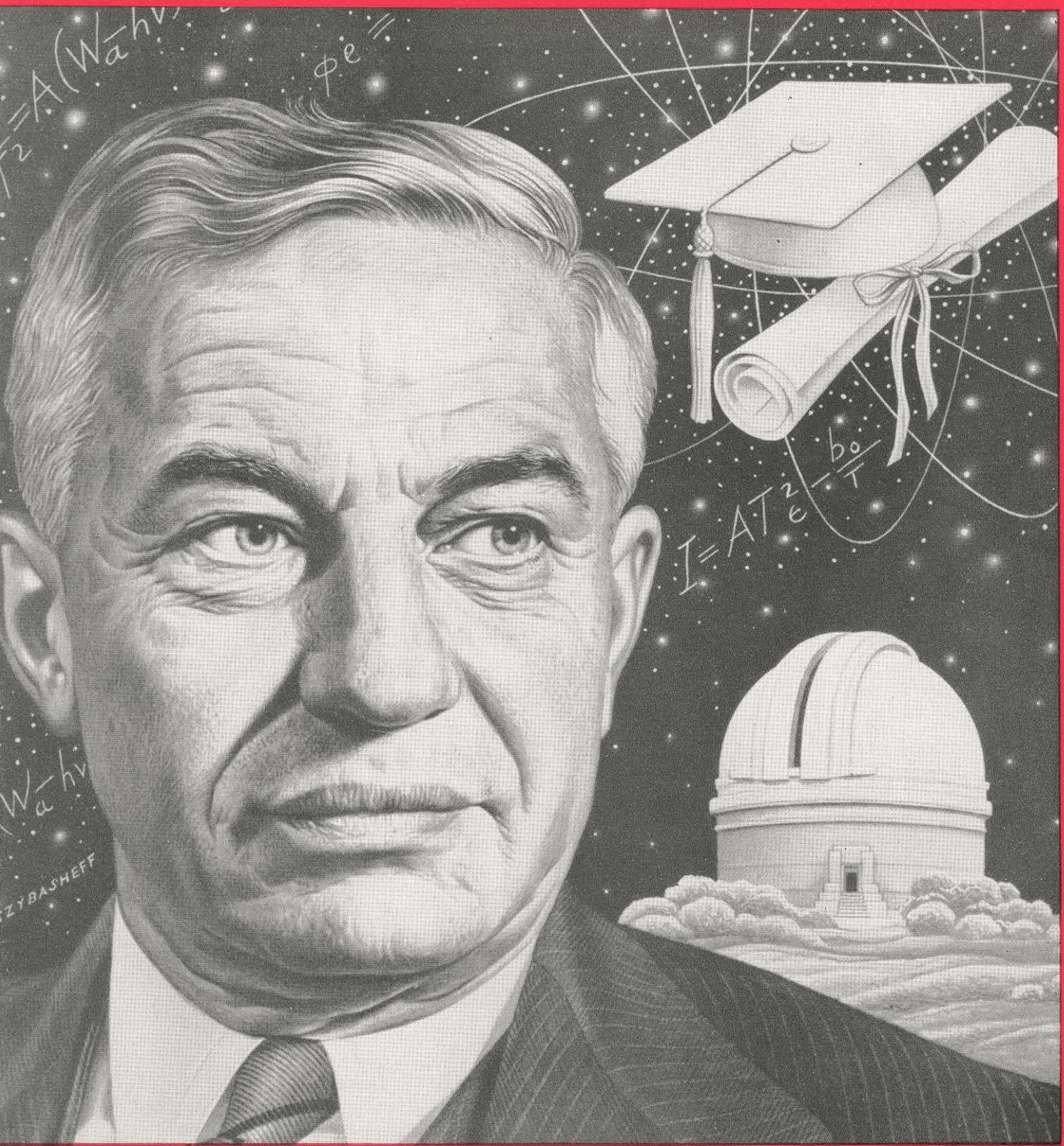
ENGINEERING | AND | SCIENCE

MAY/1955



About Time . . . page 3

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

James Chisholm, class of '41,
speaks from experience when he says,

"Men with ability and ambition really have a chance to get ahead at U.S. Steel"

● A responsible position can come quickly to those graduate engineers at U.S. Steel who show ability and ambition. Management training programs are designed to stimulate and develop these qualities as the trainee "learns by doing." His training is always a fascinating challenge and he works with the best equipment and the finest people in the business.

James Chisholm is typical of the young men who rapidly rise to an important position at U.S. Steel. Jim came to U.S. Steel as a trainee in 1941 after graduating as an M.E. Shortly thereafter he entered military service for four years. Upon his return to U.S. Steel in 1946, he advanced steadily until, in 1951, he was appointed to his present position as Assistant Superintendent of Blast Furnaces at the new Fairless Works at Morrisville, Pa.

Jim is now in charge of the unloading of all ore ships and the operation of the plant's two big blast furnaces—each with a rated output of 1500 tons per day.

Jim feels that the opportunities for graduate engineers are exceptional at U.S. Steel. He remarked that in his own department alone, six college trainees have been put into management positions within the last couple of years. He says that chances for advancement are even better now with the current expansion of facilities and the development of new products and markets.

If *you* are interested in a challenging and rewarding career with United States Steel, and feel that you can qualify, you can get details from your college placement director. And we will gladly send you a copy of our informative booklet, "Paths of Opportunity," which describes U.S. Steel and the openings in various scientific fields. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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More and better jobs for more people

GENERAL MOTORS President Harlow H. Curtice speaking:

"Just as an example of how job opportunities in General Motors have grown, here is what has happened since 1940.

"In 1940, we had 233 thousand employes on our payrolls in the United States and Canada. In 1955, our employment totals 520 thousand —an increase of 287 thousand good jobs in only 15 years."

It stands to reason that a climate where job opportunities expand with such rapidity must be especially fruitful of career opportunities for young men holding engineering degrees.

For, in the final analysis, the very life's blood of our organization is the never-ending production of "more and better things for more people"—and that, very definitely, requires the engineering mind at its best.

In point of fact, although engineering graduates comprise a mere two per cent of total GM employment, they will eventually fill about forty per cent of executive posts if the established pattern continues.

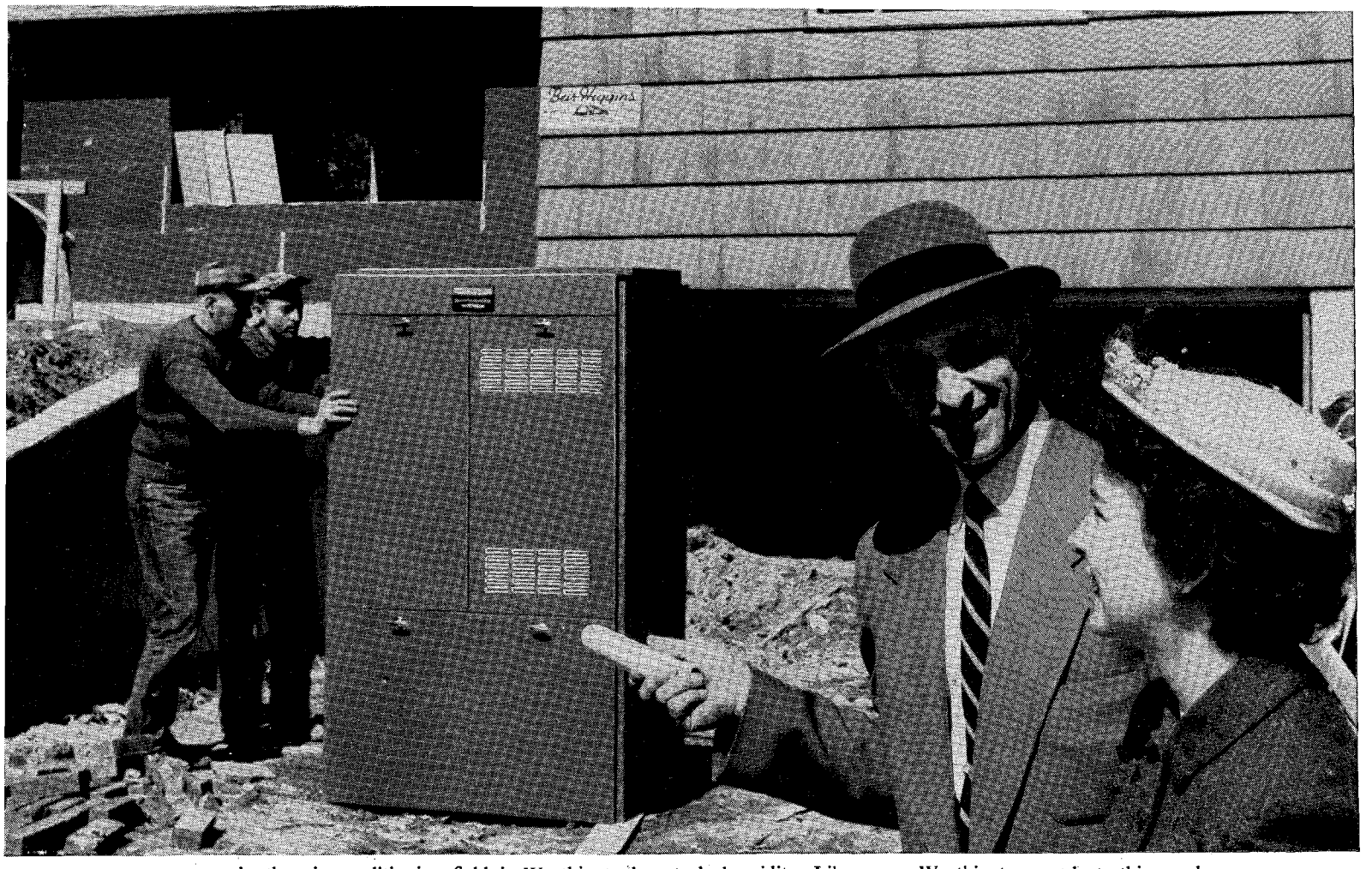
Why not, then, look into the possibility of enjoying a rewarding career as a GM engineer? You'll be interested in a big new 136-page handbook entitled, "Job Opportunities in General Motors." Your college library or placement office should have it.

GM Positions Now Available In These Fields:

MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
CHEMICAL ENGINEERING
METALLURGICAL ENGINEERING
INDUSTRIAL ENGINEERING

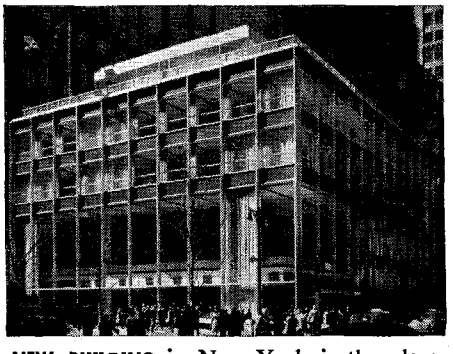
GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan



NEW PRODUCT in the air conditioning field is Worthington's ultra-modern winter and summer home air conditioner. It's a compact package that heats, cools, circulates, filters, and controls humidity. Like every Worthington product, this good-looking unit is designed and built for a lifetime of quiet, efficient service.

Making today's BIG news in air conditioning



NEW BUILDING in New York is the glass-sheathed Manufacturer's Trust Building. It's cooled by a Worthington central station system—so big it does the same job as melting 300 tons of ice daily.

NEW LIFE FOR OLD STORES. Shoppers stay longer, buy more in stores cooled by Worthington units with the new "Million Dollar" compressor. New 3-D circulation aims comfort right where you want it.

