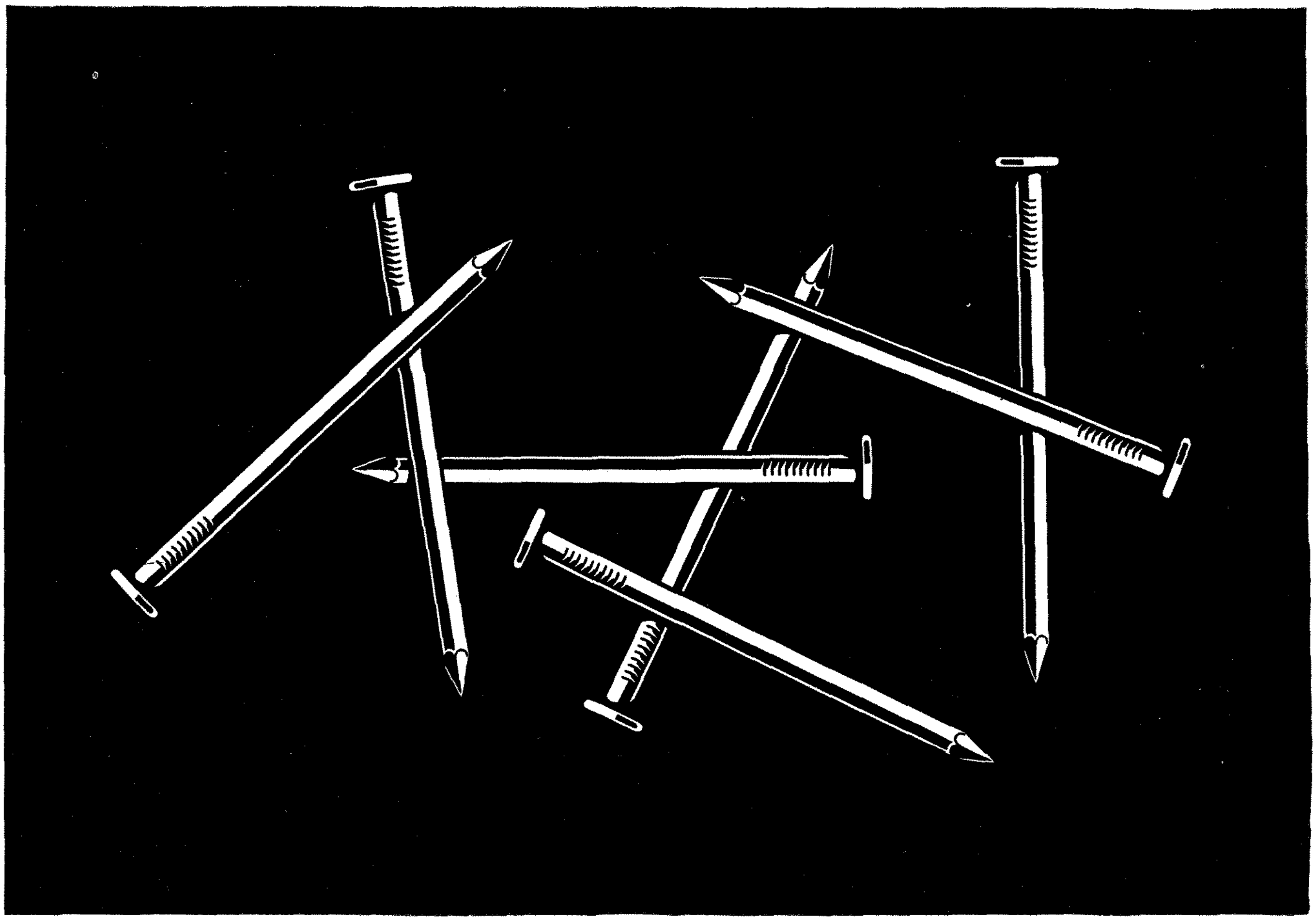

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# THE RIGHTS AND RESPONSIBILITIES OF UNIVERSITIES AND THEIR FACULTIES

A Statement on Communism and the Colleges

by the Association of American Universities

For three hundred years higher education has played a leading role in the advancement of American civilization. No country in history so early perceived the importance of that role and none has derived such widespread benefits from it. Colleges moved westward with the frontier and carried with them the seeds of learning. When the university idea was transplanted from Europe, it spread across the nation with extraordinary speed.

Today our universities are standard bearers of our whole system of education. They are the mainstays of the professions. They are the prime source of our competence in science and the arts. The names of their graduates crowd the honor rolls of two world wars and of the nation's peacetime affairs. By every test of war and peace they have proved themselves indispensable instruments of cultural progress and national warfare.

In the United States there is a greater degree of equality of opportunity in higher education than anywhere else in the world. A larger proportion of Americans study in universities and colleges than any other people. These universities have shown and continue to show greater responsiveness to the needs of our society than their European counterparts. They have equipped our people with the varied skills and sciences essential to the development of a pioneer country. They have imparted the shape and coherence of the American nation to formless immigrant groups. American ideals have been strengthened, the great cultural tradition of the West has been broadened, and enriched by their teaching and example.

Modern knowledge of ourselves and of our universe has been nurtured in the universities. The scientific, technological, medical, and surgical advances of our time were born in them. They have supplied intellectual capital as essential to our society as financial capital is to our industrial enterprise. They have more than justified the faith of the public in our distinctive system of higher education. They have proved themselves dynamic forces of American progress.

## The nature of a university

A university is the institutional embodiment of an urge for knowledge that is basic in human nature and as old as the human race. It is inherent in every individual. The search that it inspires is an individual affair. Men vary in the intensity of their passion for the search for knowledge as well as in their competence to pursue it. History therefore presents us with a series of scholarly pioneers who advanced our knowledge from age to age and increased our ability to discover new knowledge. Great scholars and teachers drew students to them, and in the Middle Ages a few such groups organized themselves into the first universities.

The modern university which evolved from these is a unique type of organization. For many reasons it must differ from a corporation created for the purpose of producing a salable article for profit. Its internal structure, procedures, and discipline are properly quite different from those of business organizations. It is not so closely integrated and there is no such hierarchy of authority as is appropriate to a business concern; the permanent members of a university are essentially equals.

## An association of scholars

Like its medieval prototype, the modern American university is an association of individual scholars. Their effectiveness, both as scholars and as teachers, requires the capitalizing of their individual passion for knowledge and their individual competence to pursue it and communicate it to others. They are united in loyalty to the ideal of learning, to the moral code, to the country, and to its form of government. They represent diversified fields of knowledge, they express many points of view. Even within the same department of instruction there are not only specialists in various phases of the subject, but men with widely differing interests and outlook.

Free enterprise is as essential to intellectual as to economic progress. A university must therefore be hospitable to an infinite variety of skills and viewpoints, relying upon open competition among them as the surest safeguard of truth. Its whole spirit requires investigation, criticism, and presentation of ideas in an atmosphere of freedom and mutual confidence. This is the real meaning of "academic" freedom. It is essential to the achievement of its ends that the faculty of a university be guaranteed this freedom by its governing board, and that the reasons for the guarantee be understood by the public. To enjoin uniformity of outlook upon a university faculty would put a stop to learning at the source. To censor individual faculty members would put a stop to learning at its outlet.

## Scholarship and politics

For these reasons a university does not take an official position of its own either on disputed questions of scholarship or on political questions or matters of public policy. It refrains from so doing not only in its own but in the public interest, to capitalize the search for knowledge for the benefit of society, to give the individuals pursuing that search the freest possible scope and the greatest possible encouragement in their efforts to preserve the learning of the past and advance learning in the present.

The scholar who pursues the search on these terms does so at maximum advantage to society. So does the student. To the scholar lie open new discoveries in the whole field of knowledge, to his student the opportunity of sharing in those discoveries and at the same time developing his powers of rational thought, intelligent judgment, and an understanding use of acquired knowledge. Thus essential qualities of learning are combined with essential qualities of citizenship in a free society.

To fulfill their function the members of university faculties must continue to analyze, test, criticize, and reassess existing institutions and beliefs, approving when the evidence supports them and disapproving when the weight of evidence is on the other side. Such investigations cannot be confined to the physical world. The acknowledged fact that moral, social, and political progress have not kept pace with mastery of the physical world shows the need for more intensified research, fresh insights, vigorous criticism, and inventiveness.

The scholar's mission requires the study and examination of unpopular ideas, of ideas considered abhorrent and even dangerous. For, just as in the case of deadly disease or the military potential of an enemy, it is only by intense study and research that the nature and extent of the danger can be understood and defenses against it perfected.

## No time for timidity

Timidity must not lead the scholar to stand silent when he ought to speak, particularly in the field of his competence. In matters of conscience and when he has truth to proclaim the scholar has no obligation to be silent in the face of popular disapproval. Some of the great passages in the history of truth have involved the open challenge of popular prejudice in times of tension such as those in which we live.

What applies to research applies equally to teaching. So long as an instructor's observations are scholarly and germane to his subject, his freedom of expression in his classroom should not be curbed. The university student should be exposed to competing opinions and beliefs in every field, so that he may learn to weigh them and gain maturity of judgment. Honest and skillful exposition of such opinions and beliefs is the duty of every instructor; and it is equally his privilege to express his own critical opinion and the reasons for holding it. In teaching, as in research, he is limited by the requirements of citizenship, of professional competence and good taste. Having met those standards, he is entitled to all the protection the full resources of the university can provide.

## The universities' commitments

Whatever criticism is occasioned by these practices, the universities are committed to them by their very nature. To curb them, in the hope of avoiding criticism, would mean distorting the true process of learning and depriving society of its benefits. It would invite the fate of the German and Italian universities under Fascism and the Russian universities under Communism. It would deny our society one of its most fruitful sources of strength and welfare and represent a sinister change in our ideal of government.

"The A.A.U. report is a most important document, clarifying in a thorough way the subject of academic freedom and responsibility, and applying these concepts to the preesnt-day situation. The statement makes it perfectly clear that academic freedom is not and never was a shield for liars, traitors or conspirators. It is only a protection for honest scholars who may hold unpopular opinions."

—L. A. DuBridge

## Responsibilities of university faculties

We must recognize the fact that honest men hold differing opinions. This fundamental truth underlies the assertion and definition of individual rights and freedom in our Bill of Rights. How does it apply to universities?

In the eyes of the law, the university scholar has no more and no less freedom than his fellow citizens outside a university. Nonetheless, because of the vital importance of the university to civilization, membership in its society of scholars enhances the prestige of persons admitted to its fellowship after probation and upon the basis of achievement in research and teaching. The university supplies a distinctive forum and, in so doing, strengthens the scholar's voice. When his opinions challenge existing orthodox points of view, his freedom may be more in need of defense than that of men in other professions. The guarantee of tenure to professors of mature and proven scholarship is one such defense. As in the case of judges, tenure protects the scholar against undue economic or political pressures and ensures the continuity of the scholarly process.

There is a line at which "freedom" or "privilege" begins to be qualified by legal "duty" and "obligation." The determination of the line is the function of the legislature and the courts. The ultimate interpretation and application of the First and Fourteenth Amendments are the function of the United States Supreme Court; but every public official is bound by his oath of office to respect and preserve the liberties guaranteed therein. These are not to be determined arbitrarily or by public outcry.

The line thus drawn can be changed by legislative and judicial action; it has varied in the past because of prevailing anxieties as well as by reason of "clear and present" danger. Its location is subject to, and should receive, criticism both popular and judicial. However much the location of the line may be criticized, it cannot be disregarded with impunity. Any member of a university who crosses the duly established line is not excused by the fact that he believes the line ill-drawn. When the speech, writing, or other actions of a member of a faculty exceed lawful limits, he is subject to the same penalties as other persons. In addition, he may lose his university status.

Historically the word "university" is a guarantee of standards. It implies endorsement not of its members' views but of their capability and integrity. Every scholar has an obligation to maintain this reputation. By ill-advised, though not illegal, public acts or utterances he may do serious harm to his profession, his university, to education, and to the general welfare.

He bears a heavy responsibility to weigh the soundness of his opinions and the manner in which they are expressed. His effectiveness, both as scholar and teacher, is not reduced but enhanced if he has the humility and wisdom to recognize the fallibility of his own judgment. He should remember that he is as much a layman as anyone else in all fields except those in which he has special competence. Others, both within and without the university, are as free to criticize his opinions as he is free to express them; "academic freedom" does not include freedom from criticism.

As in all acts of association, the professor accepts conventions which become morally binding. Above all, he owes his colleagues in the university complete candor and perfect integrity, precluding any kind of clandestine or conspiratorial activities.

He owes equal candor to the public. If he is called upon to answer for his convictions it is his duty as a citizen to speak out. It is even more definitely his duty as a professor. Refusal to do so, on whatever legal grounds, cannot fail to reflect upon a profession that claims for itself the fullest freedom to speak and the maximum protection of that freedom available in our society.

In this respect, invocation of the Fifth Amendment places upon a professor a heavy burden of proof of his fitness to hold a teaching position and lays upon his university an obligation to reexamine his qualifications for membership in its society.

In all universities faculties exercise wide authority in internal affairs. The greater their autonomy, the greater their share of responsibility to the public. They must maintain the highest standards and exercise the utmost wisdom in appointments and promotions. They must accept their share of responsibility for the discipline of those who fall short in the discharge of their academic trust.

The universities owe their existence to legislative acts and public charters. A State university exists by constitutional and legislative acts, an endowed university enjoys its independence by franchise from the state and by custom. The state university is supported by public funds. The endowed university is benefitted by tax exemptions. Such benefits are conferred upon the universities not as favors but in furtherance of the public interest. They carry with them public obligation of direct concern to the faculties of the universities as well as to the governing boards.

Legislative bodies from time to time may scrutinize these benefits and privileges. It is clearly the duty of universities and their members to cooperate in official inquiries directed to those ends. When the powers of legislative inquiry are abused, the remedy does not lie in non-cooperation or defiance; it is to be sought through the normal channels of informed public opinion.

## The present danger

We have set forth the nature and function of the university. We have outlined its rights and responsibilities and those of its faculties. What are the implications for current anxiety over Russian Communism and the subversive activities connected with it?

We condemn Russian Communism as we condemn every form of totalitarianism. We share the profound concern of the American people at the existence of an international conspiracy whose goal is the destruction of our cherished institutions. The police state would be the death of our universities, as of our government.

Three of its principles in particular are abhorrent to us: the fomenting of world-wide revolution as a step to seizing power; the use of falsehood and deceit as normal means of persuasion; thought control—the dictation of doctrines which must be accepted and taught by all party members.

Under these principles, no scholar could adequately disseminate knowledge or pursue investigations in the effort to make further progress toward truth.

Appointment to a university position and retention after appointment require not only professional competence but involve the affirmative obligation of being diligent and loyal in citizenship. Above all, a scholar must have integrity and independence. This renders impossible adherence to such a regime as that of Russia and its satellites.

No person who accepts or advocates such principles and methods has any place in a university. Since present membership in the Communist Party requires the acceptance of these principles and methods, such membership extinguishes the right to a university position.

Moreover, if an instructor follows communistic practice by becoming a propagandist for one opinion, adopting a "party line", silencing criticism or impairing freedom of thought and expression in his classroom, he forfeits not only all university support but his right to membership in the university.

"Academic freedom" is not a shield for those who break the law. Universities must cooperate fully with law-enforcement officers whose duty requires them to prosecute those charged with offenses. Under a well-established American principle their innocence is to be assumed until they have been convicted, under due process, in a court of proper jurisdiction.

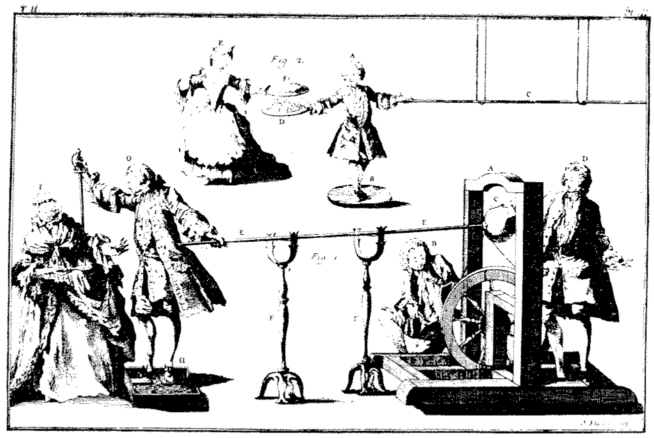
Unless a faculty member violates a law, however, his discipline or discharge is a university responsibility and should not be assumed by political authority. Discipline on the basis of irresponsible accusations or suspicion can never be condoned. It is as damaging to the public welfare as it is to academic integrity. The university is competent to establish a tribunal to determine the facts and fairly judge the nature and degree of any trespass upon academic integrity, as well as to determine the penalty such trespass merits.

As the professor is entitled to no special privileges in law, so also he should be subject to no special discrimination. Universities are bound to deprecate special loyalty tests which are applied to their faculties but to which others are not subjected. Such discrimination does harm to the individual and even greater harm to his university and the whole cause of education by destroying faith in the ideals of university scholarship.

## Conclusion

Finally, we assert that freedom of thought and speech is vital to the maintenance of the American system and is essential to the general welfare. Condemnation of Communism and its protagonists is not to be interpreted as readiness to curb social, political, or economic investigation and research. To insist upon complete conformity to current beliefs and practices would do infinite harm to the principle of freedom, which is the greatest, the central, American doctrine. Fidelity to that principle has made it possible for the universities of America to confer great benefits upon our society and our country. Adherence to that principle is the only guarantee that the nation may continue to enjoy those benefits.

# THE HEYDAY OF ELECTROSTATIC EXPERIMENTATION



*Electrical experimentation in the seventeen forties*

By E. C. WATSON

PARK BENJAMIN, in *The Intellectual Rise in Electricity* (London, 1895), gives an entertaining account of the popular interest in electrical experimentation that sprang up about the middle of the eighteenth century.

In the year 1742, he writes, "a singular and sudden interest in things electrical" arose in Germany, and "swiftly reached a stage of feverish enthusiasm."

"When it came to be noised about that the strange radiance which the English and French philosophers were exhibiting was fire,—fire which flamed in jets from the ends of rods, or, more wondrous still, leaped from the tips of men's fingers—that was a matter for everyone's personal concern. For fire was then believed to be a material substance—phlogiston—and while perhaps it might exist in iron bars and inanimate things of that kind, and be forced visibly to come out of them by friction, as well as by heating, no one had ever supposed that it resided in the human body and could be compelled to escape, with an accompaniment of sparks and crackles, from one's person. It was the idea of a human being becoming such a torch that stirred the Teutonic mind to its profoundest depths.

". . . It is doubtful to whom is due the credit of accomplishing the work which began the new era; some contemporary writers according it to Christian August Hansen, others to George Matthias Bose. . . .

". . . Both Hansen and Bose found, at about the same time, that not only could a practically continuous supply of electricity be obtained [with a glass sphere mounted lathe fashion and rotated rapidly by means of a crank-wheel and belt], but one of much greater strength than had hitherto been known.

"Hansen suspended a boy with his toes in proximity to the globe, and drew sparks from his fingers. Bose disposed twenty soldiers in line, with hands touching and administered a shock to all of them at once . . .

"No one knew better the art of playing to the gallery [than Bose]; in fact, in the great electrical drama he created the part of the 'modern wizard,' and it is doubtful whether anyone since has ever excelled him in it.

He set jets of fire streaming from electrified objects and exhibited them to the people who flocked to his laboratory. He invited guests to an elegant supper-table loaded with silver and glass and flowers and viands of every description, and, as they were about to regale themselves, caused them to stand transfixed with wonder at the sight of flames breaking forth from the dishes and the food and every object on the board. The table was insulated on pitch cakes, and received the discharge from the huge glass retort which was revolved in another room.

"He introduced his ardent pupils to a young woman of transcendent attractions and as they advanced to press her fair hand, a spark shot from it accompanied by a shock which made them reel. Others, who had the boldness to accept his challenge to imprint a chaste salute upon the damsel's lips, received therefrom a discharge which Bose says 'broke their teeth,' but Bose here either exaggerates more than usual, or else neglects to explain how the young lady bore her share of the injury."

By 1746 showmen were traveling even to America with their electrical machines, giving people shocks for a small fee. It was one of these itinerant electricians who aroused Benjamin Franklin's interest in the subject.

*One of a series of articles devoted to reproductions of prints, drawings and paintings of interest in the history of science—drawn from the famous collection of E. C. Watson, Professor of Physics and Dean of the Faculty of the California Institute.*

# THE PRESIDENT'S REPORT

**Some highlights from Dr. DuBridge's 1951-1952 report on the Institute**

THERE ARE PLENTY OF REASONS why those concerned with higher education should now be thinking deeply about the place of our colleges and universities in this kind of a world. There were times last spring, as students on various campuses gave vent in curious ways to their spring fever (as students have done from time immemorial), when many Americans wondered if college life was preparing our youth adequately for the serious business of living. Very few thought to ask whether, on the contrary, the colleges were too serious—and the safety valve just had to let loose.

In any case serious thinking about higher education—always appropriate—was now especially necessary. It has been the privilege of your president to be a member of a Commission which has been giving extensive thought to this question for the past three years.

The task of this Commission, established by the Association of American Universities, was to study the problems of financing higher education. But as this group of 12 educators and laymen faced this problem they found it necessary to ask: what *is* higher education in America and *why* should it be financed?

Our answers are contained in a recently-published report, *Nature and Needs of Higher Education* (*E&S*—February 1953). I hope many thoughtful friends of Caltech will find an opportunity to read it. Not that it pretends to say anything new; it only recalls to mind ideas that have been too often forgotten. For as we looked at American higher education we were impressed again with what a significant achievement it is.

There are in this country over 1100 four-year colleges and universities, large and small, public and private, sectarian and non-sectarian, rich and poor, good and mediocre. They are bringing higher education in some form to a far larger fraction of our youth than any other nation has ever achieved. They are typical products of a free enterprise system, exhibiting diversity and freedom, uncontrolled by any central power. Yet they all seek a common goal—the preservation of the heritage of Western culture, the broadening of man's intellectual horizons, the maintenance of the dignity and the freedom of the individual. They seek, in other words, to preserve the values which made America great.

There was never a time when these values were in greater need of being affirmed. Are the colleges succeeding in this task? Our conclusion was that, on the whole, they are. It is true that some individual students or some faculties have been irresponsible or foolish or negligent. Some colleges, too intent on "practical" or "popular" goals, have neglected their primary educational mission. Higher education as a whole, however, remains the stronghold of our vital traditions, the defender of our freedom, the leader in the quest for new knowledge, new vision, new wisdom.

Is the future of American higher education in danger? The answer is "No." There are thorny paths ahead—as there always have been. Colleges are being expected to do more things than they can afford. Inflation and fluctuating enrollments have posed grave financial problems. Yet we recall that pioneer America made the most unbelievable sacrifices to create and to maintain its colleges. Will rich, modern America neglect this heritage? Not if Americans understand the problems. It is therefore the duty of all alumni, faculty, students, trustees and friends of American colleges and universities to help Americans understand the true values of higher educa-

tion. To the extent that they are understood, to that extent will higher education receive the support it needs and deserves.

Our Commission believes that this support should come from many sources. We do not believe it should come in handouts from the Federal government. Private sources have not dried up. Individuals, foundations, and corporations can furnish the necessary funds, provided only that *in sufficiently large numbers* they understand the need and respond to it.

## The Institute and the Government

Caltech is a *private* institution. Its entire teaching program and a substantial part of its research program are financed by income from endowment and trust funds, tuition fees and gifts from individuals, corporations and foundations. However, our financial statements show also large sums of money "billed" to the Federal Government. The significance of these "billings" should be clearly understood.

The activity which accounts for the bulk of these charges to the government is the operation of the Jet Propulsion Laboratory, located about five miles from the campus at the northwest edge of Pasadena. This laboratory—land, buildings and equipment—is owned by the government, and is devoted exclusively to carrying out research and development in the field of rockets and guided missiles, principally under the auspices of the Ordnance Corps of the United States Army. The Ordnance Corps, rather than managing and operating this laboratory directly (for example, as a military station), has asked the California Institute to serve as operator, in the belief that under this plan the Laboratory will carry out its mission more effectively and more economically.

The Institute has been glad to render this service in the cause of national defense. In carrying on this service we expend, as agents of the government, large sums of money for salaries, materials and equipment as necessary in carrying out the program. The government then reimburses the Institute for these expenditures—auditing them item by item. No "management fee" is charged, but an allowance is made (also audited each year) to cover a reasonable share of the administrative or "overhead" expenses which the Institute incurs.

Thus, during the year just closed, the Institute billed the government nearly $10 million to cover expenses of the Jet Propulsion Laboratory.

Other "billings" to the government during the past year amounted to about $2 million. These covered reimbursements for the cost of research projects carried forward *on the campus.* These are projects judged by the faculty to be desirable additions to the Institute's program of education and research. Each one, however, is also of current interest to some agency of government. Because of this interest the government agency is willing to bear some portion of the costs of the project—just as an individual, a company, or a foundation may bear the cost of a project in which it may be interested. The nation's scientific strength has been greatly enhanced in recent years—and its welfare and security correspondingly advanced—by this type of cooperation between universities and the government.

But none of these "billings" to the government in any way lessened Caltech's primary dependence on private funds. In fact they all increased it; for we shall want to continue many of these special research projects even though some day the government interest in them should cease. There are many others of equal importance which can never command government interest, and we must never be forced to limit *our* interests to those of the government. In fact, except for a few large and expensive projects in fields such as nuclear physics and aeronautics, most of our educational and research work is still dependent on funds from private sources.

## Financial status

The total net assets of the Institute passed the fifty-million mark this year, continuing the slow, steady climb which has added twelve million dollars in the past six years. The chief capital increment during this past year resulted from gains from the sale of securities.

The expenditures for the campus programs of instruction and research were $5,203,000, which was $131,329 less than the income available for these programs. Again this year budget economies and better-than-expected income enabled us to end the year with a modest surplus instead of an anticipated deficit.

The above figures do not include the money expended for others in managing off-campus research and development programs. The Cooperative Wind Tunnel, the Jet Propulsion Laboratory and the (temporary) Vista Project accounted for $11,479,309 in expenses which were reimbursed.

Gifts for current operations this year amounted to the impressive total of $1,200,419. (The entire budget of the Institute was less than this amount in 1939). The many large grants by industrial corporations, some for research in certain fields, others for general support, are especially noteworthy and encouraging. While the argument goes forward as to whether—or how—business should help the colleges, many forward-looking companies are quietly doing it, and have been for many years.

## The student body

Violently fluctuating enrollments have been a cause of serious difficulty in many colleges during the past 20 years. Depression, the war, the post-war veterans' program, and now the abnormally low college-age population (reflecting the low birthrate of the depression years) have alternately boosted and depressed college attendance to an extent which has in many institutions played havoc with finances, with plant utilization, and with staff.

Caltech has been freer from these large fluctuations than most colleges. For example, as a result of the policy of keeping the entering class fixed at 180 students, the undergraduate student body, even at the peak of the veteran load, reached only about 800 compared with the present or "normal" of about 650. We expect to maintain about this level. The number of applicants for freshman admission for the fall of 1952 showed a sharp increase, which followed a more modest increase in 1951 over the low point of 1950.

Choosing 180 freshmen from several hundred applicants offers the opportunity of securing a high quality class, but presents difficult problems of selection. The Admissions Office is being greatly assisted in this task by the statistical studies on methods of predicting academic success being made by Dr. John Weir, Associate in Psychology. Scores on the College Entrance Examination Board tests are found to be the most valid single criterion of success at the Institute. But in each individual case these scores must be supplemented by information on success in school, intellectual interest and motivation, and those personal qualities associated with character.

Our aim is to select students of outstanding promise of future success—and to reduce academic failure to zero. But prediction of human achievement can never attain perfection, and in many cases failure results principally from unavoidable personal, family or financial difficulties, or occurs for reasons of health. These, too, we aim to keep at a minimum through student health and counselling services, student-aid programs, etc. Only nine per cent of the 1951-52 freshman class withdrew for scholastic reasons. Also the Caltech spohomores ranked, as a class, in number one position among 128 colleges throughout the country in a National College Sophomore Testing program involving 14,000 students. They ranked first even in such subjects as English, General Culture and Current Affairs.

The number of students needing financial assistance continues to grow. Part-time jobs (the favorite: baby sitting) were of help in many cases. Indeed more jobs were available than could be filled. But the time available for outside work is, for a Caltech student, severely limited. Scholarships were awarded to 102 undergraduate students in the amount of $47,560. In the upper three classes only those in the top quarter of the class were considered for awards. Funds are needed to assist worthy students who, often for reasons beyond their control, do not quite attain the necessary B-average.

We note with satisfaction the growing number of industrial companies which are establishing undergraduate scholarship programs. If wisely administered, these can go far toward assuring educational opportunities to all talented and ambitious young people, regardless of family economic status. Such private funds will make unnecessary the Federal scholarship aid program being advocated in some quarters.

A large fraction of the graduate students must depend upon some form of financial assistance. For the most part this is earned through part-time services in teaching or research. There are also increasing numbers of industrial graduate fellowships and now the new fellowships of the National Science Foundation. Graduate students received in grants or stipends over $400,000 during the year, distributed among 280 out of the slightly over 400 such students.

There were 344 degrees awarded at the Commencement exercises on June 6, 1952, including 126 Bachelor of Science, 133 Master of Science, 20 Engineer's degrees (M.E., C.E., Ae.E., etc.) and 65 Ph.Ds.

The geographic distribution of the student body continues to broaden. Of the freshman class entering in 1952, 35 per cent came from outside California, representing 25 states and 1 foreign country. Of the 1952 Ph.D. recipients, 80 per cent had received undergraduate degrees from institutions other than Caltech; 60 per cent of these were from institutions east of the Mississippi, and 13 per cent from abroad.

## The curriculum

The goal of Caltech is not to educate *more* scientists and engineers but *better* ones. It is in the upper ranks of talent that the shortage is most acute. But how is this goal to be achieved?

One clue to the answer to this question comes from the fact that, in the face of a severe national shortage of scientists and engineers (the demand for *new* graduates is more than double the supply), many who have been out of college for 10 to 20 years have been unsuccessful in finding better or more rewarding positions. Many have therefore left the engineering profession. There is no single simple reason for this paradox. Salary scales for white-collar workers are notoriously slow to respond to inflation; personnel directors seek freshly-trained young people in preference to the "middle-aged"; many of the latter were not trained in the newer fields of science and engineering, where demands are the greatest.

It is clearly time for industry and government to outgrow the idea that $10,000 to $15,000 is an adequate top salary for senior engineers and scientists. But it is also desirable that young scientists and engineers be broadly enough educated so that they are both prepared and stimulated to keep pace with new developments in their fields. Such men will remain in the forefront of the profession. Caltech seeks to select and to educate such creative minds.

How well do we succeed? In proportion to their numbers Caltech alumni stand at the top in the frequency with which they receive unusual honors or recognition (e. g., the Institute has now graduated two Nobel prize winners: C. D. Anderson and E. M. McMillan). A more comprehensive survey of alumni is now under way to see how they have fared and to learn what aspects of the educational program have been of greatest value.

In the meantime, the present curriculum is under continuous examination by the faculty. Substantial alterations have been made in the Humanities, Physics, Geology and Engineering Divisions, in the past year. For example, a new option has been created for Ph.D. candidates—to be called "Engineering Science." This is to give greater and more flexible opportunities for the unusual student whose interests extend beyond the bounds of one or more of the current Civil, Electrical, Mechanical or Aeronautical engineering fields. The boundaries between the fundamental concepts of these various traditional fields are already diffuse; for many students they should be ignored. This emphasis on basic concepts rather than specialized skills is behind all these recent curricular changes.