Worthington's new residential air conditioners, packaged units, big central station systems — all are making headlines in the air conditioning field. And the same research and engineering skills responsible for their development are applied to all Worthington products — engines, turbines, compressors, construction machinery, as well as pumps.

For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, New Jersey. 4.25D

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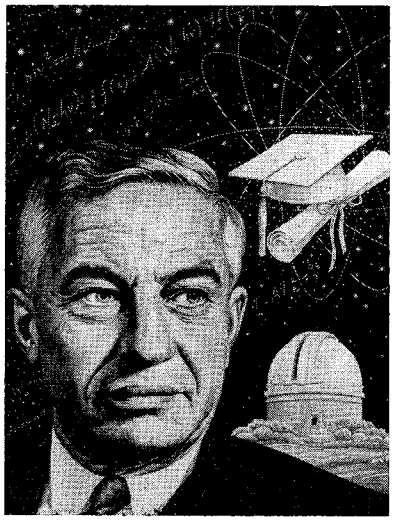
ENGINEERING AND SCIENCE

IN THIS ISSUE



On our cover this month is the cover portrait of President DuBridge, drawn by Artzybasheff, which appears on the May 16 issue of *Time*. In case you haven't seen it, that issue of *Time* carries a comprehensive story on Caltech and its president. Pretty impressive all around, too—the place, the man, and the story. Better read it.

On page 11 of this issue you'll find one of President DuBridge's most recent speeches — "Exploring the Unknown," delivered before a meeting of the Industrial Research Institute, in Buck Hill Falls, Pa., on May 2, 1955.

Henry Dreyfuss, the noted industrial designer, looks ahead to "The Twenty-First Century" on page 15 this month. The article is an excerpt—a chapter, in fact—of Mr. Dreyfuss' recently-published book, *Designing for People.* Mr. Dreyfuss, who maintains an office in South Pasadena as well as in New York, is a member of the California Institute Associates.

"The Sources of National Strength" by Robert M. Hutchins is a direct transcript of the lively talk which Dr. Hutchins gave the alumni and their guests who attended the annual Alumni Seminar Day dinner in Pasadena on April 16. You'll find it on page 20. Dr. Hutchins, former president of the University of Chicago, is now president of the Fund for the Republic, Inc.

PICTURE CREDITS

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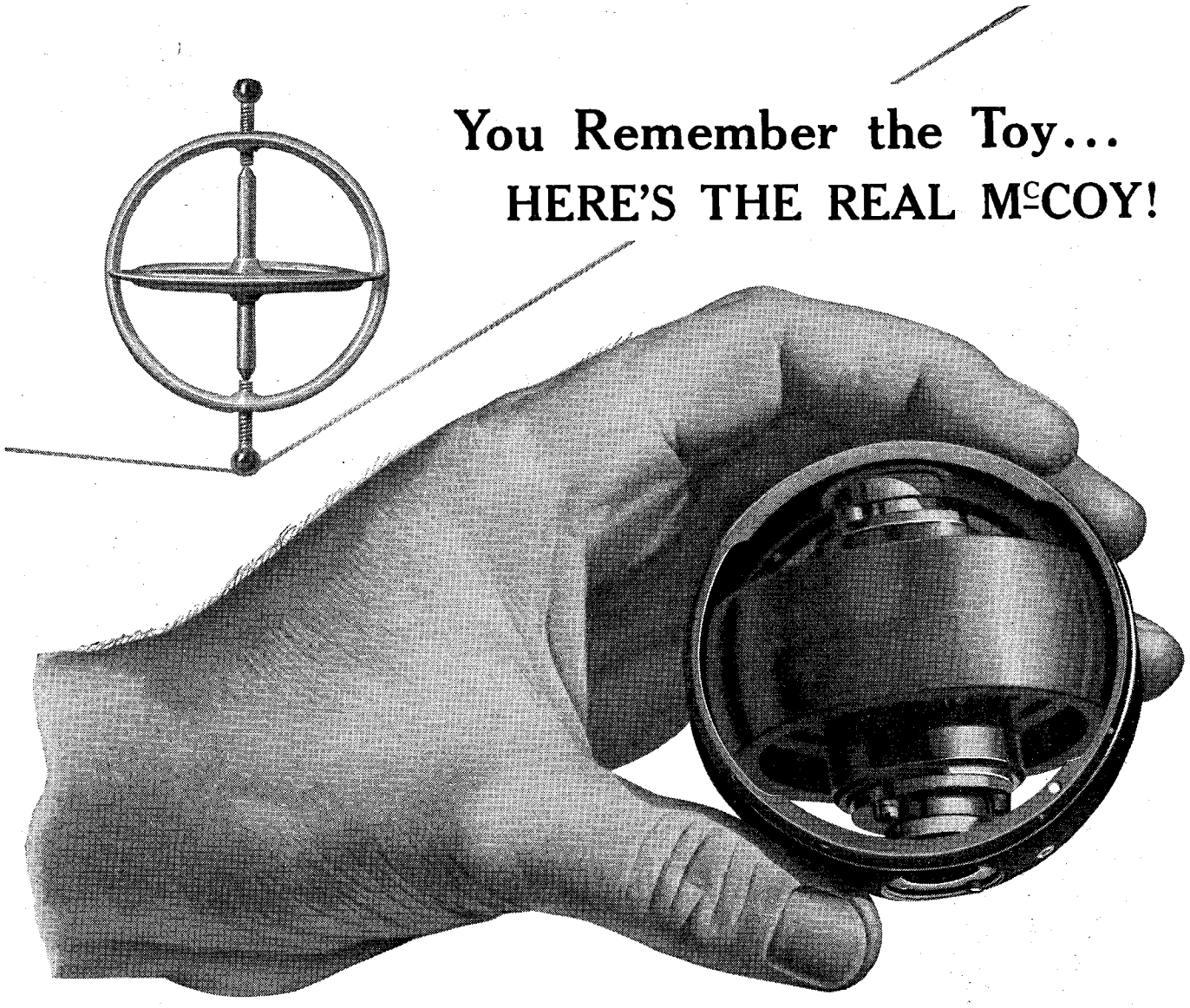


You Remember the Toy... HERE'S THE REAL McCOY!

Bendix GYROS... amazingly precise

navigate planes, guide missiles, point

ONE of the first gyroscopes on record is credited to Bohnenberger; the date, 1810. Compared to today's precision-made gyros, of course, it was in the toy class.

The evolution of the gyro from a novelty to a definite place of importance in the field of aviation and our national defense program is worth noting.

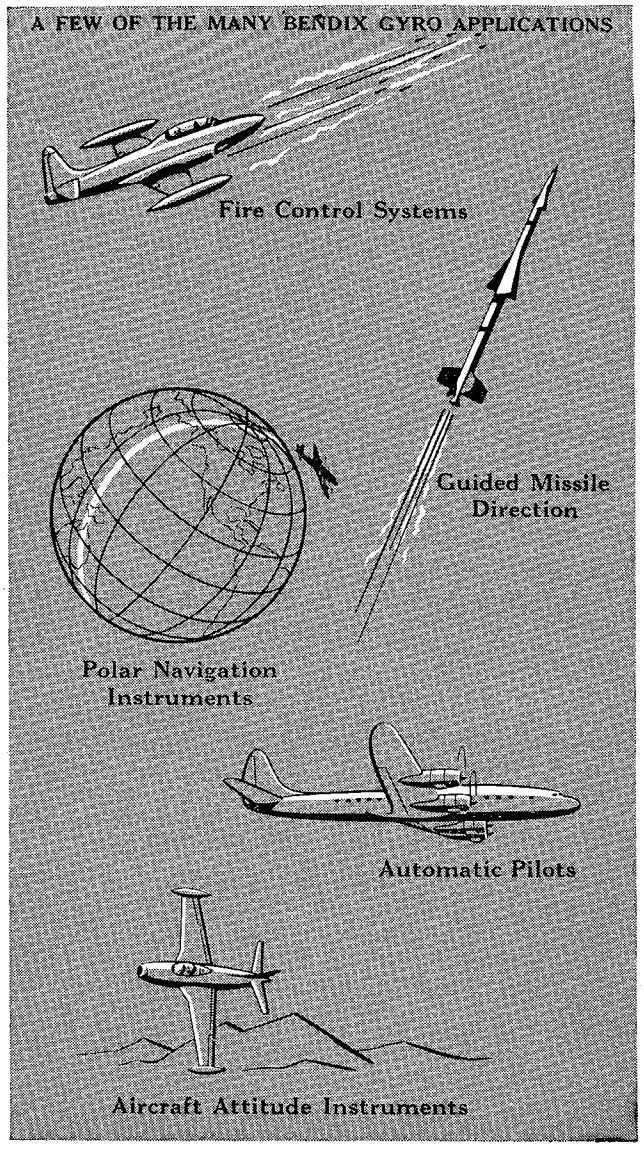
The value of a gyro is in direct ratio to its accuracy. Thus, even if early applications had been apparent, the gyros of the 19th century could not have met the requirements.

Some of the first practical applications of the gyro were in instruments for airplanes. And while most Bendix Gyros today still find their way into commercial and military airplanes, they also do many other jobs—help point guns, stabilize aerial photographic platforms, direct and stabilize radar antennas and many others.

It should be explained that a gyro does not stabilize or control anything directly—*except itself.*

But its peculiar ability to hold *itself* fixed, almost unwaveringly, in any designated position despite the movements of the object to which it is attached, provides the gyro's user with a vital requirement—a firm, stable reference point on which to base calculations or corrective actions.

Developing and manufacturing gyros and gyro-controlled instruments for blind flight, automatic pilots and the famous Bendix Polar Path† compass which has made polar navigation practical, is another facet of the Bendix Aviation Corporation's diverse operation handled by our Eclipse-Pioneer Division, Teterboro, N. J. Contacting E-P will get you quick answers to problems involving aviation instruments and components.



"tops" that help fly and guns, take pictures, aim radar!

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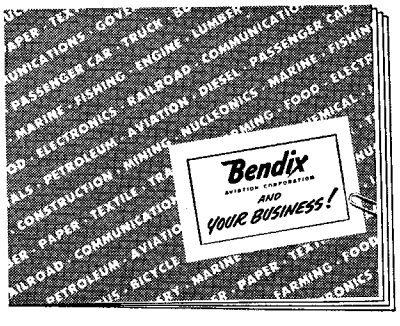

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LETTERS

The Future of Aircraft Engineering

Pasadena, California

Sirs:

As his one-time student, I am not surprised to find Dr. A. L. Klein stating, in his article: "The Future of Aircraft Engineering" *(Engineering and Science, January, 1955)* many things I cannot believe he means.

For instance, Dr. Klein justifies his unbending disbelief in personal aircraft by stating: "If our colleagues . . . cannot solve the automobile accident problem, we . . . have no chance of solving the problem of safe personal aircraft." Does "Maje" really "disbelieve" in the personal automobile?

He subsequently makes the unbelievable remark that "safety for aircraft is largely psychological" and "safe, small aircraft do not sell." Since he has stated there cannot be a safe small aircraft, we find it hard to follow his reasoning. And we wonder what psychiatric treatment Dr. Klein recommends for engine fires in flight. In passing, it should also be noted that accident records show best safety statistics for the more popular small aircraft.

Well, perhaps, as he says, some people "buy small aircraft to inflate their ego." It's true, I guess, that that psychological attitude is occasionally "similar to that of mountain climbers." It is, of course, also similar to that of authors of semi-technical papers, (although physically somewhat more demanding).