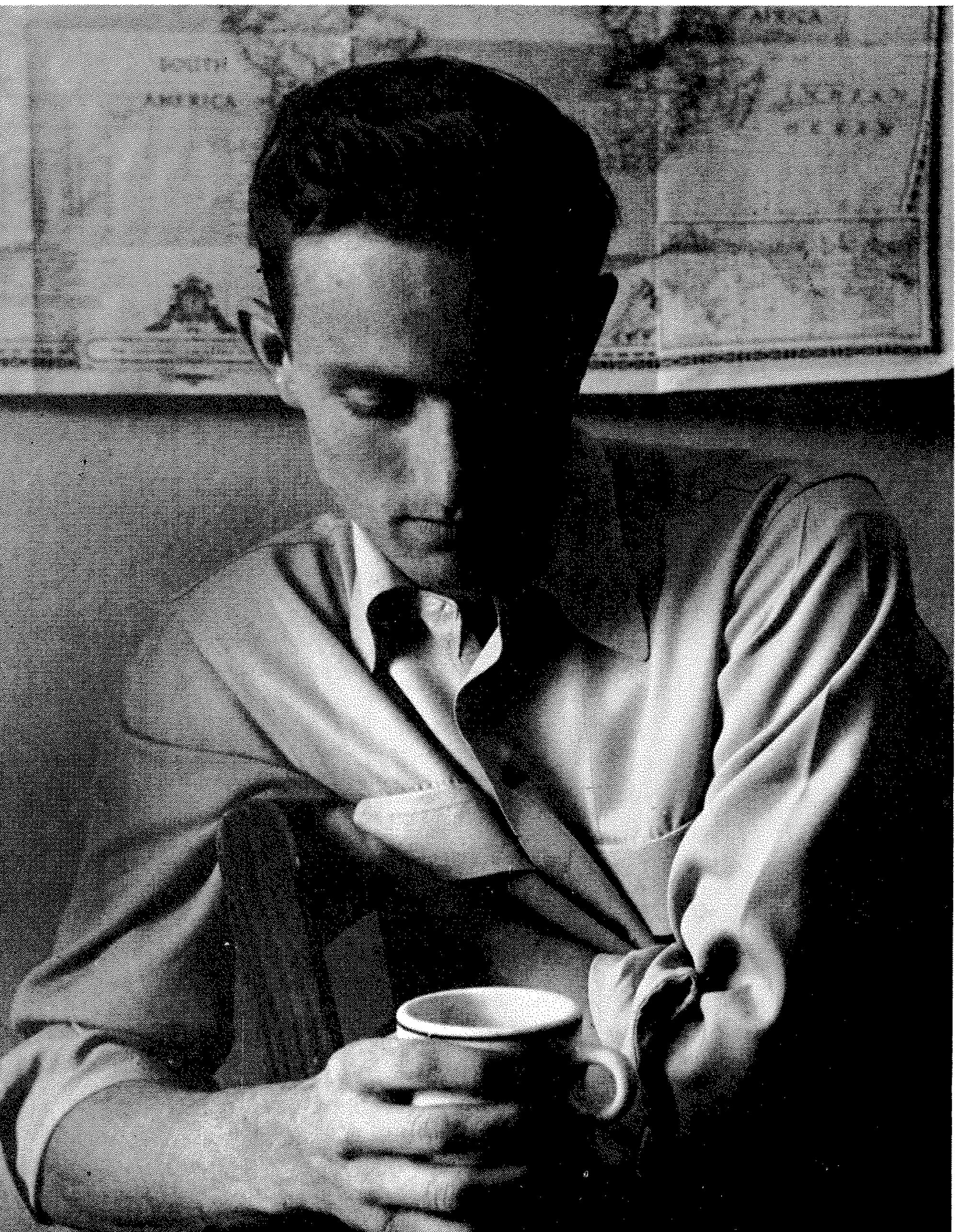
## Alumni

The alumni of an educational institution constitute its "product". Their success is a measure of the success of the institution; hence in their achievement the institution takes special pride.

Alumni achievements can not be measured in numbers or statistics, because the qualities of good citizenship are not measurable. At the same time, statistical studies are frequently made and are often of interest. Thus, a recent study published in *School and Society* lists the number of graduates of various institutions who have attained sufficient distinction to be listed in the volume *Who's Who in the West.* If one divides these figures by the number of living alumni of each institution one obtains a figure representing "the percentage of distinguished alumni". The figure for Caltech, 2.6%, is higher by 60% than that for the next highest institution.

Another study of the sources of American physicists shows that Caltech has, in proportion to its enrollment, produced more physicists (listed in *American Men of Science*) than any other institution in the country, leading by a margin of 50% the institution in second place.

As has been mentioned in previous reports, the alumni have in recent years been showing an increasingly active and most welcome interest in the Institute. The alumni magazine has been developed into an outstanding journal; the annual alumni seminars on the campus attract great interest; the alumni fund is growing at an ever-increasing rate, and it should be possible to announce in next year's annual report the completion of the alumni swimming pool made possible by gifts to the fund of almost $150,000.




# THE CALTECH STUDENT

## — His Aptitudes and Limitations

# A critical look at the technical student in general —and the Caltech student in particular

By HUNTER MEAD

*The special advantages, disadvantages—and just plain differences—of a technical education are subjects for continuous discussion. In Engineering & Science last month, Earnest Watson, Dean of the Faculty at Caltech, discussed "Liberal Education in Our Engineering Colleges." Here, Hunter Mead, Professor of Philosophy and Psychology at Caltech, preesnts some provocative ideas concerning students in technical schools. Dr. Mead's may, indeed, be a minority viewpoint; but it is one which certainly deserves to be heard.*

THE BELIEF THAT CALTECH students are a peculiar breed of humans is so widespread that it is worth examining. Even those of us who work with them constantly are sometimes moved to wonder just how "different" our students really are. We may loyally defend them to off-campus folk who raise an occasional quizzical eyebrow when newspaper publicity spotlights some campus personality or activity, but in the inner recesses of our souls we frequently raise the same quizzical eyebrow, or perhaps feel a slight uneasiness as to whether or not we really understand Techmen.

So, assuming that when we observe such puffs of smoke here and there on the campus there must be some fire, let us look at the situation. To do so we must risk some generalizations and extrapolations, but they are ones which we can document at least partially.

We can begin by verifying the popular impression that Techmen are intelligent, whether we compare them with the general population or with the college student population. Several years ago it was my interesting privilege to administer intelligence tests to a large part of the senior class during two successive years. There are difficulties in determining the I.Q. of adults, and also difficulties in working out scales for individuals who vary widely from the general population median. Granting these difficulties (and the caution which they suggest), it is still worth recording that an intelligence test, given to many thousands of subjects drawn at random from the general population, produced a median score of approximately 100; but the Caltech seniors' average was 142. It should be underlined that this is the average (median) score; this means that one-half of the group are higher than this. On this particular test I found only three students (from a group of about 160) lower than I.Q. 130. The bottom score (122) was that of an Oriental student with a severe language handicap!

What does all this mean, in terms of other intelligence groups? For one thing, it means that the poorest Techman is at, or slightly above, the median for American college seniors as a group. It also means that the poorest Techman is quite a cut above the median for all American college students. In terms of the general population, it means that all Tech students are in the top few percentiles, and the best of our students are in the top fraction of one percent.

Since the subjects for this particular test were all seniors, we cannot conclude that all Techmen are quite this high in raw intellectual aptitude. It is probable that we sometimes get freshmen who, if they did not flunk out, would pull this figure down if we tested their particular class—with them still in it—in its senior year. But, by and large, it seems safe to make the generalization that whatever else our students bring with them when they come to the Institute, they certainly bring intelligence adequate to the requirements of our undergraduate work.

They also bring with them exceptionally high motivation. This is a generalization which it is harder to document, since we have no satisfactory test to measure motivation accurately. We can only judge it in functional terms—that is, in terms of how hard our students work and the load they carry. While some Techmen do not work as hard as they tell their families and friends they do, they certainly work harder than the average college undergraduate.

I think it is inevitable that anyone joining the Caltech faculty after teaching in a non-technical institution will be impressed by the motivation and work-habits of our students. These work-habits may not be of maximum efficiency, but any student who survives our curriculum for more than a term or two has necessarily established the pattern of working hard and regularly. The present writer (who admittedly meets Techmen mostly as seniors and fifth-year students) is perpetually impressed with the motivation and ambition of most of our student body. Such a statement obviously ignores some of the flunkouts and transfers, whose motivation may be either insufficient or along other lines than technical, but I believe that we can safely generalize that the motivation of Techmen rates extremely high.

## The limitations

However, all is not sweetness and light in a best of all possible academic worlds: the Tech student usually brings with him some very definite limitations which are both frustrating and challenging to his teachers, particularly those who instruct him outside his major fields—and doubly so to those of us who work with him in our Humanities program.

Probably the most serious limitation, at least as it concerns the general education of technical students, lies in the fact that such students are top-heavy in quantitative and spatial thinking ability, and relatively deficient in what the psychologist calls verbal thinking or linguistic ability.

Within the individual's own field this limitation may not be serious, since any Tech student has at least enough verbal capacity to acquire facility in the terms and concepts of some particular field where he works constantly. Then too, in engineering and the physical sciences, most of the basic ideas of the field are expressible in quantitative terms, as formulae or equations, or they can be presented in visual terms as models or diagrams of some sort. Hence the verbal statement is greatly aided by non-verbal symbols, so that a verbal deficiency may be compensated for or masked. But when the student moves to another field, particularly one where quantitative-mathematical concepts are secondary or non-existent, we frequently find a different situation. Again the Humanities represent the most obvious example. But even a comparatively precise science like biology seems to prove a stumbling-block to some of our students who are so quantitative-minded that they are at ease only in physical science or engineering.

This same quantitative- and spatial-mindedness is usually accompanied by another characteristic which, while it is not necessarily a limitation, nevertheless produces many academic problems and student frustrations. I refer to the tendency of our students to be at ease only in clearly-organized, well-structured intellectual situations. Of course, all humans have a prejudice in favor of such situations, but technical students, as a result of both their intelligence and their training, apparently require a higher degree of intellectual organization to make them feel secure in the presence of any given situation.

This insistent "demand for structure" (if we may coin a phrase) has two consequences, one pedagogical and the other more serious, in that it will probably accompany our graduates throughout life. As far as their course work at Tech is concerned, this demand means that our students are bitterly critical of courses and teachers which they feel lack organization, logical presentation, and clearly-seen goals.

In the several polls taken on our campus in which the students have rated their instructors, this fact has become strikingly obvious. Students will apparently overlook a multitude of inadequacies and personal idiosyncrasies in a teacher, provided his presentation is logical, his course organized, and his explanations clear. On the other hand, Techmen plainly refuse to consider personal charm, light assignments, and even fair grading as substitutes for organization and clarity in a teacher.

Here we can safely risk another generalization: if the course is well-organized and logically presented, all is forgiven; if it lacks these qualities, nothing can save the teacher from damnation in the eyes of his students.

It might be argued that this constant demand for lucid explanation and rigorous intellectual structure reflects the student's quest for an easy path to knowledge and professional competence. I personally see it as something else. While admittedly students do not like to have unnecessary obstacles to understanding thrown in their way, their insistence upon logic and lucidity seems to me to represent an assumption (often probably unconscious) that degree of organization equals degree of understanding and intellectual power. However, I believe that the student is thinking of his own understanding and power when he makes this assumption, rather than that of his instructor. On the rating polls referred to above we commonly find comments like these regarding a poor instructor: "Knows his subject but can't get it over to the class," or "Knows the stuff but can't organize his lectures or demonstrations." It is rather that the student feels that he personally cannot grasp the subject throroughly until he perceives its organization and relationships.

## Logic and system

I think there is also a common tendency for students to assume that the subject matter of science and engineering courses (i. e., nature or natural phenomena) is logical and systematic, and hence that any course which has nature and its behavior as the subject should also be logical and systematic. I carefully refrain from becoming involved in a discussion as to whether the student is warranted in making either assumption, but I am certain that he very frequently makes one or both.

To my mind the more serious consequence of technical students' demand for lucid structure in situations is something else—something which constitutes a real limitation of many Techmen, in terms of both their

CONTINUED ON PAGE 24

present intellectual development and their later adjustments to life and to society. Here I refer to the almost ferocious tendency of many of our students to impose organization upon situations at almost any cost.

On the strictly intellectual level this may lead to nothing more serious than oversimplifying problems and situations, although oversimplification can of course be serious at times. On a deeper intellectual level it may lead to genuine blind spots—that is, to a tendency to dismiss genuine problems as unreal because they resist formulation in clear-cut terms, or even to shrug off whole fields of human endeavor because they are not "scientific." This really amounts to saying (although our students seldom verbalize it) that if a field is less structured than the sciences are, its subject matter is either trivial or unreal. To my mind this self-imposed limitation which many of our students make constitutes the most serious intellectual deficiency of technical students as a class. Perhaps the faculty in the division of the Humanities is most aware of this limitation in a large percentage of our students, but I believe any thoughtful person who works with technical-minded and technical-trained persons finds this to be a characteristic blind-spot.

Of course, as long as Techmen work and associate largely with other individuals whose possible limitations are likely to be similar to their own, serious social consequences seldom follow from even drastic instances of over-structurizing intellectual situations. But when our students leave the campus, either socially during their student days, or permanently with a degree or two, real trouble may arise.

It is all too common for Techmen to carry their Tech-ness into every human situation, seeking to impose the same rigor and logical organization upon people and society that they find (or attempt to find) in their technical subjects.

## The slide-rule tells all

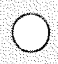
We have all heard remarks about the Tech student "trying to figure people out by slide-rule" or "seeking a formula for getting along with women." Apparently there is as much truth as wisecrack in such remarks. The Techman is prone to handle people in general as he handles tools and equipment, and in social situations where relationships are not clear on the surface he is likely to be baffled and irritated in the extreme.

In the case of our students this is more than youth's characteristic demand for candor and the elimination of hypocrisy in social situations. There is, in addition, an insistent need for clear-cut organization, obvious cause and effect relations, and for opportunities to frame inductive social generalizations. Since people are too complex and society too devious to permit this very often, our bright but sometimes limited students are frequently at a marked social disadvantage. While we manage to keep all but a few from crawling into an antisocial shell of research laboratory isolation, it seems to me that the Institute must keep seeking for more effective ways to teach our students how to get along better with people.

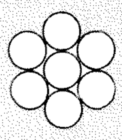

*Isn't there a formula for this kind of thing?*

We share this problem with all technical schools, and we pride ourselves that Tech has pioneered efforts toward humanizing scientists and civilizing engineers. Because a high percentage of our graduates eventually assume supervisory and managerial positions of some kind, in which working with people becomes of greater importance than working with things and physical forces, the problem is particularly urgent on our campus.

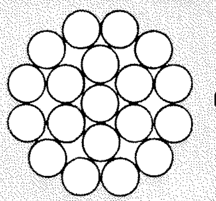
The Humanities Division, together with the Institute administration, constantly seeks better ways of meeting the problem, and suggestions from alumni are particularly welcomed. There is every indication, however, that any real solution will be far in the future. Both by nature and by nurture, technical students are too habituated in rigorous, highly-organized types of thinking to acquire facility easily in other types of thought. Yet some facility in this secondary type of thinking must be acquired if one is to be a good citizen, a tolerable neighbor, and a socially-integrated person. Hence, it seems obvious that the Institute has obligations in this direction which are just as compelling as our obligations to give the student professional competence.



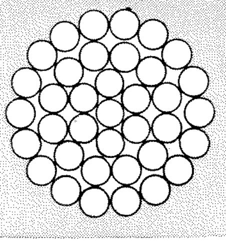
Solid



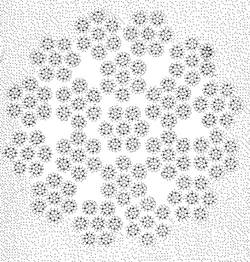
7 strand Concentric Stranding



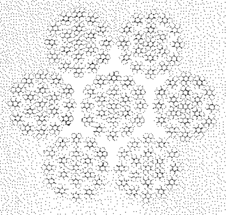
19 strand Concentric Stranding



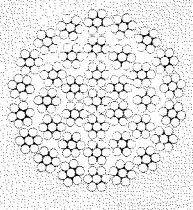
37 strand Concentri Strandin



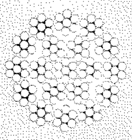
19 x 7 x 19 Rope-Lay Bunched



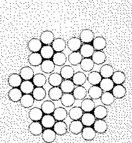
7 x 19 x 7 Rope-Lay Bunched



37 x 7 Rope-Lay Concentric



19 x 7 Rope-Lay Concentric



7 x 7 Rope-Lay Concentric

**No. 2 in a series**

# The Importance of Electrical Conductors

**In the ability to transmit electricity,** all forms of matter may be divided into two general classes, namely, conductors and insulators. Conductors permit electric current to flow readily; that is, they offer little resistance to its flow, whereas, insulators offer relatively great resistance to the flow of electricity. All substances at normal temperatures offer some resistance to the flow of electric current. In general, the metals are good conductors, while glass, oil and most organic substances are classed as insulators. Although silver offers the lowest resistance to the flow of electricity of the common metals, its cost is such that it is not widely used as a conductor. The conductors most generally used in the cable industry are made of copper or aluminum.

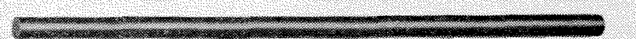
The manner in which electricity flows through elementary material may be readily visualized from the modern concepts of the structure of matter. According to these concepts all elements are made up of minute indivisible particles called atoms. These in turn are composed of a positively charged nucleus around which one or more very small negatively charged particles, called electrons, rotate at high velocity. In conductors, some of these electrons are free to move when only a small difference of potential is applied to the ends of the conductor and, since they are negatively charged, they flow to the positively charged end. This movement of electrons is electric current.

**In passing through conductors,** *the electrons must pass through the electron fields of many atoms. They thus collide with the atomic nuclei and other electrons. These collisions obstruct the flow of electrons and result in electrical resistance.*

The resistance of a homogeneous conductor of uniform cross-sectional area varies directly as its length and inversely as its cross-section, the length being in the direction of current flow. That is, $R = \rho L/A$ where, R is the resistance in ohms, L is the length in the direction of current flow, A is the area perpendicular to the length and $\rho$ is a constant of the particular material known as its specific resistivity. When the length and area are expressed in the same units such as L = one inch and A = one square inch, $R = \rho \times 1/1$ or $R = \rho$, the specific resistance of the material in ohms per inch cube.

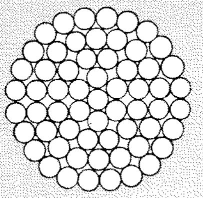
The length and area of a conductor are generally expressed in other units than inches. The most commonly used unit of cross-sectional area used in the cable industry is the circular mil, usually designated as cir. mil or CM. This

**UNITED STATES RUBBER COMPANY**

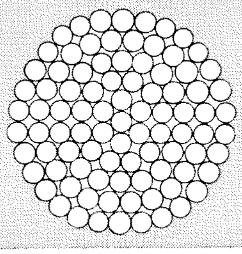


Solid

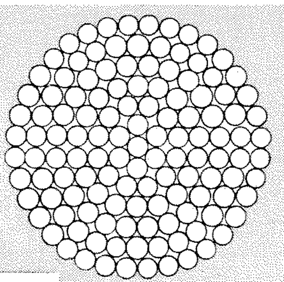
Concentric Stranding



61 strand
Concentric
Stranding



91 strand
Concentric
Stranding



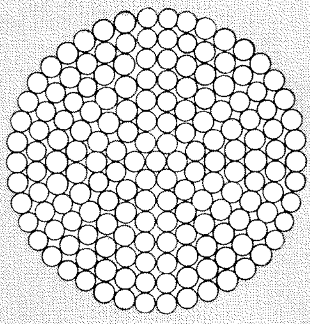
127 strand
Concentric
Stranding

the area of a circle whose diameter is ne mil, 0.001 inch. The area of a cir- ılar mil is $\pi/4$ or 0.7854 of a square ıil. The unit of length usually associ- ıed with this unit is the foot and the ›sistance becomes ohms per CM-foot. he resistance of annealed copper and uminum per circular mil-foot at 20C ·e 10.371 and 17.011 ohms respec- vely. The resistance of a copper con- ıctor 64 mils in diameter and one foot ›ng thus becomes $10.371 \div 64^2$ or .00253 ohms.

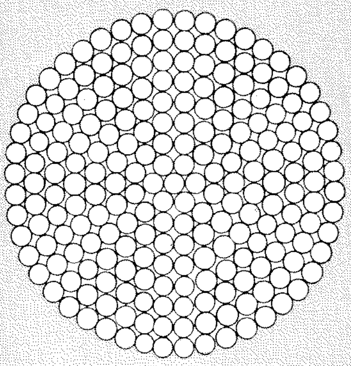
**ie sizes of electrical conductors** *are ex- ·essed in the United States in terms of ıe American Wire Gauge. This was ·iginally set up on the basis of a geo- ıetrical progression of 39 steps or sizes ·tween a wire 460 mils in diameter ·ize 4/0) and a wire 5 mils in diameter ·ize 36). The ratio of the diameter of wire to that of the next larger size in ıis series is 39 $\sqrt{460/5}=1.12293$. This ıtio has since been used to extend the merican Wire Gauge (AWG) to sizes naller than 36 AWG (5 mils). The zes of conductors larger than 4/0 are ·pressed in circular mil area. The size ' a conductor made up of a number of ires is determined from the sum of ·e circular mil areas of the individual ires.*

When current flows through a con- ıctor there is, according to Ohm's law, voltage drop of $E = IR$, where E is in ›lts, I is in amperes and R is in ohms ong the conductor and power equal to I watts is converted to heat. Since $=IR$, this power converted to heat be- ›mes $I^2R$ watts. These two factors, ›ltage drop and conductor heating, are ∶ prime importance in the design of conductors. Conductors must be suffi- ciently large in cross-sectional area, that is, must have sufficient low resist- ance that the voltage drop does not be- come excessive. In good design this voltage drop should not exceed 3 per cent for power circuits or 1 per cent for lighting circuits. The conductors should also be large enough that their tempe- rature does not exceed that for which their insulation is designed. This is re- ferred to as the current carrying capac- ity of conductors. The current carrying capacities of the various sizes of con- ductors, conductor insulations and in- stallation conditions have been estab- lished. It should be noted that the temperature attained by a conductor depends not only on the amount of heat generated but also on the thermal resist- ance of its surroundings.

**In addition to providing satisfactory** voltage drop and current carrying ca- pacity, conductors must be designed to provide adequate flexibility during in- stallation and service. This is accom- plished by building up the conductor from one or more adequately small wires depending on the flexibility re- quired. For example, the conductor for heater cord or welding cable which is subject to repeated flexing in service is usually made up of copper strands hav- ing a diameter of .005″ or .0063″ while the conductor for overhead weather- proof cable may be a single wire.



169 strand
Concentric
Stranding



217 strand
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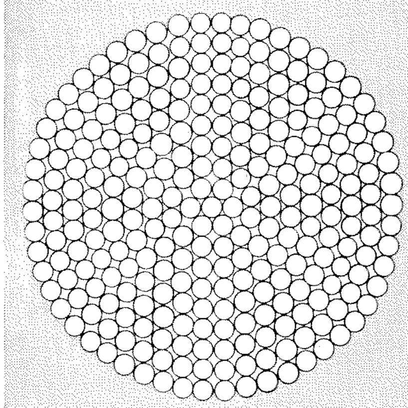

271 strand
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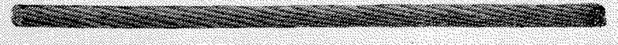

Rope Stranding

Bunched Stranding

*The tables are turned—and the Caltech faculty provides waiter service for the students for a change*

**STUDENT LIFE**

# FACULTY WAITERS

ASCIT VICE-PRESIDENT Pat Fazio hatched a novel idea to promote the 1953 Consolidated Charities Drive. The Drive, representing the World Student Service Fund, the Pasadena Community Chest, and the American Heart Association, enables the donors to kill three birds with three stones, but they can toss all the stones with one throw. Before the drive, Fazio announced that a unique "prize" would be awarded to the student house having the highest per capita donation.

As the Drive progressed it was announced that the prize would consist of special waiter service for one meal from a few select faculty members, including Beadle, Pauling, Sharp, Strong, Eaton, Kyropoulos, Schutz, Varney, Weir, and Feynman.

The winning house turned out to be Dabney, so the Dabneyites were treated to a steak dinner, amid flowers, candle light, champagne bottles filled with punch, tuxedo-clad faculty waiters, and a trio consisting of John Scott Campbell (piano), Pol Duwez (cello), and A. Erdelyi (violin). Hero of the evening was Professor George Beadle who, except for one unfortunate mishap in the kitchen, displayed a degree of polish and finesse carrying trays with one hand that suggested that biology was not his only profession.

## Basketball Prospects

IT WAS EXACTLY thirty years ago that Caltech took first place in the conference in basketball, and even that victory had to be shared with Oxy.

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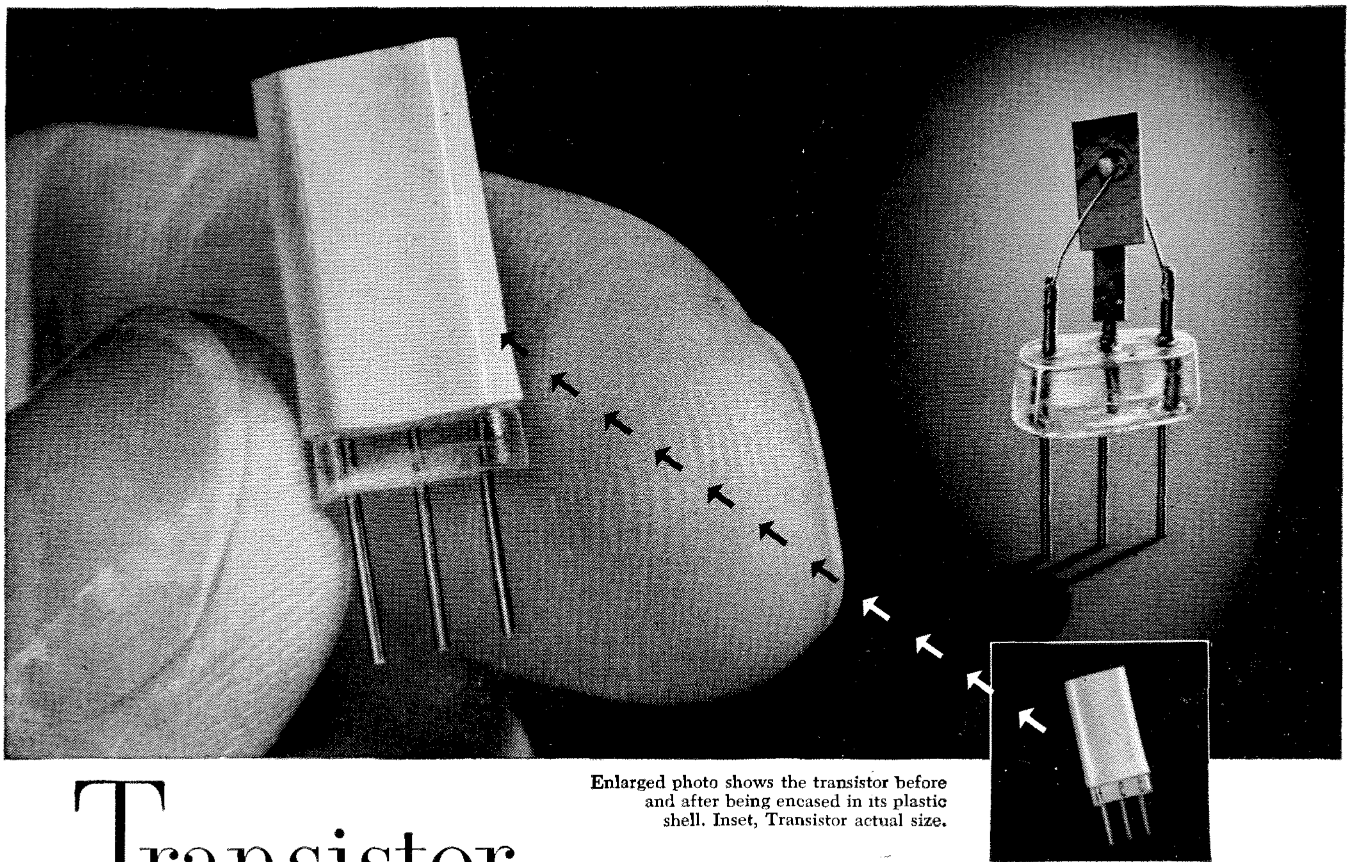


Enlarged photo shows the transistor before and after being encased in its plastic shell. Inset, Transistor actual size.

# Transistor—

# mighty mite of electronics

Because of growing public interest in transistors, RCA—a pioneer in their development for practical use in electronics—answers some basic questions:

**Q:** ***What is a transistor?***

**A:** The transistor consists of a small particle of the metal germanium imbedded in a plastic shell about the size of a kernel of corn. It controls electrons in solids in much the same way that the electron tube handles electrons in a vacuum. But transistors are not interchangeable with tubes in the sense that a tube can be removed from a radio or television set and a transistor substituted. New circuits and components are needed.

**Q:** ***What is germanium?***

**A:** Germanium is a metal midway between gold and platinum in cost, but a penny or two will buy the amount needed for one transistor. Germanium is one of the basic elements found in coal and certain ores. When painstakingly prepared, it has unusual electrical characteristics which enable a transistor to detect, amplify and oscillate as does an electron tube.

**Q:** ***What are the advantages of transistors?***

**A:** They have no heated filament, require no warm-up, and use little power. They are rugged, shock-resistant and unaffected by dampness. They have long life. These qualities offer great opportunities for the miniaturization, simplification, and refinement of many types of electronic equipment.

**Q:** ***What is the present status of transistors?***

**A:** There are a number of types, most still in the development stage. RCA has demonstrated to 200 electronics firms—plus Armed Forces representatives—how transistors could be used in many different applications.

**Q:** ***How widely will the transistor be used in the future?***

**A:** To indicate future applications, RCA scientists have demonstrated *experimental* transistorized amplifiers, phonographs, radio receivers (AM, FM, and automobile), tiny transmitters, and a number of television circuits. Because of its physical characteristics, the transistor qualifies superbly for use in lightweight, portable instruments.