The crowning blow, however, falls with: " . . . if everyone were properly adjusted, none of these (small aircraft, mountain climbers, hot-rodders) would exist." This would, we presume, leave the properly adjusted world free to follow some adjusted pursuits outlined by Dr. Klein, such as " . . . enable us to escape into space." Perhaps the "international tensions WILL "continue for the next 50 years," or even, with just the right dose of proper adjustment, "a war will replace the present turmoil," as he hopefully suggests. This will, of course, do little for mountain climbing or personal aircraft, but might precipitate the well adjusted into the promised land, where the designer, as Dr. Klein sees him, "will be used to large calculating machines, and familiar with the characteristics and capabilities of analogs." He might even have a miniaturized, multi-dimensional one to solve his poly-dimensional, nonlinear problems directly."

Dr. Klein doesn't say how he will solve his other problems, which is perhaps just as well. I prefer to look to a different future, anyway.

J. C. Schwarzenbach, MS, AeE, '42
President
U. S. Propellers, Inc.

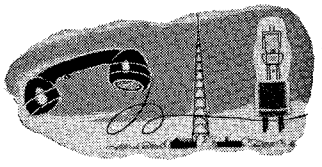
Dr. Klein replies:

I discovered in reading Mr. Schwarzenbach's letter and from some other comments that perhaps I was too severe on personal aircraft. In my article I meant to refer to "no purpose" aircraft usage, and was not referring to corporate users and other serious users of airplanes. The Air Safety Foundation statistics and other sources of information indicate that private airplanes are at least 40 times as dangerous as automobiles when operated by amateur pilots. The corporate users of aircraft and other professional users have excellent safety records approximately equal to those of the airlines.

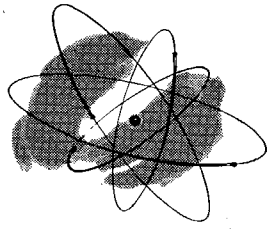
I am sorry I offended Mr. Schwarzenbach and caused him to react so violently to my article. I still believe, however, that our experience in the industry does indicate that most amateur users of aircraft have a hot-rod psychology.

A. L. Klein
Professor of Aeronautics
California Institute of Technology

12 of the basic industries in which Bendix products play a vital role



ELECTRONICS



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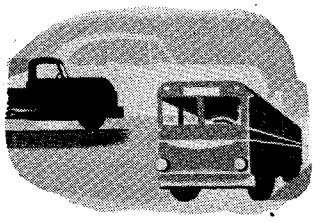
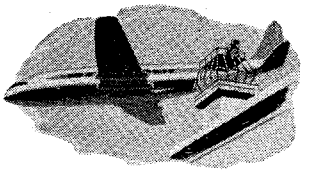


AUTOMOTIVE



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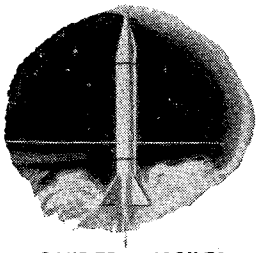
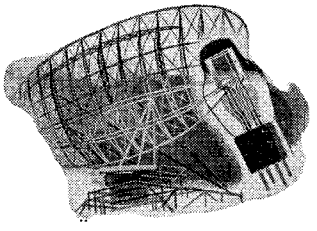
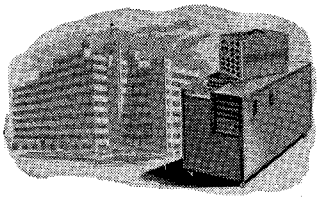


GUIDED MISSILES



RADAR



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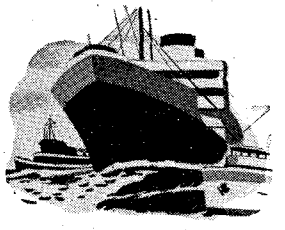

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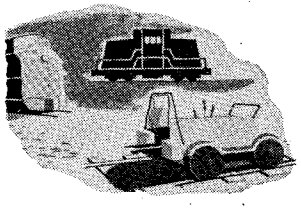

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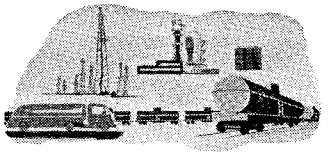

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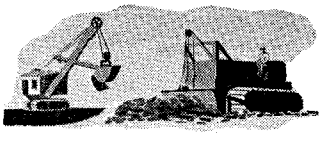

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BOOKS

THE ACCIDENT
by Dexter Masters
Alfred A. Knopf, 1955 **$4**

Reviewed by R. F. Christy, Professor of Theoretical Physics

THIS BOOK, although it is a novel, is based on a radiation accident at Los Alamos in 1946, which resulted in the death of Louis Slotin. The book is perhaps particularly pertinent at this time because of the recent revelations on the radiation fall-out from hydrogen bombs. No one can read it without some sober reflection on the catastrophic consequences of the current nuclear arms race.

The story starts with the accident, in which seven persons, including the ultimate victim — here called Louis Saxl — who receives by far the largest dose, are irradiated because of a slip in the assembly of a critical mass of fissionable material. The slip brings the assembly over critical and a burst of nuclear radiation follows, which is stopped only by Saxl's immediate reaction of tearing the structure apart. The story then follows the inexorable course of his sickness, which terminates in his death a week later. Many aspects of this part of the book are written in a very powerful and moving way.

Woven through the accident story is an account of Saxl's life as a boy, a student, a physicist, and a man. The blending of these two principal parts of the book is not always too skillful, and at times it seems to the reader that he is reading two books at once.

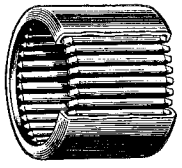
In the course of the story of the accident and of Saxl's life, there appear many long discussions of a more or less philosophical nature. Although many sound arguments and interesting points of view are to be found in these, on the whole they are somewhat overwhelming and tend to alienate the reader because of their unnecessary verbosity.

The character who emerges from the book as the most real person—one of great depth and presented in a sympathetic fashion—is David Thiel, a friend of Saxl's who attends him throughout his sickness. In contrast, no other character in the book appears in any very real light as a person.

In conclusion, the author has attempted a monumental task—and has succeeded surprisingly well.

Dr. Christy spent three years—1943 through 1945—at Los Alamos, working on the Manhattan Project.

The Torrington Needle Bearing ...designed for easy, effective lubrication



One major advantage inherent in Needle Bearing design is the ease with which the bearing can be lubricated.

The full complement of small diameter rollers continuously carries a thin film of lubricant to all contact surfaces. The turned-in lips of the outer shell retain the lubricant and effectively seal out foreign matter.

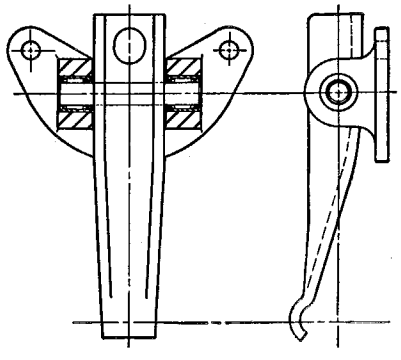
Methods of Lubrication

When Needle Bearings are shipped, they are normally protected with a high-grade slushing compound which has lubricating value at ordinary temperatures. This compound is left in the bearings in most instances. Needle Bearings in many applications run for long periods of time without further attention to original lubrication.

There are several methods of providing additional lubricant to Needle Bearings, as illustrated and described below.

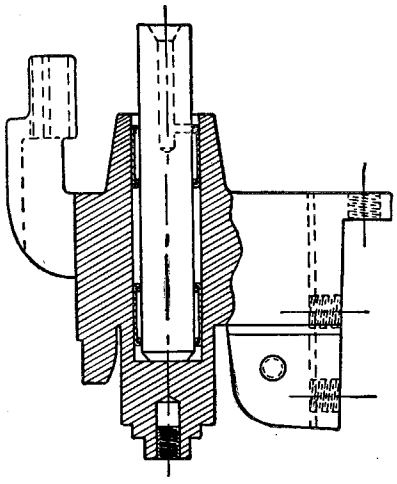
PERMANENT LUBRICATION

For low speed and light load applications, as in the fingers of the automobile clutch illustrated, the Needle Bearings are packed with grease before assembly. No additional lubrication is needed.



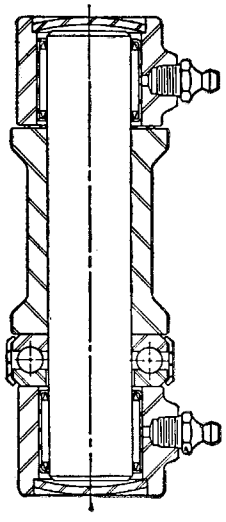
THROUGH THE SHAFT

If it is necessary to lubricate through the shaft, a hole is drilled along the shaft axis, with a cross hole leading under the lips of the Needle Bearing. This hole is located under the lip of the bearing rather than in the roller contact area. Textile machine spindle swing bracket below illustrates this method.



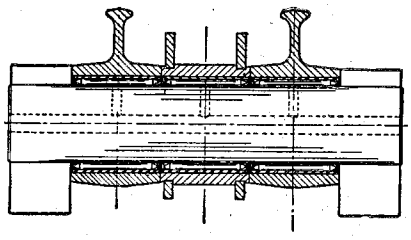
THROUGH THE HOUSING

When lubricant is to be delivered through the housing, an oil hole is furnished in the middle of the outer shell. In automobile king pin below, Needle Bearings are lubricated with Alemite fittings through the oil hole. This oil hole in the outer shell should be outside the load area.



CIRCULATING OIL SYSTEM

For high speeds and heavy loads, a circulating oil system is preferred as it aids in carrying away heat as well as in providing a continuous supply of lubricant to the bearing contact surfaces. A typical example of this method is shown in this Needle Bearing application in the valve rocker arm of a large diesel engine shown below.



Selecting A Lubricant

While oil is the best lubricant, it is difficult in many cases to retain it in the bearing housing. In general, a soda base grease is used in the absence of moisture, and a lime base grease when moisture is present. It is usually advisable to consult a grease manufacturer regarding a particular application.

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EXPLORING THE UNKNOWN

In the end, this is the way we will conquer fear —by continuing to explore the unknown in every field of human endeavor.

by L. A. DuBRIDGE

INDUSTRIAL RESEARCH in America today is, taken all together, an enormous and far-flung enterprise. It must account for the expenditure of between 3 and 4 billion dollars a year, of which the Federal Government supplies about one-half. Hundreds of thousands of scientists, engineers and technical workers are engaged in it. There are products of such research which were unknown 20 years ago but which today account for substantial fractions of the income of many companies—and the entire income of some companies.

Yet, 20 years ago industrial research was still only an adolescent. Forty years ago it was a mere child and 50 years ago it hardly existed at all. Now 50 years is not a very long span in human history. From the long-term view, industrial research has literally exploded into being in a miraculously short period. Why did it not begin sooner?

The answer to that is simple. Industrial research is, I take it, the process of putting scientific knowledge to work for the purpose of developing new industrial products and techniques. Scientific knowledge thus had to exist before the exploitation and use of such knowledge could come about. But the scientific knowledge of, let us say, the theory and structure of atoms and molecules — on which much of the modern chemical industry is based — was only coming into focus 40 years ago. The electron and X-rays were discovered less than 60 years ago; radio waves are 67 years old; the decisive discoveries on the nature and behavior of electricity were made by Faraday only 110 years ago. And, for that matter, modern science itself came into existence less than 300 years ago. It was then that Newton put together the observations of Galileo on rolling marbles, of Tycho Brahe and Kepler on the motions of the planets and deduced the first great theoretical principles of physical science: the laws of motion and of gravitation.