* * *

*RCA scientists, research men and engineers, aided by increased laboratory facilities, have intensified their work in the field of transistors. New applications in both military and commercial fields are being studied. Already the transistor gives evidence that it will greatly extend the base of the electronics art into many new fields of science, commerce and industry. Such pioneering assures finer performance from any product or service trade-marked RCA and RCA Victor.*

**CONTINUE YOUR EDUCATION WITH PAY—AT RCA**

**Graduate Electrical Engineers:** RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

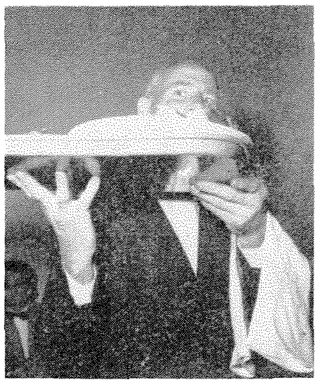
- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

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

RCA ®

***RADIO CORPORATION OF AMERICA***

***World leader in radio—first in television***



*Beadle in balance*

*1—Charming hostess—1*

## STUDENT LIFE . . . CONTINUED

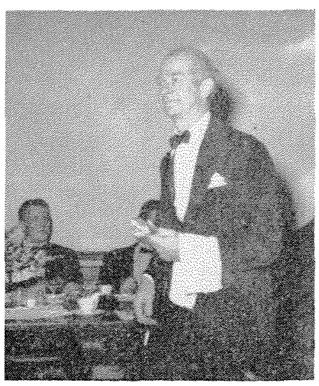
Although we cannot report that we turned the trick again, prospects for doing so in the relatively near future are looking up. With only one senior on the first team, our squad managed to tie with Redlands for second place behind Whittier.

The play-off game was on our home floor at PCC and at the end of the first three quarters, Tech held winning margins of 18-17, 40-30, and 53-42, respectively. It was then that the Tech team began to show that strain is proportional to stress, and Redlands nipped the lead steadily until the gun sounded with the score tied at 68-68. In the following overtime period that was to determine second place in the conference, the Beavers' wind and talent lasted longer than their temporary and almost disastrous fourth-quarter slump.

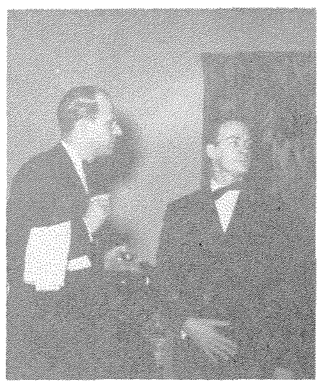
After the smoke of battle had cleared away, Tech had captured undisputed second place and placed junior center Fred Anson on the all-conference first squad, and sophomore Bill Chambers on the all-conference second team. Because only a very few of the squad are seniors, and also because a large part are sophomores, it looks as if our basketball teams may indeed do even better in the next year or two. What more could we want than a championship team and a new gym?*

**Girl Cheerleaders*

*—Al Haber '53*



*Spoons coming up*



*That tie—it won't do*

to the

# ELECTRICAL ENGINEER

or

# PHYSICIST

with an interest in

# RADAR

or

# ELECTRONICS

*Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operation.*

## *Here is what one of these positions offers you:*

### THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

### THE NEW OPENINGS

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

### THE TRAINING

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work with us.

### WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

### YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

## *How to apply:*

**HUGHES**

**RESEARCH AND DEVELOPMENT LABORATORIES**

*Scientific and Engineering Staff*
*Culver City, Los Angeles County, California*

*See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.*

# THE MONTH AT CALTECH

## Smog Progress

SPEAKING AT THE ANNUAL meeting of the American Chemical Society in Los Angeles last month, Dr. A. J. Haagen-Smit, Professor of Bio-Organic Chemistry at the Institute, predicted that 50 percent of the present smog menace in this area will be banished by the middle of 1955.

Because of the cooperation of oil refineries, said Dr. Haagen-Smit, the amount of smog produced daily has already dropped from 1800 to 1600 tons. In two more years, he anticipates another decrease of 400-500 tons. "This rate of decrease," he said, "will cut eye irritation materially as the companies cut out more 'swimming' oil tanks and adjust their tanks.

"We now get about 800 tons of smog daily from automobile exhausts and 800 tons from industry."

Also, last month, Dr. Haagen-Smit witnessed a demonstration of a new device intended to eliminate materials from automobile exhausts that cause the worst part of our smog problem.

Called the Oxy-Catalyst Muffler, the device replaces regular mufflers in cars, and takes carbon monoxide and fumes out of spent gasoline—thus preventing it from contributing the hydrocarbons in smog that irritate the eyes and lungs.

The muffler was invented by Dr. Eugene Houdry of Philadelphia—who also perfected the refinery cracking process that has been blamed for adding to Los Angeles' smog. It contains porcelain, coated with catalytic aluminum and platinum alloys. Now undergoing tests in the County Air Pollution Control laboratories, the muffler, at present, is effective only on white gasoline.

"When it is perfected to do the same on leaded gasolines," says Dr. Haagen-Smit, "we will have the means at hand for bringing the end of smog problems much closer, if our public representatives can induce the public to cooperate."

## Caltech on TV

CALTECH IS COOPERATING with some 20 other colleges and universities on a television educational project which will get under way next fall. It will consist of a weekly series of filmed programs showing research activities at various schools. The series, to be known as "The Search," will start on the CBS television network on October 1, and run for at least 26 weeks.

Typical projects already scheduled for broadcast are "The Old Folks," a study in geriatrics by the University of Chicago; "Great Issues," a Dartmouth College course designed to make students aware of global cross-currents of thought; the Massachusetts Institute of Technology's "Labor-Management Institute"; and "Oceanography" at Columbia University.

Caltech's subject, still to be decided, may concern research with the 200-inch telescope, the new electron synchrotron, or work in aeronautics and jet propulsion, or the life sciences.

## Pauling's Peregrinations

DR. LINUS PAULING, Chairman of the Division of Chemistry and Chemical Engineering of the Institute, left this month for a five-week visit to Europe and the eastern United States.

He was scheduled to visit protein research groups in London and Cambridge, England, enroute to Brussels, Belgium, to attend the 9th triennial Solvay Congress starting April 6. Topic of the Congress is "Chemistry of Proteins," and Dr. Pauling will report recent Caltech findings regarding the molecular structure of proteins (*E&S*—February, 1953).

Dr. Pauling will return to this country in time to deliver the Treat B. Johnson Lectures in chemistry at Yale University, April 16-21.

On April 17 he will attend the annual Page One Ball of the Newspaper Guild of New York at the Astor Hotel, where he will receive one of the Guild's annual Page One awards for "opening the way to understanding the structure of the substance of life, the protein molecule." Others to receive awards this year include Judge Learned Hand, actor Victor Moore and author Carl Sandburg.

Dr. Pauling will also attend the meetings of the American Philosophical Society, of which he is a vice-president, and of the National Academy of Sciences, in Philadelphia and Washington, respectively. He returns to Pasadena May 6 after delivering the Foster Lectures in chemistry at the University of Buffalo.

## Sloan Scholarships

THE ALFRED P. SLOAN Foundation of New York announced a new National Scholarship program last month which provides for a minimum of 25 scholarships to be awarded for undergraduate study at Caltech, the Carnegie Institute of Technology, Cornell University, or the

CONTINUED ON PAGE 34

Massachusetts Institute of Technology. The scholarships will provide up to $2,000 a year for four years of study.

The purpose of the program, according to Alfred P. Sloan, Jr., President of the Foundation, is "to find and gather together on each of these four campuses outstanding representatives of American youth, regardless of their economic background, who show exceptional scientific promise. We are as anxious to find the so-called 'rich' boy as we are the 'poor' boy; it is the man that is important."

Basic to its national program, he said, is the belief of the Foundation that:

"1. Vigorous private education at all levels is vital to the health of the American way of life and the American educational system and that, consequently, American business has a responsibility to support private education.

"2. There is a constant and ever-expanding need in our society for leaders of high character, sound personality, and exact training who have been imbued with the ideals inherent in our American spiritual and political heritage. We believe private institutions are particularly successful in developing this kind of man.

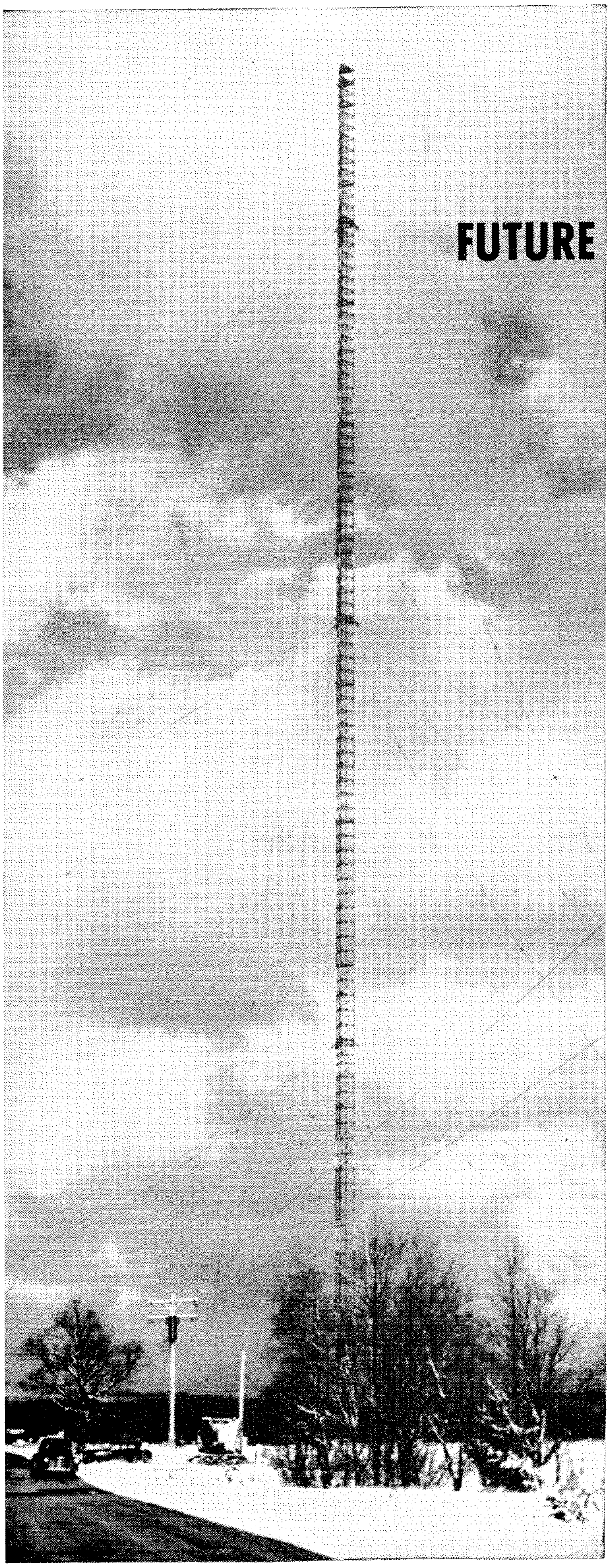
"3. Philanthropic organizations, business, and individuals should, in making grants of all kinds to education, take into account the fact that tuition and fees paid by students do not cover the cost of education and overhead."

## Union Carbide Scholarships

The Union Carbide and Carbon Corporation announced a new scholarship program this month which gives Caltech 16 new undergraduate scholarships. The scholarships will cover tuition and provide allowances for books and required fees for four years of undergraduate study. The Union Carbide Educational Fund will also match each scholarship with a $600 grant-in-aid annually to the Institute.

Caltech and Pomona College are the only two California institutions among the 24 in the country chosen to participate in this program, which is to include some 400 scholarships at an estimated yearly cost of $500,000.

Eight of Caltech's 16 scholarships will be awarded for the coming school year. Four three-year scholarships will go to qualified freshmen, when they become sophomores next September; and four four-year scholarships will go to qualified students who have already applied for scholarships and for admission to Caltech next year. The deadline for new applications for the 1953-54 school year had already passed when Union Carbide announced its new scholarship program, but students who seek admission as freshmen for 1954-55 and succeeding years may apply directly for the four-year Union Carbide Scholarships. Four are to be awarded to incoming freshmen each year.



# A Quarter Mile Up
# FUTURE JOBS ARE BEING ENGINEERED

Your future lies not in the obvious, the complete, the established. It is forming on the drawing boards, in the laboratories and within the minds of men.

Don't look to what is, but to what shall be. Fortune comes from the new.

This Air Force Radio tower, a 1218-foot equilateral steel triangle, is the tallest in the world; second among man-made structures only to the Empire State Building. It was designed and fabricated by Republic's Truscon Steel Division. The operation of this tower is government business. But its stresses and its resistances are Republic's. The engineering of this lacy pinnacle will find adaptations in the near future. They are being shaped now in the metallurgy and design departments of Republic. A quarter mile above the earth, the steel toys with gales and totes an unpredictable burden of ice. And the facts of these achievements shall be translated by men of your generation into the still higher pinnacles of the future.

Republic's Truscon Steel Division leads the world in radio towers. Republic's other divisions push forward other frontiers. No manufacturer makes more kinds of steel, nor any better. But the making of steel is only one phase of Republic. Our many divisions design innumerable products, fabricate thousands of items.

Here lies the new—the realm for young men of talent and vision.

**REPUBLIC STEEL**

REPUBLIC STEEL

WORLD'S WIDEST RANGE OF STEELS AND STEEL PRODUCTS

# ALUMNI NEWS

## Alumni Treasurer

HENRY R. FREEMAN, Ex. '25, recently resigned from the position of Treasurer of the Alumni Association, and turned over the job to George B. Holmes '38. The switch was made so smoothly and quietly, however, that a good many alumni still aren't aware of the change.

Hank Freeman served as Treasurer of the Alumni Association, by popular demand, for six years. Hank is a native son, born in South Pasadena, where he went to high school. He was studying civil engineering at Tech when he transferred to the University of California at Berkeley in his senior year, and took a course in commerce.

After graduation, Hank went to work for a year in the surveyor's office of the County of Los Angeles. He then transferred to the road department, under Earle Burt '15. All told, Hank worked for the County for 18 years. While he was there he studied accounting, at night, then went to work for a national firm of Certified Public Accountants. In 1945 he passed his CPA exam, and went into partnership with Richard Miller. He's still a partner of Miller & Co. in Los Angeles today.

He served as Treasurer of the Alumni Association from 1946 through 1952.

"It is gratifying to me," says Alumni President John Sherborne, "to have the opportunity to express appreciation for the really splendid contribution Hank

*George B. Holmes*

*Henry R. Freeman*

Freeman has made to the Alumni Association.

"Had he done no more than to look after the Association's financial matters, his performance would have been worthy of tribute. However, over and above what was required of him, he regularly attended meetings of the Board of Directors of the Association and made many valuable suggestions.

"I am confident that everyone concerned with alumni affairs shares with me the pleasure of having worked with Hank."

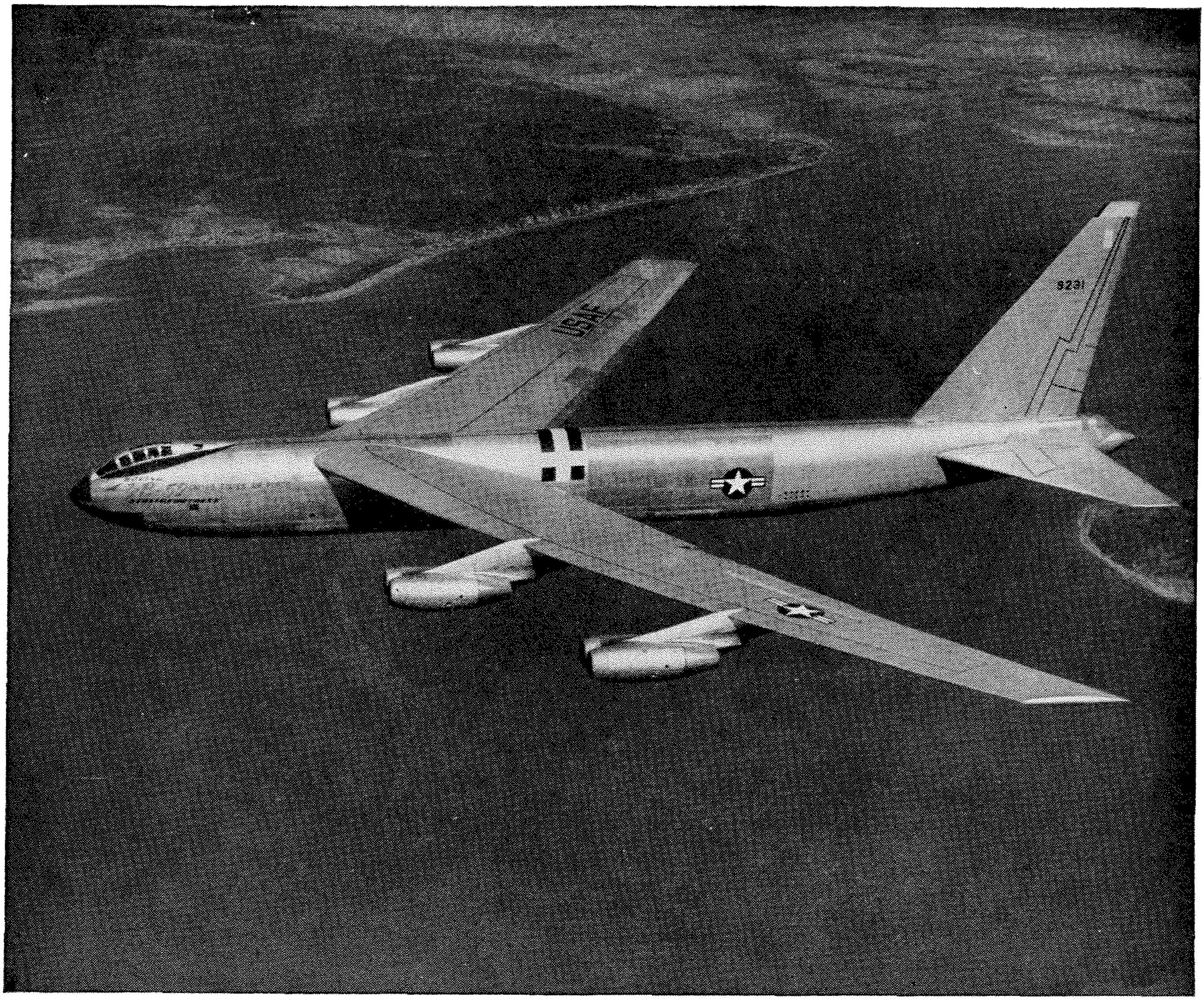
George B. Holmes, the new treasurer, received his B.S. in engineering at Tech in 1938. In 1941 he got his MBA degree from the Harvard Graduate School of Business, and, in June of the same year, joined Douglas Aircraft's Santa Monica plant.

In 1943 George transferred to the new Oklahoma City plant of Douglas, to direct budgetary control and special cost analyses for the plant comptroller.

In 1945-46 he did a short hitch in the Navy. After a year of management counselling, George joined the staff of the Huntington Memorial Hospital in 1948 as chief accountant, supervising all accounting and budgetary functions. This year George is also serving as treasurer of the Economic Section of the Hospital Council, professional association of Southern California's hospitals.

## Coming Events

The Annual Alumni Family Picnic will be held on June 27 at the San Diego Zoo. Save the day . . . The Class of '43 plans a three-day celebration for its 10th reunion, June 12-14. Details on both these functions next month.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# PERSONALS

## 1920

*Walter A. Keith* died on January 12, 1953, at the White Memorial hospital in Los Angeles. He had worked for the Los Angeles County road department for 33 years, the last 12 of which he spent in this area as district engineer. He is survived by his wife, Josephine, his son, Fred, of Alhambra, and his mother, Mrs. Alice Keith, of South Pasadena.

## 1923

*Jack R. North* is one of five engineers appointed to serve on the Scientific Advisory Committee on Specialized Personnel to the Director of Selective Service, General Lewis B. Hershey. Jack is located in Jackson, Michigan, where he is vice-president and chief electrical engineer of Commonwealth Associates Inc., and a member of the Board of Directors of Commonwealth Services Inc. of New York.

## 1928

*Douglas G. Kingman*, M.S. '29, is now manager of Joint Venture Operations, Production Department, of the General Petroleum Corporation. Doug has been assistant manager since mid-1952, and from 1945-52 was superintendent of the department's San Joaquin division.

## 1931

*Glenn M. Webb* has been advanced to section leader on catalyst research and development at the Standard Oil Company's Whiting, Indiana, laboratory. Glenn joined the company as a research associate in 1948.

## 1932

*Robert W. Webb*, M.S., Ph.D. '37, Professor of Geology at the University of California, Santa Barbara College, has been appointed to the joint position of Executive Secretary of the Division of Geology and Geography of the National Research Council, and Executive Director of the American Geological Institute. As Executive Director he will supervise the program of education, public relations, and the representation of geological viewpoints to Federal and State governmental agencies. Bob is also co-author with Dr. Joseph Murdoch, Professor of Geology at U.C.L.A., of a 1952 supplement to "Minerals of California," published by the Division of Mines of the Department of Natural Resources. He is on sabbatical leave this year, doing special research at Harvard and visiting other Eastern colleges to survey new discoveries in the field of geology.

*Charles D. Coryell*, Ph.D. '35, was recently awarded a Louis Lipsky exchange fellowship to study nuclear phenomena and the structure of the pigment of the red cell at the Weizmann Institute in Rehovoth, Israel.

## 1933

*Wyatt Lewis* was recently awarded the General Electric Company's Charles A. Coffin Award for his work in developing a system of controlling the quality of electric irons manufactured by G. E.'s Ontario, Calif., plant. He was one of 40 men across the nation to receive this award for outstanding merit. Wyatt is manager of quality control at the Ontario works. He is also regional director of the American Society for Quality Control for the Western region, and is currently an instructor for evening courses at Norton Air Force Base in San Bernardino.

## 1935

*Bruce Gravitt* left San Diego in August, 1951, after being a sales engineer for General Electric there for more than 12 years. He is now manager of instrument transformer sales for G. E. in West Lynn, Mass. Bruce is married and has two sons—Jimmy, 3 and Stephen, 2. He recently made a swing around most of the West Coast General Electric offices, including San Francisco, Los Angeles, and San Diego.

*Jack M. Roehm*, M.S., resigned his position with Pullman-Standard Car Mfg. Co. last October to accept a position as Director of Research and Development for the Kawneer Company in Niles, Michigan. The Roehms (including their two children, Judy and Ed) are enjoying their new associates and finding this resort area of Michigan a delightful place to live.

*Dan H. Miller* has been appointed district manager for the Square D Co. in the Pacific Northwest, with headquarters at the company's Seattle plant. Dan has been with the Square D Co. for 17 years as field engineer, industrial control sales specialist and industrial control sales manager for the western division.

## 1938

*Philip T. Ives*, Ph.D., says he's still involved in research work with Drosophila at Amherst, in population and radiation genetics. He's also active in town affairs, particularly in problems in the public schools, and in church work. Phil got back to

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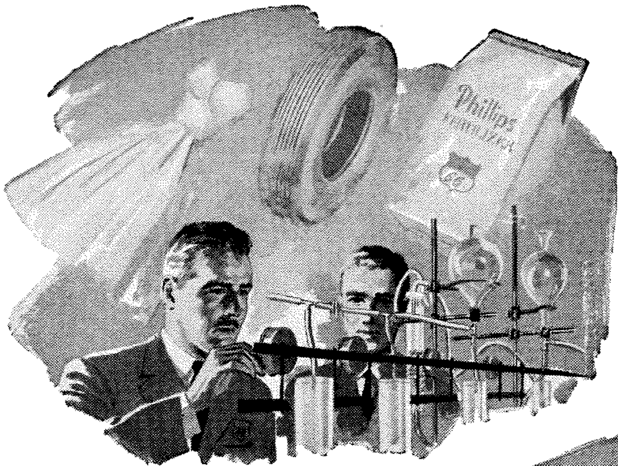



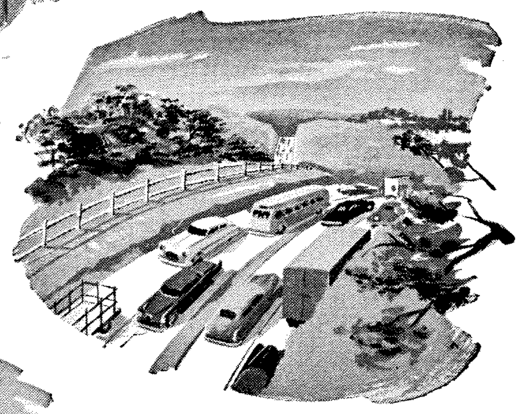





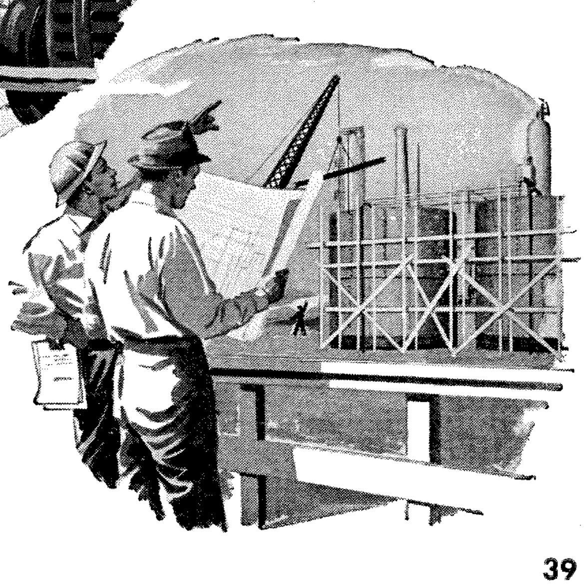

Pasadena last summer for the first time since leaving Caltech in 1938. He found the changes impressive. Phil's the father of four fast-growing children.

## 1939

*William S. Stewart,* Ph.D., has been named chairman of the Department of Orchard Management at the University of California's Citrus Experiment Station in Riverside. A former member of the Experiment Station staff, his research led to the use of 2,4-D and other plant growth regulators on citrus to prevent leaf drop, fruit drop and twig dieback resulting from oil sprays; and also to hold the fruit on the trees until it was profitable to market. Prior to joining the staff of the Citrus Experiment Station, Bill served with the USDA Bureau of Plant Industry, and during World War II was assigned to emergency investigations on rubber production in Mexico. He joined the staff of the Pineapple Research Institute of Hawaii in 1950, where he is currently head of the plant physiology department. He's expected back in Riverside this month.

*Frederick C. Hoff* is still on active duty in the Navy at the Hingham Naval Ammunition Depot in Massachusetts. He has recently been made acting Ordnance Officer as well as Production Officer. He expects to be released from the service around the lrst of July, but plans thereafter are still in doubt—although he has been considering attending the Harvard Grad School of Business. The Hobbs' third child, Douglas Paul, was born January 21—to the delight of his sister Laura, 4, and brother David, 9.

## 1940

*Robert Cox* is still president of Lauderdale Marina, Inc., which now specializes in fibreglas-plastic boats and is probably the biggest dealer handling this line. Bob also passed his exam last fall and is now a registered professional engineer in the state of Florida. His oldest boy is now 15, and 6 feet tall.

## 1941

*Berl D. Levenson,* M.S. '42, joined the Radar Laboratory of the Hughes Aircraft Research and Development Laboratories in Culver City, Calif. He was formerly an engineer with Gilfillan Bros., Inc.

*Col. Von R. Shores,* M.S., following two and one-half years as Chief of the Air Force Sectiou of the Military Advisory Assistance Group to Norway, has been re-assigned to the 27th Air Division (Defense) of the Air Defense Command as Vice Commander.

*Reuben P. Snodgrass,* M.S. '42, who has been with the Sperry Gyroscope Company in Ronkonkoma, New York, since 1948, as an engineering test pilot, has now been promoted to chief engineering test pilot in the company's Flight Operations Department. In this position he supervises the flight test of aircraft indicating and navigation instruments, controls, and armament equipment.

*E. R. Bartlett, Jr.* writes that he's been married since 1949, now has two children—Susan, born in August, 1951; and Ted III, born this January. The Bartletts are living in Wilmington, Delaware, where Ted's doing economic analysis work in connection with synthetic fibers.

*Willard J. Hendrickson* received his M.D. at the University of Michigan in 1945. At present he's instructor in psychiatry at the University of Michigan Medical School in Ann Arbor. He's married and has a three-year-old daughter.

*Robert A. Cooley,* Ph.D., was recently made head of the Rocket Powder Section of Olin Industries, Inc. Formerly on the staff of the University of Missouri as an Associate Professor of Physical Chemistry, he joined Olin in 1951.

*Carol M. Veronda* is engineering section head, working on klystron research, at the

CONTINUED ON PAGE 42

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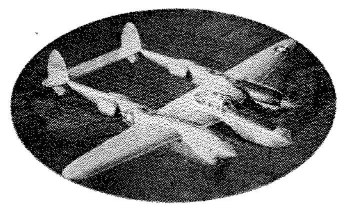
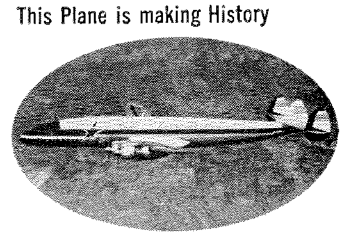


The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



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## PERSONALS . . . CONTINUED

Sperry Gyroscope Company in New York.

*Roy Weller* is still sales engineer for the Ingersoll Rand Company in St. Louis, Missouri. He says he saw *Harrison Price* '42 several times in the last few months, when Harrison was in St. Louis on jobs for the Stanford Research Institute. He also saw *Paul Allen* '42 in St. Louis before Christmas. Paul is living outside Minneapolis, where he works for Parsons Engineering. He moved there in September for a two-year span.

### 1943

*Stanley A. Dunn* has transferred to the Kinetic Sales Service group within the DuPont Company. He still works in the Jackson Laboratory, Penns Grove, New Jersey for the most part, but now makes some contact with various customers in the Aerosol Packaging industry.

*Frank E. Webb*, M.S., was promoted this year to vice-president of the Coast Brokerage and Investment Company in Gulfport, Mississippi. He is also chairman of the town forum meetings held locally by the Chamber of Commerce.

### 1944

*Frank A. Barnes*, a research engineer on the M.I.T. guided missiles program, writes that he's living in Waltham, Mass., now has two daughters—Marilyn, three years old; and Laurel, eight months old.

### 1945

*Stanley D. Clark*, who received his LL.B. degree from Loyola University in 1952, is now associated in the general practice of law with the firm of Chase, Rotchford, Dowmen and Drukker, Los Angeles.

### 1946

*John Showell*, M.S. '49, has been appointed Assistant Professor of Chemistry at Rutgers University, New Brunswick, N. J.

### 1947

*Robert B. Harris* writes from Ann Arbor, Michigan to announce the arrival of James Frederic Harris on February 27. Young James is the Harrises' second child, and second son.

*Robert Ilfeld*, M.S., recently became executive vice president and general manager of Quick Industries, Inc., a company in Jackson, Michigan, engaged in heat treating and hot dip galvanizing. The Ilfelds have three children, aged 6, 3, and 1, and have just moved into a new house they built.

*Richard A. Boettcher*, M.S., has joined the engineering firm of Holmes & Narver, Inc., of Los Angeles, as Project Engineer (Overseas Projects). He's been with Standard Oil of California, El Segundo, and on domestic and foreign engineering assignments for the Arabian American Oil Company since 1948. Before his resignation from Aramco he was staff engineering adviser to executive management in New York.

*L. Edward Klein* has been appointed manager of the intermediates and exploratory products section of the Monsanto Chemical Company's Organic Chemicals Division development department in St. Louis, Mo. He's been with the company since 1947.

### 1948

*Lt. Col. Leroy O. Land*, MS., Engr., has been named chief of the training branch of the operations section at X Corps headquarters in Korea. His wife, Marjorie, recently joined him in Korea. The Lands have three children.

### 1949

*Kent M. Terwilliger* received his Ph.D. in physics at the University of California last September and is now an instructor at the University of Michigan. He was married in December, 1951, to Doris Heisig of Minneapolis.