After thousands of years of civilized history, it was not until the 17th Century that man finally uncovered the fact that nature operated in accordance with laws that could be discovered; laws that were so exact that they could be used to predict with precision the behavior of physical bodies. And at the same time men were uncovering these startling regularities of nature — the grand and beautifully simple laws which nature obeyed — they also discovered the infinite complexity of nature; that there were undreamed-of phenomena awaiting discovery — for those who were willing and able to explore.

And so it was that during the past 300 years scientific knowledge slowly came into being until, at the beginning of the 20th Century the time was ripe for the explosive rise of applied science.

Now this development of applied science has been one of the most spectacular phenomena of our generation. It has revolutionized our way of living — and possibly also, our way of dying. It has transformed the lives of millions of people, and has elevated their hopes and ambitions too. Science has become the new "magic" — it is, some people seem to think, capable of doing anything.

And yet there are disquieting notes mixed in with the growth in public acclaim for applied science. The refrigerators and toothpaste are appreciated and enjoyed. But the scientific knowledge which made all these things possible is forgotten or ignored. The latest gadget for better living is promptly purchased on the installment plan. But when someone mentions weapons for defense, a great cry goes up: "The scientists are trying to destroy us." In fact, in these days it has

become fashionable in some circles to say we have had "too much science"; that "science is the cause of most of the world's troubles"; that we ought to "return to the liberal arts"; that science ought now to wait a while so that social science can "catch up." The idea is, presumably, that social science or the liberal arts or something will then teach us all how to love one another so that human beings won't end up by atom-bombing themselves off the face of the earth!

To hear some people talk, you would think that science causes nothing but unhappiness, conflict, war; that science denies the finer things of life; is too "technical" to have a place of respect in modern education. You would think that the fate of the world rested on the outcome of some sort of a race between scientists on the one hand and all the historians, philosophers, writers, economists, poets, preachers, and political and social scientists on the other, with the implication that if science wins, the human race will be blasted to oblivion.

Anti-science

Some people talk as though they really believe some or all of these things. In fact, there are some very important people who are making it their business to promote these ideas. I think it is time that we, the scientific community, began to do something about the attacks which have been made on science and on scientists. For they are having profound and even terrifying effects. They have already caused an alarming drop, for example, in the number of high school students who take mathematics and physics. They have caused many a serious-minded college or university student to avoid all science courses and to look with disdain on those who major in science fields. They have caused well-meaning people to believe that scientists are necessarily so specialized and blind as to be wholly untrustworthy the moment they step out of the laboratory, and to class all scientists and engineers as "narrow-minded technicians."

How then do we go about meeting these charges, these misunderstandings and prejudices?

First, I want to say that I do not think the way to do it is to brag more about the gadgets and devices and weapons which have come about as a result of the systematic attempts to make use of scientific knowledge. I have great admiration for deep freezes and bulldozers and jet airplanes and detergents and penicillin — and even pink and white Cadillacs. But the values of science really do not lie in these things in themselves. Rather, they lie in the way in which pure and applied science contribute to man's physical, intellectual and spiritual well-being. The true values of science lie not in its by-products, but in its goals; not in its dollar value, but in its human value. The value of science will be judged not by how fast it helps us to travel, but where it helps us to go.

In order to get a better look at this problem, I think we should forget about applied science for a moment and think about basic science, the pure search for knowledge.

First let us ask why men *are* scientists. Why do some men spend their lives in pure science? Well, I can assure you it is not because of any desire to destroy the world or even to harm a single human being, or make him less happy. Quite the contrary! Nor is the scientist usually impelled primarily by a desire to make money—though I am sure he looks forward to receiving the monthly paycheck as much as anyone (especially when the fresh PhD today can go out into his first job at $10,000 a year).

On the other hand, I can't claim either that the scientist's objective is wholly or primarily an altruistic one — trying to make the world over into a Utopia, for example. He simply hopes that his work will be some contribution to human welfare.

Primarily, it seems to me, the scientist is impelled by certain basic human urges. One is the urge to explore. The spirit of Christopher Columbus, of Magellan, of Admiral Byrd; the spirit of all those who have first discovered unknown places or climbed unconquered mountains — such a spirit is in each of us to some extent. It is certainly in every scientist, even though few of them have bothered to recognize it.

Another common human urge is the urge to create. Every human being would like to create something new. Just look at the "do-it-yourself" business! Some people create music or poetry; some create beautiful pictures, fine statues, magnificent buildings, exquisite furniture or jewelry or clothing. So too, a new discovery in science is a creation — and in the eyes of scientists it has a beauty and an elegance all its own. To be able to contribute, even in only a small way, to the building of the magnificent edifice which we call science is a great creative satisfaction.

Add to the urges of exploration and creation the urge of competition — the desire to be the first to find a given piece of knowledge — and one has a good description of a scientist's motivation.

Public understanding

How can it be then that the structure of science, which results from such almost purely aesthetic motivation and which is admired by the scientist as a thing of beauty and a joy forever, can be looked on by the general public as an ugly, mundane, or even dangerous product? It is true, of course, that some works of art are admired only by the artist, and the artist then complains that the public doesn't "understand" his work. So I guess the scientist also sighs that the public does not understand *him* or what he does. But, if science is to have the surging vitality that it should have in modern America, the public should understand science.

Our usual attempts in this direction, however, are often inadequate. We usually try to explain the value of science not by telling why it is beautiful, but only why

it is *useful*. Hence, the public concludes that scientists are materialists, that they are mere technicians, specialists, unaware of the finer things of life!

Now, explaining why a thing is beautiful is much harder than explaining why it might be useful. Yet it is worth trying. We can be encouraged, I think, by the great public interest in astronomy. Everyone knows that the Palomar 200-inch telescope has no very "practical" uses. Yet thousands of people journey to Palomar every month to see that magnificent instrument and to hear about the awe-inspiring picture of the universe which it is revealing. Exploring the universe is an adventure which almost anyone envies and admires. And the beauty and grandeur of the universe is at least dimly visible to almost everyone who cares to listen and to look at pictures.

However, I claim there is an equal beauty and grandeur to the picture of an atom of iron or copper or uranium which modern science has revealed. Even more beauty, perhaps, is to be found in the structure of a protein molecule. More still is in the structure of the gene as it is built up of spirals of nucleic acids all so ingeniously designed that the gene can make a copy of itself — can reproduce its kind. With all due respect, I claim there is as much beauty in such things as can be found in great paintings or fine literature or music.

Am I crazy?

One of the liberal arts

In any case, if science were seen and taught in such a light, we would not see the presidents of great universities (not scientists) going around the country saying, "There is too much emphasis on science; let us return to the liberal arts."

Science *is* one of the liberal arts—one of the first and greatest of them. It certainly is one of man's greatest arts and is one which has done the most to *liberate* the human spirit. Science, more than any other subject, has freed men from ignorance and from consequent fear. Consequently, it has elevated man, intellectually and spiritually.

How does it happen that many people have just the opposite conception — that science has been degrading to man; has made him materialistic, unmoral? Apparently it is because scientists are wholly misunderstood.

For example, a distinguished religious leader recently said, "Modern technologists and scientists have come to regard themselves as supreme masters of the universe." Well! That's news to me. Does anyone here think *he* is the supreme master of the universe? Some of you might have good ideas about some improvements you would make if you were! But the only men in recent times who have thought themselves masters of the universe (Hitler, Mussolini, Stalin) were certainly not scientists! Science is a pursuit that makes men humble — because in learning a few things we come upon so many that we don't know.

But why do these misconceptions of scientists exist?

Personally, I put part of the blame for this on certain misguided philosophers. For example, since the instruments of the scientists have discovered no nonmaterial or nonphysical aspects of the world, therefore the scientist is accused of saying that such immaterial things do not exist. Because the anatomist found no place in the body to house a soul, therefore, says the philosopher, this proves man has no soul! That's nonsense, of course. Physical instruments were never intended to measure nonphysical things and, by their nature, they can never do so. Science thus gives no support to materialism — nor, of course, can it ever disprove it either. Philosophical theories are just not susceptible to experimental proof or disproof.

Misunderstanding and misrepresentation

Again — philosophers have gone wild speculating about the theory of relativity and its philosophical implications. Now the special theory of relativity is simply a theory in physics which describes how the results of observations made on various phenomena will depend on how the observer is moving relative to what he observes. "Aha!" says the philosopher, "that means everything is relative; nothing is absolute. There are no absolutes physically; therefore there are none intellectually or morally either. It all depends on your point of view."

Nonsense again. Aside from the fact that physical theories have no necessary relevance to moral problems, the philosopher totally misunderstands Einstein's relativity theory. Though the relativity theory did show that many observed quantities were changed when there was relative motion (as had always been known), Einstein found that certain things (the velocity of light, for example) were unchanged. They were "relativistically invariant"; they were "absolutes."

A beautiful physical theory thus has been misunderstood and misused; again science has been misrepresented.

Then, too, there were philosophers who said that the theory of evolution denied the existence of God! No scientific theory can either affirm or deny a spiritual existence, of course. But, even so, why does anyone think it is degrading to have God create man by the beautiful processes of organic evolution rather than by making him out of a piece of clay? Especially when He then made Eve by the process of swiping one of Adam's ribs!

To me the whole picture of the universe as revealed by science, as well as the picture of the processes that go on within it and of the life that inhabits it, is one of magnificence, vastness, order, splendor, precision, beauty. It is a picture that exalts the Creator of the Universe — and exalts the dignity of the men He created, the men who can discover and comprehend this majesty of creation.

You see, perhaps, why I can claim that science is

one of the "liberalizing arts." You see why it deserves a place of respect along with the humanities, the fine arts and social and behavioral studies as partners and coequals in the intellectual and cultural fields. You see why to dismiss science as too "technical" and too "vocational" is both false and revolting.

However, there are men who say science is still not enough. Of course it isn't! And I do not know any scientist who ever claimed it was. The study of the physical world is *one* important aspect of man's use of his intelligence and his talents. It is one expression of the urge to know, to create. But the studies of the world of human beings, of the world of beauty and the world of moral values are equally essential activities — all are necessary to the educated and civilized man.

"Science is not enough"

Some of those who say science is not enough, however, mean more than that. They mean to reduce science, to eliminate it, to cast it out of a liberal education, to put it in the same class with manual training and shop work. Because science is useful it is dismissed as "mere vocationalism." Because it is exact it is said to be "too technical." There has been created a cult of antiscience — a group of superior beings who read only old books, look only at old pictures, think only old thoughts. They disdain the crass technicalities of algebra, the boring regularities of Newton's laws, the smelly products of chemistry. (However, at the first opportunity they don their nylon shirts and hose and take a Super-Constellation to Paris!)

And why do these antiscientists get so wide a hearing? There are many complex reasons — but partly it is our own fault — the fault of scientists. We have, in times past, not distinguished between the problem of training an automobile mechanic and of educating a mechanical engineer. As late as 20 years ago there were so-called engineering colleges which trained only the hands and not the mind. There were also schools which had eliminated all educational opportunities except in the scientific and technical fields.

But I know of no such colleges today. The best modern institutes of technology offer superb programs in humanities and social studies — and they insist that the students take them. Overspecialized scientists or engineers are no longer being graduated in any numbers from the American system of higher education — and the number who graduated in the past was not so large as many people pretend. Most of the scientists and engineers that I know — of any age — are well-educated, well-rounded people; many are persons of very extraordinary culture and cultivation. Of course, I also know a few characters who can talk of nothing but their specialty. But I know similar people who are lawyers, doctors, business men and English professors too.

Every now and then even the proponents of the liberal arts realize that some of their members have gone too far and claimed too much. Listen to this wonderful statement by Lynn White, Jr., President of Mills College:

"Spokesmen for the colleges (including me) are constantly trumpeting the importance of the liberal arts as inculcating resourcefulness, spontaneity of spirit, the ability to meet unexpected situations, and that sort of thing. In its extreme form this sound metal contains a certain alloy of nonsense. The Mid-Victorian view that reading Horace at Oxford prepared one to be proconsul over steaming tropical millions overlooked the fact that Oxford in its great days was deftly designed to convince its aristocratic denizens that they were God's anointed, predestined to shepherd and shear the less elect portions of the human race. Such massive self-confidence, even when occasionally coupled with stupidity and inefficiency, was irresistible on the banks of the great, gray-green, greasy Limpopo and one may doubt whether the Latin poets had much to do with the diffusion of the Union Jack."

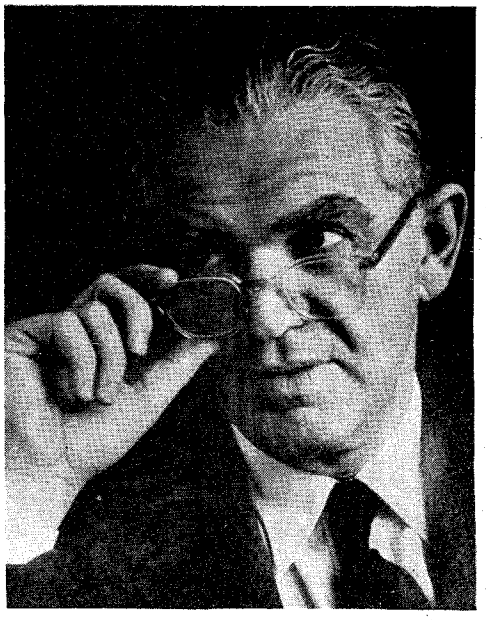
I think it is important then that we think of pure science as a dignifying and edifying — as well as a useful — area of human learning. Possibly then when we come to think of applied science we will think and speak not only of the useful gadgets that we produce, but of the goals of human comfort, leisure, culture and happiness they help us achieve.

Perhaps, however, the most damaging blows struck by the antiscientists are those which prey upon the fears and dangers of the modern world which applied science has helped to build. These dangers are indeed real and terrifying. And scientists will do well to continue making factual statements about what these dangers are. Thermonuclear bombs are really horribly devastating weapons — and don't let anyone tell you otherwise.

Freedom from danger

But the real basis for our fears today is not the human ingenuity that produced terrible weapons, but the human cussedness that threatens to use such weapons against us. The world has never been free from danger. But if we contrast the western world of today with that of 100 years ago, we find much to be proud of. We have eliminated slavery — because our work is now done for us by lumps of coal and pools of oil. We have eliminated much of human suffering caused by ailments and disease — and we will no longer tolerate the existence of suffering caused by human cruelty or neglect.

We have eliminated many evils and many dangers; we face many more of both old and new varieties. But we shall conquer danger not by weeping and wailing, not by stopping or impeding any worthwhile human endeavor, by belittling any noble human aspiration. We shall conquer fear in the end only if we continue to explore the unknown in every field of human endeavor, continue to extend always the frontiers of knowledge, aiming always to elevate the human mind and the human spirit.



An industrial designer looks ahead to

THE TWENTY-FIRST CENTURY

by HENRY DREYFUSS

IN LESS THAN HALF A CENTURY it will be A.D. 2000. Who can say what life will be like then? One can only speculate, knowing that for all the incredible scientific progress of the last fifty years, limitless vistas lie ahead. Perhaps, by the end of the second half of the twentieth century, the one remaining adventure of modern times, travel in space, will have been accomplished. Possibly, the giant eye of Palomar or an even more far-sighted cyclops will have determined whether life exists on neighboring planets. Conceivably, the Martians will have lived up to their mythological name and attacked the earth and thus united the people on this uneasy sphere. Only one thing is certain—Joe and Josephine, the indestructible, will wander through this panorama, whether it's a utopia or a maze. How they act, and what they think, will be a development—an extension, as a matter of fact—of how they act and think today.

Americans are healthier and more comfortable than ever before. The sweep of technology has not been too much for them. On the contrary, they take for granted, even consider indispensable, things that to their grandfathers could have been little more than a pipe dream—the coast-to-coast dial telephone, radio, television, automobiles, motion pictures, mechanical refrigeration, frozen foods, automatically controlled cooking and washing, cellophane, color photography, sound amplification, stain-repellent fabrics, and the countless applications of electricity. They casually accept the fact that an airplane travels 1500 miles an hour when they read it in the paper and then go on to the comic page to see how Buck Rogers is doing.

This period of mid-century is known as the atomic

This article appears as the final chapter in the book, "Designing for People" by Henry Dreyfuss, published by Simon & Schuster, April 1955.

age and the electronics era. Atomic-powered submarines are already a reality. Ironically, guided missiles, originally conceived for offensive warfare, have become this country's guardian angels. On a more comforting note, research men are working to adapt the products of atomic energy to medicine and to countless everyday uses.

It is part of the industrial designer's business to let his thoughts roam—actually, clients pay him to dream a little—and it is not too difficult to look ahead to the beginning of the twenty-first century, when, doubtless, today's sleek designs will seem quaintly amusing to our great-grandchildren.

By then, it is not unreasonable to assume, babies will be immunized at birth against disease, autos or their equivalent will run on atomic power. A great deal of farming will be done chemically, and farm implements will be operated automatically. I have already seen a tractor that can be set to travel in a series of diminishing squares until an entire field is plowed. No driver is needed, as a special finder wheel is placed in the furrow it made the first time around, and this gradually narrows down, toward the center. With such equipment a farmer could cultivate half a dozen fields at one time.

It is possible that telephones will have miniature television tubes, so that the person at the other end can be seen, perhaps holding a diagram that is pertinent to the conversation or showing off a newborn babe for Grandpa's examination, back in Iowa.

Mail will probably be dispatched across the country by rockets, a civilian application of the guided missile. By this means a letter could span the continent in half an hour.

Rocket oil-well drilling is not improbable. Experiments have already been made, and the rockets, traveling at terrific speed, burn a smooth hole in the earth, making an iron casing unnecessary.

Airplane Travel

Changes are inevitable in city planning because of traffic congestion, and it's quite possible that in the future people will park their cars on the outskirts and use fast helicopter transportation to get into downtown sections and crowded areas. Certainly, we have seen only the beginning of helicopters. In the realm of airplane travel, the Pittsburgh airport led the way with a sixty-four-room hotel, including conference rooms. By appointment, people fly from neighboring cities, confer with Pittsburgh associates, then fly off, without ever having left the airport. Similar accommodations have been provided at La Guardia in New York and at Los Angeles International Airport, and more are being built throughout the country.

Wireless transmission of power is possible today, but is not economic. Atomic energy may provide cheap enough power to make it feasible.

The telephone and radio may come into an entirely new development. Just as we can sit in a pool of directed light with the rest of the room in darkness, it is conceivable that one day we will sit in an invisible cone of directed sound wherein we will be able to hear and speak to someone at a distance, as in a phone conversation, but people near us will be excluded from the conversation or, if it is a radio, from the program.

It is conceivable that all clothing will be made of synthetics, and people will look back on those who wear natural skins or fibers as barbarians. The expensive procedures of getting wool from sheep, growing cotton, or having silkworms spin for us may be antiquated. And instead of being sewn together, which leaves uncomfortable seams, garments may be blended with heat.

Microfilm

The use of microfilm will probably be extended to the point that it will be possible to have the dictionary in a box the size of the telephone, with a lens and spinning device, so that time will be saved in looking up words. The Bible, novels, textbooks, and valuable file material will be made similarly accessible next to your easy chair.

Perhaps cameras will be built into television receivers, so that by pushing a lever a person will be able to obtain a permanent record, which could be developed immediately, the way Polaroid cameras operate today.

What will become of the urge to travel when Paris and New York are only two hours apart by plane? Perhaps we must project ourselves into an ectoplasmic future, when the act of being somewhere will entail no travel at all. A man in Istanbul may decide he wants to spend the evening with friends in Ames, Iowa. The turn of a switch will establish a connection between them and their life-size images in color and 3-D and their natural voices will be in each other's front parlors. Face-to-face business conferences may be carried on between men whose physical presence is actually in such widely separated places as Rio, Copenhagen, and Hong Kong. Remember, seventy-five years ago, people were not visiting on the telephone or flying through the air or seeing a performer in Hollywood miraculously appearing instantaneously on a glass tube in their living room.

Meanwhile, there's disquiet in mid-century. despite the good living that is available to everyone and the prospect of even more. From the headlines and the voices of the commentators and the analyses of the experts comes the suspicion that, without warning, the roof may cave in. From experience, people know that it takes only an arrogant gesture by an ambitious man to start the bombs dropping. A man with a good ear can also detect dissatisfaction of a much milder sort. It is the frequently heard contention that the nation's educators, philosophers, psychologists, and social workers have failed to keep pace with technology in this country. Indeed, some persons argue that the pressing technology of the times is in itself responsible for standardizing life, reducing it to the level of uninspired gadgetry, and thus creating an emptiness in the lives of many Americans.

The combination of science, engineering, industrial

design, and manufacturing skill has brought Americans not only undreamed-of comforts, but a gift of an estimated thousand more hours of leisure each year than their grandfathers had.

Expressed in another way, the real triumph of the American way of life is that although the work week has steadily shrunk, productivity has steadily risen. In 1800 the average work week was eighty-four hours, a century ago it was seventy hours, in 1925 it was forty-five hours. Today the forty-hour week is almost standard, the two-day weekend is almost universal, three-week vacations with pay are more and more the practice, and the coffee break has become an institution. Despite all this, average production per man-hour increased forty-eight percent between 1928 and 1953. And not long ago, it was forecast that the average work week in 1975 will not exceed thirty-two hours.

Joe and Josephine share in this dividend of leisure. Joe's office or factory is cleaner than was his father's, and it has better lighting. His nerves are less jangled by uncontrollable noise, his tools are more efficient. If he is a farmer, he can harvest four acres in one hour, whereas it used to take a man a day to harvest one acre. His day has been shortened by the mechanized plow, disk, harrow, corn picker, cotton picker, and motor truck.

If she is a secretary, Josephine has bookkeeping machines, the electric typewriter, a dictating machine, and a check-writing machine. If she is a housewife, she takes many fewer steps, she bends and kneels much less than her mother did. Her home is studded with the symbols of good American living—the refrigerator and freezer, the automatic stove, dishwasher, garbage grinder, and washing machine. Nostalgic diehards may doubt if the cake she bakes from a box of ready-mix will be as good as Mother used to make, but it is likely to be surprisingly close. And whereas Mother used to be weary after several hours over a hot stove, taking occasional peeks into the oven to see if it were done, Josephine simply pops the batter into the oven, sets a thermostat, and forgets it. Her chores are easier, too, in the bathroom, where the gleaming tile and chrome can be wiped spotless in minutes. And she shops in a supermarket where in a short time she can buy supplies for a week instead of going from butcher to grocer to vegetable store, often blocks apart, as her mother did.