*Milt Andres*, M.S. '50, is still at M.I.T., but hopes to finish work on his Ph.D. in physics by June, and then head back to southern California.

*Charles H. Arrington, Jr.*, Ph.D., has been made a research supervisor in the

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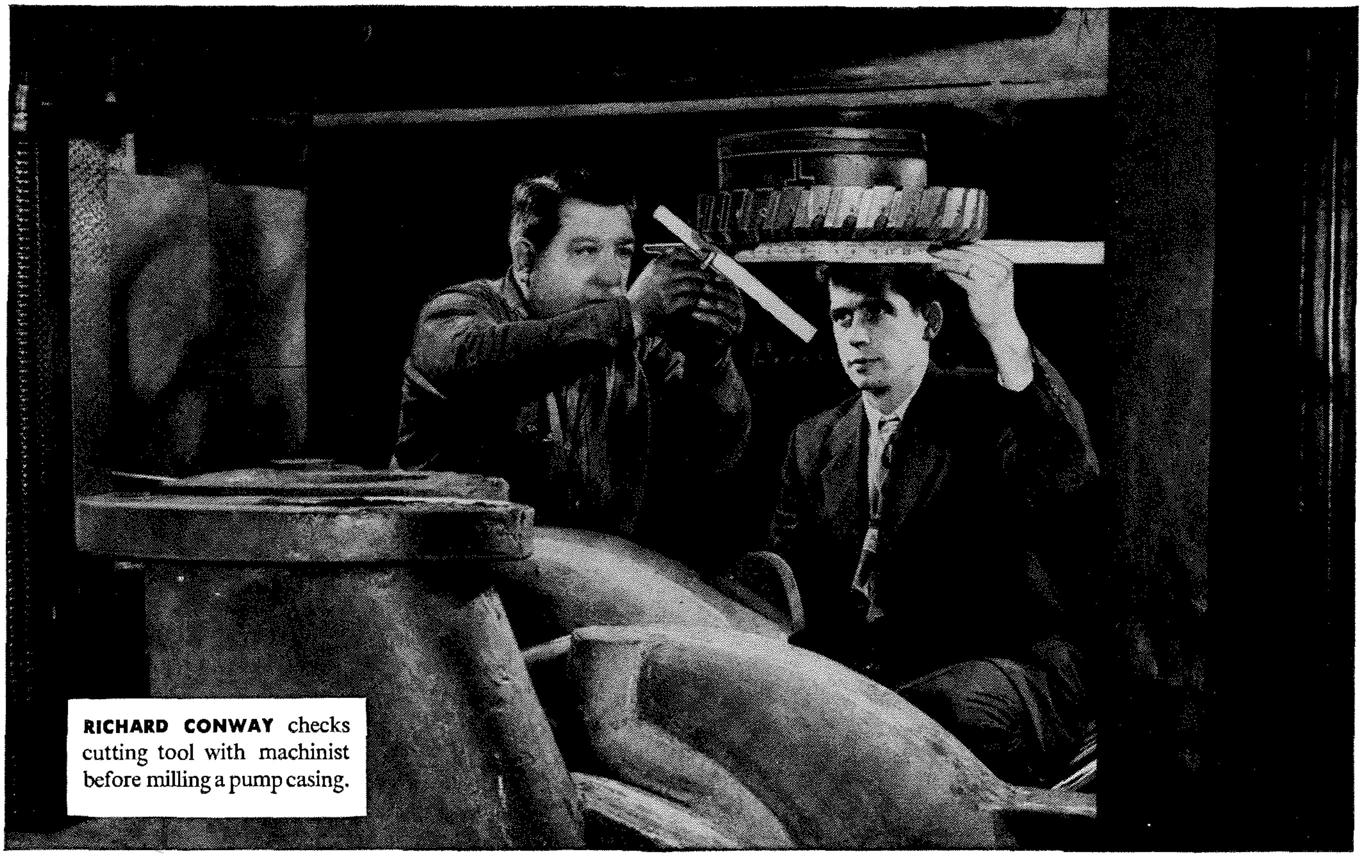
# Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington



**RICHARD CONWAY** checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

"I enjoy my work because I'm doing the work I want and my formal education is being supplemented with practical knowledge gained from the tremendous wealth of knowledge available to me at Worthington. I know from personal contact with many other departments in the Corporation that Worthington can and will find their young engineers a spot which will give them the same opportunities as have been afforded me."

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

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

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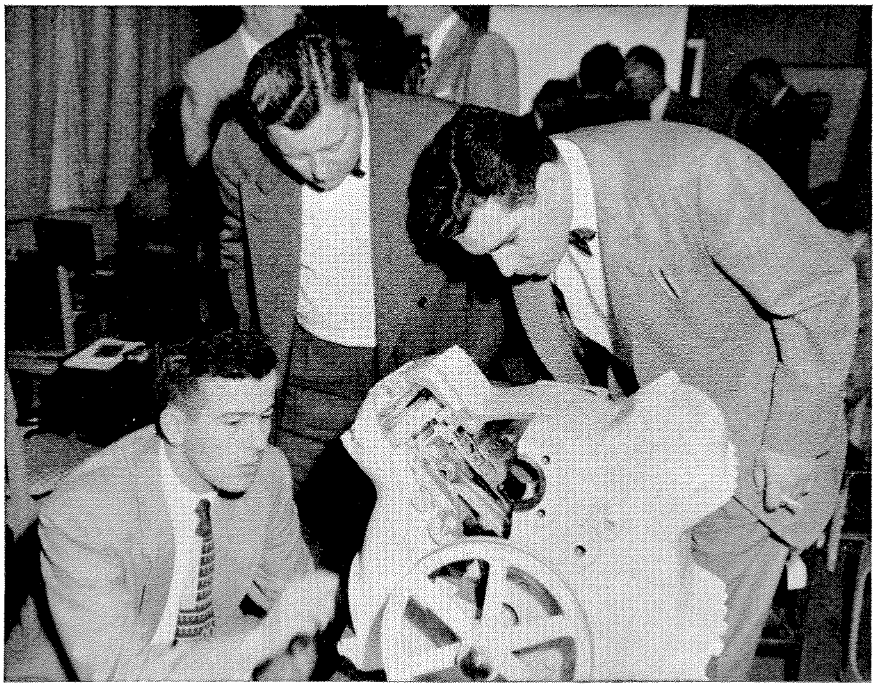

Preparing for specific responsible positions with Trane in sales, research and product design, these graduate engineers are attending a streamlined six-month training course at full pay. This interesting course moves rapidly and adapts the graduate's knowledge of engineering to the position he has chosen.

*Trane Offers Engineering Graduates*

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Those selected will join the Trane Graduate Training Program in La Crosse at full pay. Each man will receive a specialized course to assure personal success in the position he has chosen.

He will learn how Trane equipment is used in jet aircraft, tanks, submarines, ships, skyscrapers, factories, industries, homes and buildings of all types. He will see how rapidly air conditioning is becoming a necessity . . . how it is destined to become a standard requirement in homes, automobiles, schools, offices . . . everywhere.

Graduates move quickly into responsible, well paid positions. Men who joined the company through this training program include the president and numerous company officers, managers of most Trane sales offices and home office sales divisions.

Trane's record has been one of steady growth and leadership for nearly forty years, during both peace and war. Today, new Trane products are being developed constantly . . . creating new departments and promotions . . . assuring continued growth and business opportunities.

For an outstanding career in one of the fastest growing industries, consider your future in air conditioning with Trane. Write immediately to Milton R. Paulsen, Training Department Manager, for the brochure "Trane Graduate Training Program". Next six-month class starts in July

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**For the unbiased answers, read FORTUNE magazine's report on Trane in their August, 1951 issue. Your library should have a copy. A reprint of this report is included in the "Trane Graduate Training Program" brochure which is in your Placement Office.**

# TRANE

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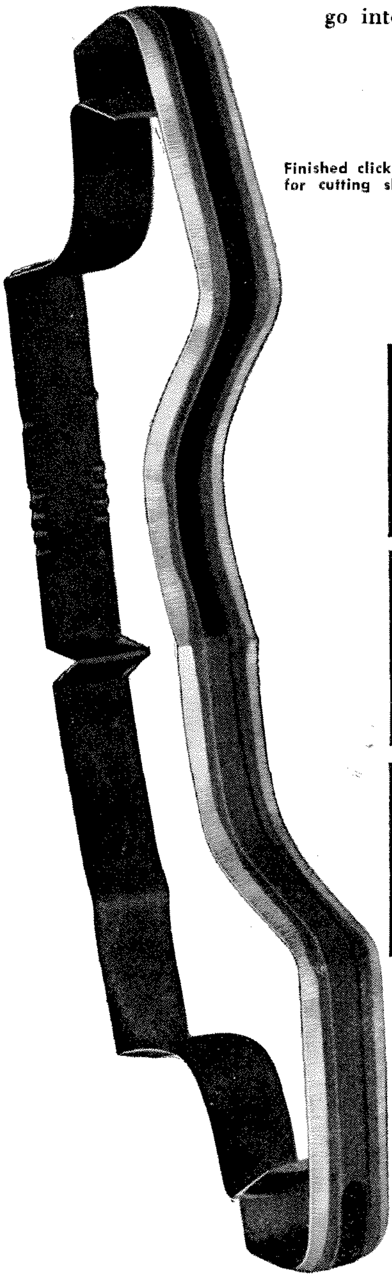
# What's Happening at CRUCIBLE

## *about clicker die steel*

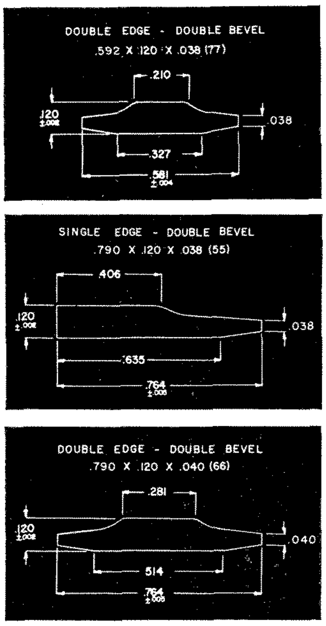
### what it is

Clicker die steel is a special cold rolled alloy steel. It is used in making clicker dies for cutting leather, rubber, plastic, felt and fabrics of other compositions that go into the making of shoes and similar products.



Finished clicker die ready for cutting shoe leather.

Some of the clicker die steel standard shapes.




Wider shapes are used when dies are sized by surface grinding after forming and welding. Standard widths are provided when the dies are not to be surface ground.

### how it is used

Clicker die steel is furnished to the die maker in either single or double edged form in one of several standard shapes. The die maker first shapes the die by bending the die steel to a pattern that provides the desired configuration, and then welds the two ends at a corner. He finishes the die by grinding a bevel on the outside of the cutting edge and filing the inside edge. Before the finished die is hardened and tempered, the die maker forms identification marks – combinations of circles and squares – in the cutting edge so that the material cut from it may be easily identified as to its size and style.

In the cutting operation, the leather or other material is placed on an oak block in the bed of the clicker machine. Then the die is placed by hand on the material which is cut as the aluminum faced head of the machine presses the die through it. The clicking sound which the head makes as it strikes the die is where the term "clicker machine" derived its name.

### what it is composed of

Clicker die steel as produced by the Crucible Steel Company of America is a controlled electric steel in which the combination of carbon and alloy is designed for maximum toughness and proper hardness after heat treatment.

Experience has proved that cold finished clicker die steel is superior to hot rolled material for sizes approximately ¾ inch and narrower because of its lower degree of surface decarburization which permits the use of slightly thinner sections. Cold finished material also has a better surface finish with closer width and thickness tolerances and thinner edges that require less grinding and filing to complete the die.

### CRUCIBLE'S engineering service

As with clicker die steel, the Crucible Steel Company of America is the leading producer of special purpose steels. If you have a problem in specialty steels, our staff of field metallurgists with over 50 years experience in fine steel making is available to help you solve it. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

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53 *years of Fine steelmaking*

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# PERSONALS . . . CONTINUED

Chemical Department of the Dupont Company's Experimental Station in Wilmington, Delaware. He has been with DuPont since 1949, doing fundamental research in various branches of physical chemistry, including fiber research.

1950

*Richard Scott Pierce*, Ph.D. '52, is one of five outstanding young scientists named by the Bell Telephone Laboratories to receive a Frank B. Jewett postdoctoral fellowship for 1953-54. Dick, who is presently conducting studies for the Office of Naval Research, proposes further research on the principles of automatons, clarifying the mathematic fundamentals of how machines can perform near-human operations.

*C. James Blom* is at the University of Innsbruck, Austria, working for a Ph.D. in geology.

1951

*William D. Staples*, M.S., recently returned from a Navy Instructors School in Norfolk, Va., is now working as an electronic scientist with the National Bureau of Standards in Washington, D. C. "Still single," Bill writes, "—but looking."

*Tony Malanoski* is working for the Food and Drug Administration in Washington. He plans to marry Louise Jansen of Philadelphia on June 20.

1952

*Bob Stanaway*, studying law at Stanford, says he's enjoying it very much. He's still a bachelor and still undrafted.

*Len Herzog* is head of the Mass Spectrometric Laboratory which the AEC has set up in the Nuclear Geophysics section of the Geology-Geophysics departments at M.I.T. While he says it's not as grandiose a project as the one at C.I.T., they hope to do some exploring in isotopic abundances (especially of strontium, calcium and argon) of fundamental value.

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bility," Professor Smith's handling of the pastoral and the heroic poetries is illustrative. As he demonstrates, fundamentally important polarities of experience, both of the community and of the person, are rendered in these *kinds;* respectively, the mode of human behaving which is associated with poise, or with man and nature and man and woman in agreeable composition—in short, with *otium*, or the life of contentment; and, the other, which respects action, not aimless, but directed and controlled according to the richest sense of what is purposeful.

"Heroic poetry, then," as he puts it, "points to an ideal comparable to that of pastoral with the difference that the desired state must be earned, must follow the achievement of fame and glory through action. The resolution is therefore on a higher level. The guiding and predominating motive was that of Virtue."

Terms like "pastoral" and "heroic" admittedly are quaint to our ears, as quaint, perhaps, as "glory," "virtue," and "contentment"; but the "desired states" to which they are attached are radically human—and persistent, and we reach feebly for their meanings with the current abstractions of economics and psychology. What the Elizabethans had were the art structures in which the primary "urges" were endowed with meanings appropriate to them, and embodied with movement and beauty which could carry the meanings into the midst of human experience, as something to be cherished, something exemplary.

It is routine stuff nowadays to call attention to our shortcomings, and if that note is struck, it is mine, not Professor Smith's, for at no time does he glorify the Elizabethans at our expense. He does something much better. In examining the nature of their "creative process," he makes clear that the products of this process were indeed "earned"—through study, practice, and imitation ,and, possibly above all, through delight in the "search for vitality" in the art of language.

Although it is no part of the purpose of the book to show us how we may regain what we may have lost, Professor Smith has so well interpreted the creative process as a response to the fundamental human demand that, if we will, we may hope to improve the ordering of our own experience through the appropriation of some part of our large heritage of Elizabethan letters, much as the Elizabethans themselves took advantage of their own inheritance.

Between the chapters on the pastoral and the heroic, Professor Smith treats the sensuous, Ovidian poetry, the sonnet, and satire. The section on the sonnet more than any other comes to close grips with the texts under discussion, notably some of Shakespeare's best-known sonnets. But throughout the middle ground of the book the reader is kept in connection with a range of literature, not, I should say, so directly symbolic of the larger motions of human behavior as the pastoral and heroic are concerned with, but those reflecting the intimate motions of the individual and of his immediate social and political environment.

While in the laboratories we are studying the responses of rodents and arthropods for whatever illumination of the human situation we may get, we may profitably reckon with the enormous documentation of this same situation, which Professor Smith here reminds us that the arts are always giving. It is good to know that the large provision of the California Institute of Technology includes the humanities "laboratory" where the reckoning is being made under such able direction.