Leisure—and happiness

Inevitably the question comes: to what use is this leisure being put? Is it making its recipients happier, better equipped to live a full life, to realize their full potential of personal development? The positive gains are obvious—physical well-being, higher level of health, a life span prolonged nine years in the last quarter century. But does leisure produce happiness? We can scarcely claim to have generated a happier people when we see mounting tension all around us, when it is estimated that one in twenty Americans will spend part of his life in a mental hospital. Nor can we be smug about the blessings of leisure when we consider that many industrial employees who reach the age of retirement plead to be permitted to continue working rather than accept a pension. They don't know what else to do with their time. Have we created leisure only to train a nation of passive participants, filling their time with wrestling on TV, comic books, and predigested digests?

Certainly, if the men who make our mass-produced conveniences are to blame for leading people into spiritual frustration, the industrial designer must share the blame. But I do not concede that Americans are overwhelmed by materialism because they enjoy good living. The figures show that there is an accompanying surge of interest, even enthusiasm, in the fine arts, which can be attributed at least in part to the improved design of the ordinary objects that are all around them. I sometimes wonder if those who put the question really want an answer or are more interested in keeping alive a quarrel.

Meeting the challenge

I would like to meet the challenge in another way. Wherever I go, I look for people who have achieved tranquillity. Occasionally it is to be found in a person who has dedicated his or her life to a religious order. People who alleviate suffering often have a serenity in their work. The very young, who know no pain, and the very old, who acknowledge and accept suffering, may know this feeling. Next to inner serenity, a person can aspire to live and work in an environment of meditative calm. But even serenity can mean different things to different people. I have been in great cathedrals and become almost belligerent at their busy architecture, their vulgar and excessive decoration, and their raw and brilliant stained glass. On the other hand, I have felt complete inner peace surrounded by the superb glass of Chartres. Nature, perhaps, supplies the best atmosphere for this feeling. The forest, with its deep shade and singing birds, can bring solace, but a turbulent sea, a heavy rainfall, a gale, by their simplicity and immensity, can also bring quiet. I have the temerity to suggest that, by reducing objects to simple, unobtrusive forms, by using appropriate colors and textures, and by avoiding obtrusive noises, we contribute to the serenity of those who use them. This is what we try to do.

For many years I have been guided in my work by this cherished quotation by Daniel Burnham, great architect and great American:

> *Make no little plans; they have no magic to stir men's blood and probably in themselves will not be realized. Make big plans; aim high in hopes and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone will be a living thing, asserting itself with ever-growing intensity. Remember that our sons and grandsons are going to do things that would stagger us.* LET YOUR WATCHWORD BE ORDER AND YOUR BEACON BEAUTY.

Dr. John Pellam, Professor of Physics, lectures on low temperatures at the 18th annual Alumni Seminar.

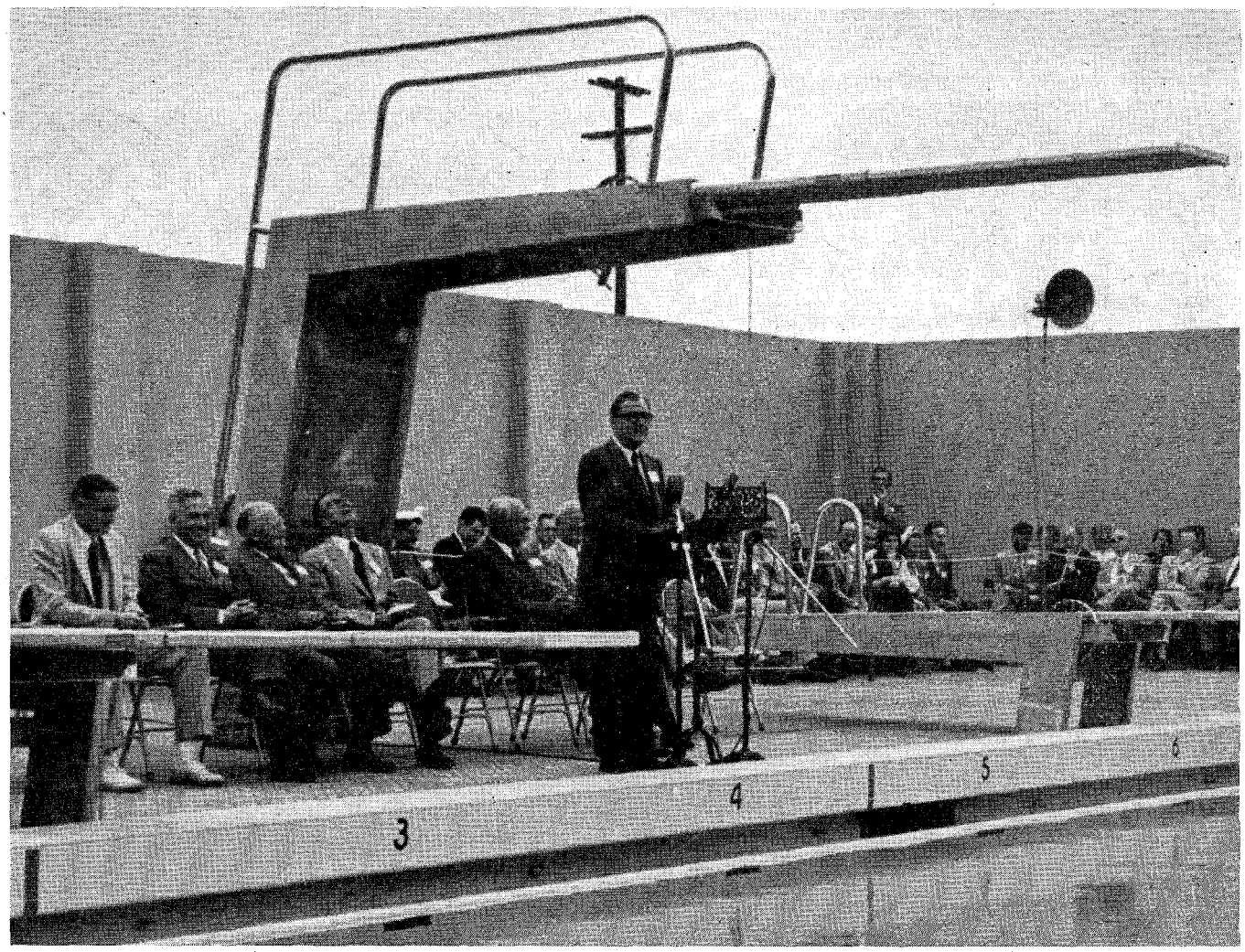
ALUMNI SEMINAR DAY

A TOTAL OF 628 PEOPLE attended the 18th annual Alumni Seminar on April 16—298 alumni, 135 wives, 31 faculty and their guests, and 14 Industrial Associates of the Institute.

The daytime program featured a series of eight lectures which provided a varied sample of the sweep of activities at the Institute. Dr. Dan Piper, Assistant Professor of English, spoke on "French Distrust of Uncle Sam"; Dr. Peter Kyropoulos, Associate Professor of Mechanical Engineering, discussed high octane fuel; Dr. William A. Baum, of the Mount Wilson and Palomar Observatories staff, reported on "The Size of the Universe—Today"; Dr. A. J. Haagen-Smit, Professor of Bio-Organic Chemistry, told of the varied uses of essential oils; Dr. Lester M. Field, Professor of Electrical Engineering, discussed microwaves; Dr. Henry Hellmers, Research Fellow in Biology, spoke on vegetation as an erosion control; Dr. John R. Pellam, Professor of Physics, discussed extreme low temperatures in "Surprises Near Absolute Zero," and W. H. Hildeman, Graduate Teaching Assistant in Biology, talked on tropical fishes.

Highlight of the afternoon program was the official dedication of the Alumni Swimming Pool, followed by a water ballet, a diving exhibition by Olympic champions—and a chance for the hardier visitors to try out the pool for themselves.

After dinner at the Pasadena Elks Club, President DuBridge reported on recent developments at the Institute, and Dr. Robert M. Hutchins gave a talk on "The Sources of National Strength," which may be found on page 20 of this issue.



Dedicating the new Alumni Swimming Pool—Albert B. Ruddock, chairman of the Caltech Board of Trustees, at the microphone; seated are student body president Phil Conley, President DuBridge, Prof. Royal Sorensen, Alumni president Kenneth Russell, Alumni Fund founder Howard B. Lewis, athletic director Hal Musselman.

A near-record crowd of 628 alumni, their families and guests, attended this year's seminar.

Security, secrecy, and conformity may be desirable in certain connections, but do they make a country stronger —or weaker?

THE SOURCES OF NATIONAL STRENGTH

by ROBERT M. HUTCHINS

YOU MAY KNOW that story about Constable, the 18th Century English painter, who left a note on the back step for the milkman which read, "Dear Sir: In future please leave the water and milk in separate containers."

I feel that there is a certain—I won't say incompatibility—but some lack of communication between you and me due to the difference in our education. Nevertheless, it gives me the greatest pleasure to be here tonight; this is the very first alumni I have ever addressed from whom I was not seeking to raise money. In a way, I regret this, because you are the only alumni I have ever addressed who *had* any.

When everything is said and done, though, I do feel at home here—and not merely because we are neighbors. (For four years I have lived four blocks away from the Institute.) It is your athletic record that makes me feel at home. I can only say that if I had had a football team like yours at Chicago I would not have bothered to abolish it.

I don't know that you realize how glad we are that the Institute is in Pasadena. The Institute is the one, and perhaps the only one, of the institutions here with which I am acquainted that has insisted on quality and has maintained the quality on which it has insisted in the last quarter of a century under the greatest possible pressure.

There is another educational institution in the community. It is now offering—I am happy to tell you—one unit of credit toward the Bachelor's Degree for a course in rest. This gives you some idea why I am glad that Caltech is in Pasadena.

What is going to happen is that we are going to have courses in elementary, intermediate and advanced rest, and then, of course—because all of the courses have to be taught by professors, and these professors have to have a PhD in the subject—we shall shortly have Doctors of Philosophy in Rest.

It is easy to understand why courses in listening are given at this other educational institution, but last week a new course was announced that seriously alarmed me—a course in selling free enterprise, for which (and this is what I object to) only a *half* unit of credit is given. You can get twice as much credit for resting as you can for selling free enterprise.

I am a little confused, I must admit, about the smog matter. I have the impression that half of you are trying to get rid of smog and the other half are making it. That probably accounts for the air of Afghanistanism that one can detect in this gathering. Afghanistanism, as you know, is the practice of referring always to some remote country, place, person or problem when there is something that ought to be taken care of near at home that is very acute. So you say to a professor at Caltech, "What about smog?" and he says, "Have you heard about the crisis in Afghanistan?"

Transcribed from a recording of Dr. Hutchins' talk to the Caltech alumni at the Alumni Seminar dinner in Pasadena, April 16, 1955.

I want you to know that this attitude is not appreciated. The four blocks between here and my house are practically impenetrable, and the half of you who are working to clear the smog up should clear it up, or the other half should stop making it. This takes care of Pasadena; we now pass to California.

I am glad that the California Institute of Technology is in California. This is the land of the oath. If you want anything in California, you have to take an oath before you can get it. This oath specifies that you have not nor have you ever been. I would like to tell you *what* it specifies that you have not nor have you ever been, but that would take too long.