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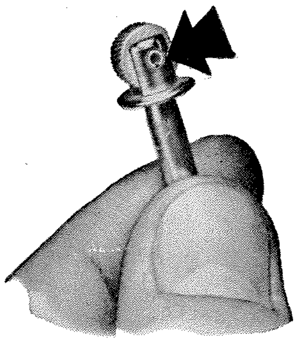
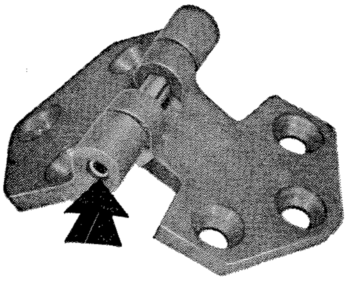
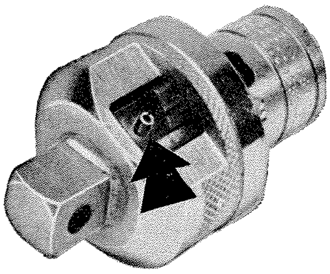
Signode Steel Strapping Co., 2600 N. Western Ave.



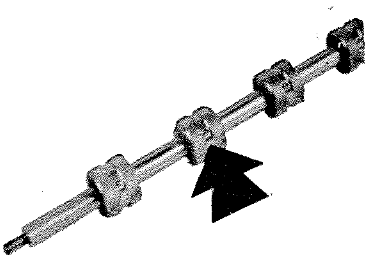
Replacing a rivet



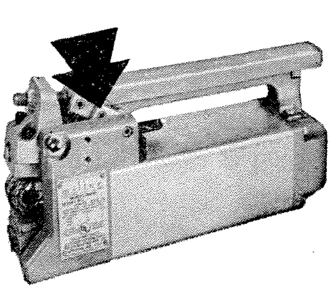
. . . a hinge pin



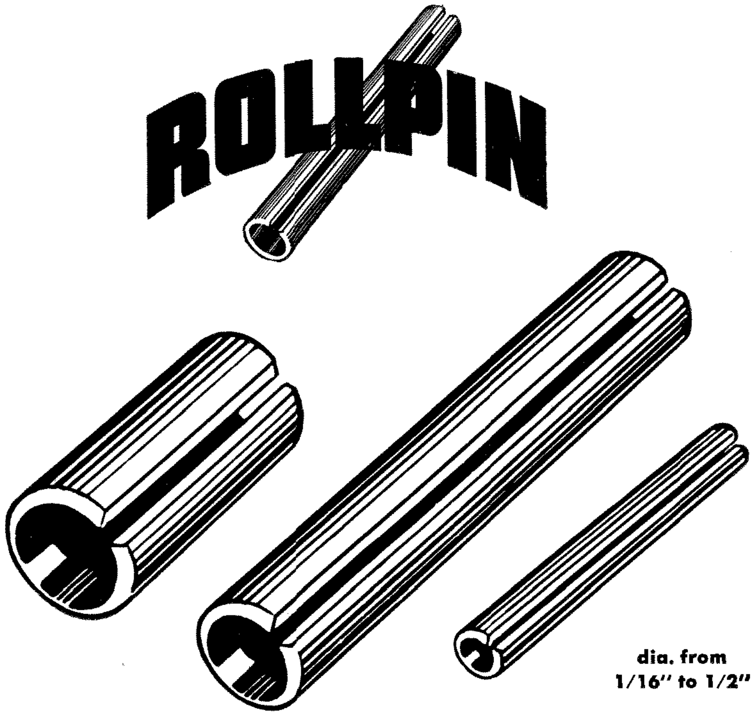
. . . a stop pin



. . . a set screw



. . . a bolt and nut




# . . . a modern fastener that saves time and money on thousands of applications

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

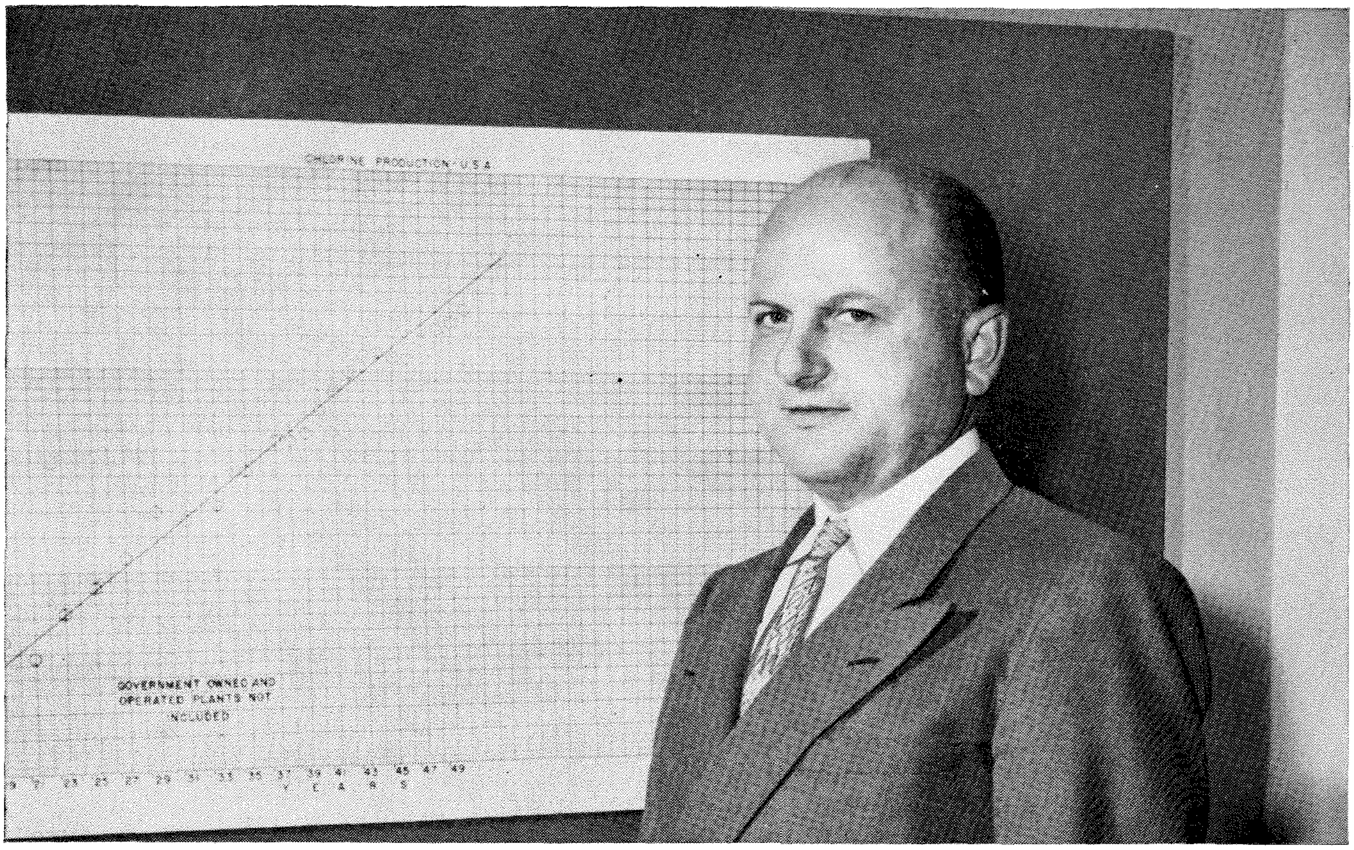
Because of its versatility—and the production economies it makes possible—Rollpin is finding wide usage in almost every phase of manufacturing activity. Write for design information on the Rollpin. It will enable you to cut costs for many applications where use of rivets, set screws, dowels, and straight, serrated or cotter type pins create installation or performance problems.

**ELASTIC STOP NUT CORPORATION OF AMERICA**

**2330 Vauxhall Road, Union, New Jersey**

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

ESNA



# "...Give him the opportunity to grow"

This is Joseph A. Neubauer. He is an important member in the Columbia-Southern organization.

Right now, Mr. Neubauer is Technical Director of the Corporation. He has been on the move, upward, ever since he joined Columbia-Southern after graduation from college.

His progress is worth emulation. But initiative alone is not always the answer to a man's career. You can't launch an ocean liner in a mountain stream. Neither can a man travel far in an unprogressive, stagnant organization. A man needs freedom to put his ideas into action; he needs to move ahead without waiting for vacancies to occur from death or retirement. We believe Joe Neubauer's story will interest you and give you something to think about.

He graduated with a Bachelor of Science degree in Chemical Engineering from Case Institute of Technology in 1932. In 1933, a depression year, he joined Columbia-Southern as a production operator. Within a year, he was named shift foreman.

Shortly afterward, Joe was assigned to the Development Department to work out some problems involving the Soda Ash process. Following this he supervised the engineering and construction of Columbia-Southern's first chlorine unit at the Barberton, Ohio plant. He became assistant production manager at Barberton and, in 1942, was assigned to engineering and construction of the plant at Natrium, West Virginia.

He was elevated to superintendent of operations at Natrium and in 1946 moved to Pittsburgh as technical assistant to the Vice President. In 1949 he was named Technical Director of the Corporation.

Just this past year he was sent by Columbia-Southern to take the Advanced Management Program at Harvard University.

Joe Neubauer has some good advice to pass on to the 1953 graduate. "The main thing for a graduate is to select a company which will give him the opportunity to grow. In the Columbia-Southern organization, the road to top positions is open from many fields . . . whether it be sales, chemical engineering, electrical engineering or various other backgrounds. I would strongly advise any graduate who has an interest in the future to look into the opportunities at Columbia-Southern."

For further information, write now to our Pittsburgh address or any of the plants.

## COLUMBIA-SOUTHERN CHEMICAL CORPORATION

SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY

*420 DUQUESNE WAY, PITTSBURGH 22, PENNSYLVANIA*

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# CALTECH CALENDAR

April 1953

## ALUMNI ACTIVITIES

June 10 — Annual Dinner Meeting

June 27 — Annual Family Picnic at San Diego Zoo

## ATHLETIC SCHEDULE

### VARSITY TENNIS

April 18, 1:30 p.m.
Caltech at Pomona

April 21, 3:00 p.m.
Muir at Caltech

May 6, 3:00 p.m.
Occidental at Caltech

May 8, 1:30 p.m.
Conference Qualifying at Pomona

### VARSITY TRACK

April 17, 3:00 p.m.
Chapman, Cal Poly, Westmont at Caltech

April 21, 7:30 p.m.
Conference Meet at Occidental

### VARSITY SWIMMING

April 22, 4:30 p.m.
Whittier at P.C.C.

April 24, 4:00 p.m.
Redlands at Redlands

May 1, 4:30 p.m.
Pomona at P.C.C.

May 7, 3:00 p.m.
Conference Preliminaries at Pomona

### VARSITY GOLF

April 24, 1:30 p.m.
Caltech at Whittier

May 1, 1:30 p.m.
Caltech vs. Occidental at Brookside

### VARSITY BASEBALL

April 15, 4:15 p.m.
LaVerne at Caltech

April 18, 2:15 p.m.
Redlands at Caltech

April 21, 4:15 p.m.
Muir at Caltech

April 25, 2:15 p.m.
Caltech at Pomona

May 2, 2:15 p.m.
Caltech at Whittier

May 5, 4:15 p.m.
Loyola at Caltech

May 9, 2:15 p.m.
Caltech at Redlands

## DEMONSTRATION LECTURES

Friday Evenings
7:30 p.m.—201 Bridge

April 24—"Radioactive Minerals; Where Are They Found," by Dr. D. F. Hewett

May 1—"Modern Motor Oils," by Professor Peter Kyropoulos

May 8—"The Contribution of Mathematics to the National Welfare," by Professor C. R. DePrima


# . . . to speed production, cut costs, here's how the Douglas Aircraft Co. uses Photography throughout its plants

LIKE thousands of other manufacturers and businesses —large and small—Douglas knows the camera is a short cut to greater production at lower cost.

So, from the time a new employee is welcomed to a plant by motion pictures, until a finished plane is on the ramp ready for delivery, photography is hard at work—training workers, testing metals, checking stresses, reproducing drawings, making records, and speeding work in the business offices.

There are countless ways photography saves time and cuts costs. Any business profits when photography gets to work.

There are so many ways photography aids engineering and so many new applications being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, New York.

**FUNCTIONAL PHOTOGRAPHY**

**. . . serves industrial, commercial and scientific progress**

Kodak
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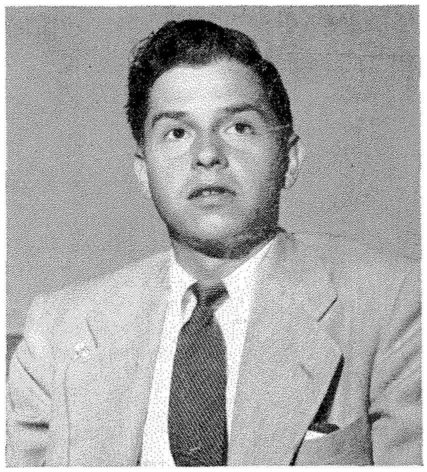
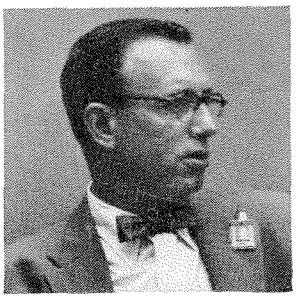
# MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

## *"What opportunities are available in General Electric for a career in manufacturing?"*

. . . EARLE E. WARNER, U. of Illinois, 1952



The answer to this question, presented at a student information meeting held in July, 1952 between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Co., Schenectady, N. Y.



G. C. HOUSTON, *Manufacturing Services Division* . . . In General Electric manufacturing operations involve supervising and administering the activities of more than 100,000 men and women in more than 100 plants. This includes the operation of approximately 75 distinct product businesses, producing some 200,000 different products ranging from heavy industrial equipment to precision instruments and consumers' goods.

The cost of manufacturing our products represents 70% of the total expenditure for all operations including research, engineering, marketing and other administrative functions.

With these activities and expenditures in the field of manufacturing one can readily visualize the breadth of opportunity in the area of manufacturing. This wide scope of manufacturing activities and the importance of their integration into an effective organization provide opportunity for challenging and rewarding careers in such areas as follows:

**Manufacturing Supervision:** The most important part of any manufacturing organization is men—those who apply their varied skills and talents to perform the many tasks involved in the manufacturing process. To direct the activities of these men, to inspire performance, co-operation and teamwork, to provide fair and equitable treatment, to see that work is done in required quantity—on time—and at the lowest possible cost, is the responsibility of Manufacturing Supervision. It offers a challenging and satisfying career for individual growth and development.

**Manufacturing Engineering:** This is the creative portion of modern manufacturing. It involves interpretation of initial product designs into good manufacturing practices through planning the methods by which a product will be manufactured, specifying and designing machine tools and equipment, and planning and developing new processes. It is vitally concerned with such subjects as plant layout, materials handling, operation planning, and quality control. It requires a thorough knowledge and broad understanding of how these subjects influence the manufacture of a product.

**Purchasing:** General Electric is one of the most diversified purchasers in the country today, buying material from every industry. Much of this purchasing involves technical problems, and requires a knowledge of sources of supply, market trends, and new products. Many items purchased are components or finished products of other technical industries. Constant contact with price, as well as evaluation of current and long-range raw material supply situations, is another phase of this activity. It is becoming more and more important as a career opportunity for young men.

In addition to the above described areas of opportunity in manufacturing, such manufacturing services as wage-rate determination, production control, inventory management, production planning and development, and materials handling offer opportunity for highly trained specialization and for competent management supervision.

These areas of manufacturing, together with many others, offer the college graduate of today a wealth of opportunity for a challenging and rewarding career.

*You can put your confidence in—*

**GENERAL ELECTRIC**