Before you get a driver's license you will have to take an oath which says: I am not nor have I ever been. And if you don't believe that there are laws pending to that effect in Sacramento, you just don't know what is going on in this state.

Security on the campus

This is the land of the California Senate Committee on Un-American Activities, the counsel of which is a man by the name of Combs. Mr. Combs lately testified before the Subcommittee on Security of the U.S. Senate. He testified that he had welded a chain of security officers on 11 campuses in California that are busily engaged in spying on faculty members and students of those institutions. He also announced, to the evident sympathetic ears of those who were present, that he had arranged a system of clearing faculty members; if you wanted to be a teacher in a California college, you had to clear with him. As a result, one hundred or more—he wasn't quite sure, but he knew it was at least a hundred—had been fired, and a hundred or more had failed of appointment.

Mr. Combs indicated further that he was keeping a careful watch on the curriculums of the higher institutions of learning in this great state. He referred—and his reference seemed to cause obvious alarm among those who were listening—to certain changes which had been effected in the curriculum of a great California university. (Although they had been subterraneously made, they had not escaped his notice.) He said that the title of a course in public speaking at this California university had been changed to "Speech" and that the books had been changed from Kipling, Robert Louis Stevenson and Masefield to John Stuart Mill.

Now the subversive character of these alterations may not be obvious to you, but they were clear to Mr. Combs and to the California Un-American Activities Committee, and also to the Senate committee as well.

We now pass to the Pacific Coast. I am glad that the California Institute of Technology is on the Pacific Coast because Robert Oppenheimer was not competent to lecture on physics at the University of Washington. If Robert Oppenheimer is not competent to lecture on physics at the University of Washington, I don't know who is. Therefore, the faculty of physics—if there is one at the University of Washington—should be at once disbanded, or it should be announced that the test of competence is no longer applied. The reason that I am glad that the California Institute of Technology is on the Pacific Coast is that the California Institute of Technology applies the test of competence to the members of its staff.

I am also glad that the California Institute of Technology is in the United States because we are in the midst of considerable confusion about the sources of our national strength. The sources of our national strength are supposed to be security, secrecy and conformity. It occurs to me that nobody gets into Caltech unless he has the I.Q. of a genius, and nobody can graduate—well, I don't know *what* he has to have to graduate. He probably has to marry a genius to graduate.

Therefore I am sure that it is clear to you that security, secrecy and conformity may be desirable in certain connections, but they do not and cannot constitute the sources of our national strength. In the first place, these are purely negative ideas. They result from a negative psychological condition. This is the condition of being scared.

Far be it from me, before such a distinguished scientific audience, to try to tell you anything on my own. I will quote to you from scientific authorities; I will quote to you from the Board of Directors of the American Association for the Advancement of Science. To think that this Board was ever able to agree on anything is sensational in itself, but to have them agree on a series of highly controversial subjects shows that they are almost qualified for entrance to, if not graduation from, Caltech.

Security risks and secrets

In the first place, the Board of Directors of the AAAS says, "Everybody is a security risk." It follows that if you take the idea of security to its logical limit, you will never employ anybody. The question, therefore —says the Board of Directors of the AAAS—is not how we can avoid leaks, but how we can best aid national progress. The question is not how we can minimize our losses, but how we can maximize our gains. As to secrecy, the Board of Directors of the AAAS really lets itself go. On this subject the Board says, "There is no such thing as a permanent, scientific secret."

The first question I suppose we should ask is: Has the security system really strengthened the country? It would appear to be that the loss of Robert Oppenheimer and Ed Condon alone would suffice to give the answer. Why should we weaken the country by refusing to employ competent people?

Not long ago I was at dinner with the senior faculty members of the University of Birmingham in England. Across the table sat a professor—he was, of course, a scientist—who was a member of the executive committee of the Communist Party of Great Britain. I inquired

of the vice-chancellor, and of various professional characters in the vicinity, what the effect of having this dangerous Red in their midst was, and, after they had succeeded in identifying him by this description, they said there wasn't any effect at all—that he was a very good scientist. It is, of course, clear to you that no American university—no *great* American university, at least; we can't tell what a poor university would do, but no university that would attract public attention—would employ this man.

I call your attention to the great principle that now guides the actions of our country in these matters. It is the principle of irrelevance. It is not contended any longer that the charges that are made have any bearing on the quality of the work that is done. Even at Harvard they don't say: What was the effect of this man's teaching on the innocent minds of the students? They don't ask whether it had any effect at all. The question at Harvard is not: What is this man teaching? Is he any good at his work? The question at Harvard is: What did he belong to? Did he lie about it? Or did he refuse to answer questions on that subject?

In Los Angeles, New York, Philadelphia, no effort is made to show that the school teacher is bad for the pupils. In cases where such evidence was offered to show that the teacher was *good* for the pupils, it was indignantly rejected as impertinent. When there is no obvious reason for getting rid of a teacher, and the question is, "How can we do it?", the answer is simple. They ask the teacher about her political affiliations. The teacher declines to answer. She is then held to be insubordinate, and she is fired. Surely it cannot be insubordination to refuse to answer illegitimate questions. No question can be legitimate about the activities of the teacher which has no bearing on his or her work.

Textbooks

Let's go back to California for a minute. In this great state there is a textbook commission and it announced the other day that it was sitting on 23 books —just about enough to go around. It has to figure whether these books can be let loose in the school rooms of California, and Dr. C. C. Trillingham, who, in addition to having the honor of being a member of this commission, is distinguished by being the Los Angeles County Superintendent of Schools, made the following statement: "If the author of any one of these books is aligned with the Communists, we don't want his book. We don't want his book even if there is no Red propaganda in it."

In other words, he said: "We are opposed to people who are said to be associated with people who are said to have ideas, even if they themselves have never expressed them."

I have some news for you from Washington. There are several government departments in Washington which have now set up guidance clinics for their employees. These guidance clinics tell you how *not* to look like a security risk. (This is no laughing matter; this is serious.) Of course, there is no difference between looking like a security risk and *being* a security risk, so really what they are trying to tell you is how not to *be* a security risk.

How about the Bill of Rights—and the 6th Amendment? The 6th Amendment provides that the defendant in a criminal case shall be informed of the nature and cause of the accusation against him, shall be confronted with the witnesses against him, have compulsory process for obtaining witnesses in his favor, and have the assistance of counsel. But in a security case, a man's career may be sacrificed to rumor.

The 5th Amendment

Or take the 5th Amendment. The 5th Amendment, as everybody knows, provides that, in any criminal case, the defendant cannot be compelled to be a witness against himself, and the courts extend this to Congressional investigations. All over the country, if a man invokes the 5th Amendment, this is taken to be a confession of guilt. Actually, the 5th Amendment is nothing but the extension of the presumption of innocence. Why should a man convict himself out of his own mouth instead of compelling the prosecution to establish the charges that are brought against him? All that the 5th Amendment means is, "Prove it."

Now we come to secrecy. Secrecy brings us to the nature of education and research. There used to be a saying in Chicago—where everybody talks wildly—that the atomic bomb would not have been built if the secrecy regulations had been literally observed. And the reason, of course, is that even when you are making an atomic bomb, you have to talk to somebody about it, or you won't make any headway. Learning proceeds by discussion, and discovery takes place as a result of discussion. Except under unusual circumstances, secrecy can do nothing but thwart the scientific progress of the country that insists on it.

Now, since learning proceeds by discussion, it is important to present different points of view on important subjects. The great educational crime is indoctrination. This is why I object to the half unit of credit for being sold the free enterprise system. It is not the object of education to sell anybody *anything*—certainly not the slogans of the National Association of Manufacturers, or Americans for Democratic Action, or the Republican or the Democratic Party. The aim of education is to learn for yourself, and the claim of academic freedom is based on the necessity that the teacher feel free to discuss all points of view, or education cannot take place.

I think that in this part of the world particularly, a misconception of education is rampant. I sometimes think that our fundamental trouble in California is our conception of what the university professor is. I think the general conception is that the teacher of today is the nursemaid of yesterday. You know—our children

A Campus-to-Career Case History

"This is what I did yesterday"

"I like a job that keeps me jumping," says Bill Jermain, C.E. from Marquette, '52. "And my first management assignment with Wisconsin Telephone Company does just that. I'm Service Foreman at Sheboygan, with nine installers, and that means variety of responsibility. But judge for yourself. Here's a quick run-down of what I did yesterday, on a typical day—

8:10—"Checked day's work schedule. One of my new men was putting in a buried service wire, and I went over the job specs with him to be sure he had things straight.

8:30—"Answered mail while my clerk checked time sheets from previous day.

9:30—"Out to supervise installation of the first aluminum Outdoor Telephone Booth in my exchange. Reviewed the assembly instructions with the installers, then arranged for special tools and bolts to be delivered to the job.

11:30—"Drove across town. Made a 'quality inspection' on a telephone installed last week. Everything checked O.K.

12:00—"Lunch.

1:00—"Picked up film for next day's safety meeting. Watched the film, made notes for discussion.

2:00—"Met with moving company manager to estimate cost of telephone cable lifting for a house moving job. Drove the route he had planned and worked out schedule for construction crews.

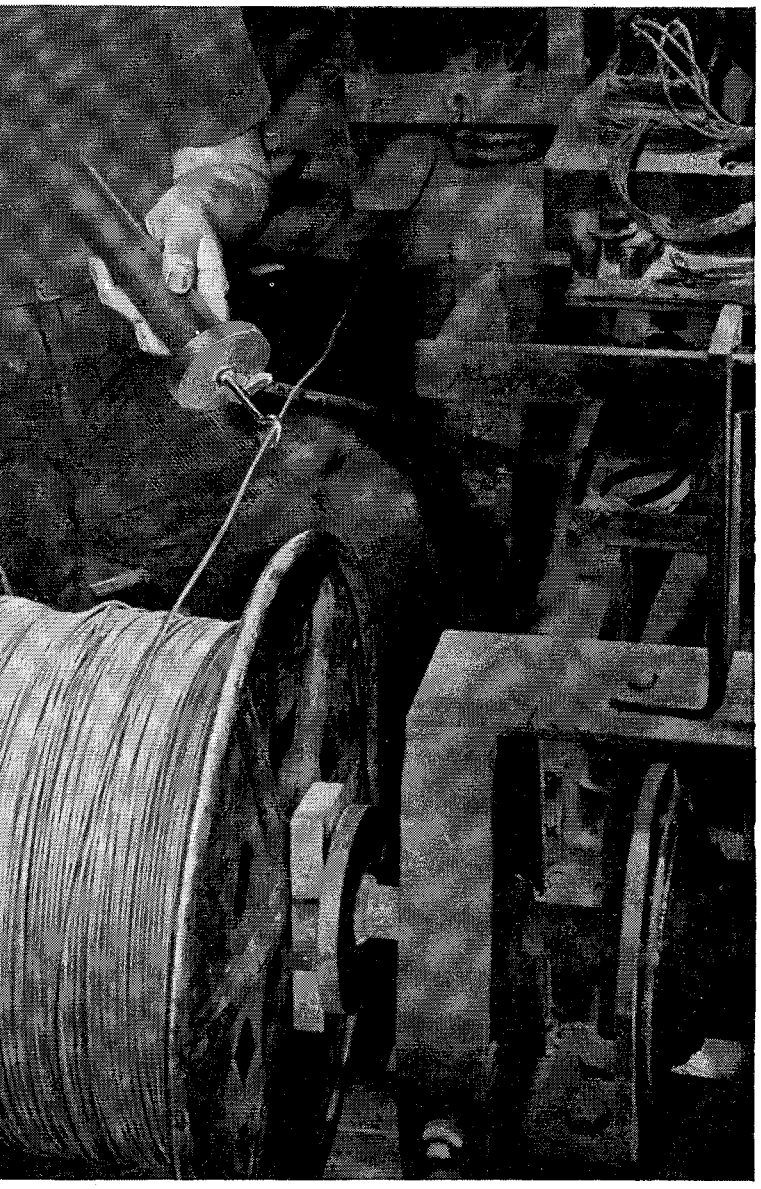
3:30—"Returned to aluminum booth installation. Went over wiring specs with the electrician.

4:00—"Stopped at Central Office to pick up next day's orders. Met installers at garage as they checked in and assigned next day's work."

Bill has been in his present job about a year, and is looking forward to new responsibilities as his experience increases . . . as are the many young college men who have chosen telephone careers. If you'd be interested in a similar opportunity with a Bell Telephone Company . . . or with Bell Telephone Laboratories, Western Electric or Sandia Corporation . . . see your Placement Officer for full details.

BELL TELEPHONE SYSTEM

Factory testing of "U.S." electrical wires and cables



CABLE TESTING (Part I)

It has been indicated in a previous section of this series entitled "Cable Specifications" that practically every element of insulated electrical wires and cables may be covered by some specification requirements. Numerous tests are, therefore, necessary to determine the suitability of such cables for the application for which they are designed. These tests may be conducted on (a) the cable elements during manufacture, known as preliminary tests, (b) the completed cables at the factory, final tests, and (c) after installation. Some of the preliminary and final tests at the cable factory such as conductor resistance, high voltage, insulation resistance and corona level are, generally, non-destructive tests and may be conducted on each entire length of cable manufactured. Other tests, such as insulation and sheath thickness, physical, aging, moisture, resistance, ozone resistance, capacity and power factor, short-time dielectric strength and cold bending and long-time dielectric strength tests are made on short samples selected from a lot of cable.

The following is a general description of these tests and their significance as applied to insulated electrical wires and cables. Details of the test equipment required and the specification requirements are not discussed since they are covered by industry publications such as those of the American Society for Testing Materials and the Insulated Power Cable Engineers Association.

FACTORY TESTS

Factory tests are performed for the following purposes: (1) to determine whether the materials of which the cable is made have the required quality; (2) to determine whether the manufacturing processes such as wire drawing, annealing, compound mixing, insulation extrusion and vulcanization have been performed properly; (3) to detect partial or incipient faults that may have accidentally failed to be detected in the tests indicated in (2); and (4) to determine whether the cable meets the customer's specifications.

Tests on Entire Lengths

CONDUCTOR RESISTANCE. Test is made to insure that the conductor has the required average cross-sectional area and, hence, that its resistance does not exceed the allowed maximum.

SPARK TESTING. The entire length of insulated conductor is subjected momentarily to a high potential to detect and permit the repair of imperfections in the insulation that might cause failure on subsequent voltage and insulation resistance tests.

HIGH VOLTAGE TEST. This test is conducted on each entire length of insulated cable to detect potential faults or weak spots in the insulation and to insure that the insulation will withstand the minimum voltage required by the specification for its rated voltage. The magnitude of the test voltage is determined by the type and thickness of the insulation as shown in the following table for 600 volt cables. The time of application is one minute for code grade insulation, and five minutes for the higher grades.

Insulation Thickness and Test Voltage for Rubber Insulations for 600 Volt Service

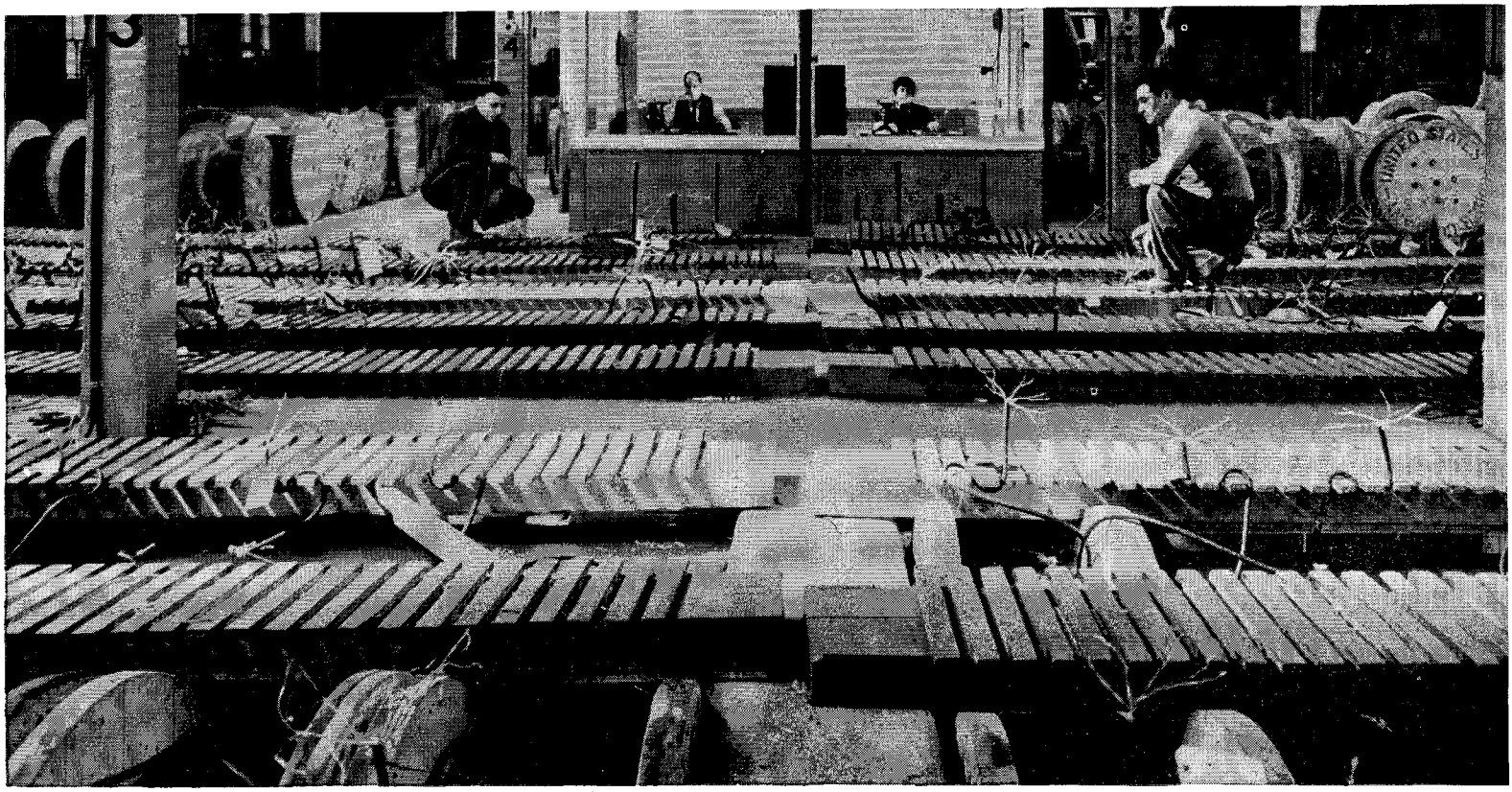
Conductor Size, Awg or MCM	Insulation Thickness, 64ths Inch	Code Grade	AC Test Voltages Performance and Heat-Resistant	(KV) Ozone-Resistant
14 to 9	3	1.5	3.0	4.5
8	4	1.5	3.5	6.0
7 to 2	4	2.0	3.5	6.0
1 to 4/0	5	2.5	4.0	7.5
225 to 500	6	3.0	5.0	8.5
525 to 1000	7	3.5	6.0	10.0
Over 1000	8	3.5	7.0	11.5

Cables designed for operation at voltages above 5001 are required to withstand a d-c test voltage in addition to the a-c voltage. This d-c voltage is three times the a-c voltage for ozone-resistant insulations and it is usually applied for 15 minutes.

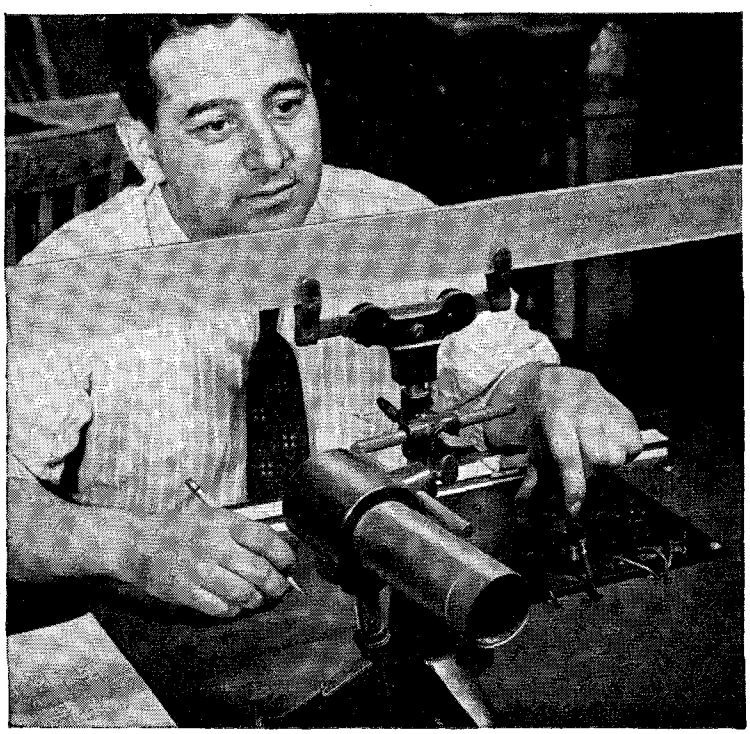
The high voltage test is made by applying the required voltage between the conductor and water in which the cable has been immersed for at least six hours. When metallic coverings are present, the voltage is applied between the conductor and such coverings. Any failures are repaired and the cable again subjected to the voltage.

US RUBBER

UNITED STATES



INSULATION RESISTANCE. The insulation resistance test consists of applying a direct voltage of from 125 to 500 volts, usually from a battery, between the conductor and water in which the cable is immersed, or other ground, and measuring the current that flows through the insulation after an electrification of one minute. A suitable galvanometer is generally used for this measurement. From this current and the applied voltage, the resistance of the insulation is calculated and expressed, usually, as megohms (1 million ohms). This test is conducted after the voltage tests and, hence, serves to indicate whether the insulation failed on that test. Insulation resistance also serves to indicate uniformity in processing, particularly insulation compounding, since a well-processed compound should give reasonably uniform insulation resistance. Most wire and cable specifications contain minimum requirements for insulation resistance so that this test determines whether or not the specification is complied with.



The resistance of insulations is inversely proportional to the temperature, that is, it is lower at high temperatures. It is, therefore, necessary to note the temperature at which the insulation resistance is measured and to apply a correction factor to reduce the resistance to a standard temperature. The insulation resistance varies with the type of insulation, its thickness and the size and length of the conductor. The following formula gives the relation between these factors.

$$\text{Insulation Resistance, Megohms} - 1000 \text{ feet} = K \log_{10} \frac{D}{d}$$

Where, D = Diameter over the insulation, inches
d = Diameter over the conductor, inches
K = A Constant for the insulation used

CORONA OR IONIZATION LEVEL. This test determines the voltage at which ionization or corona develops in a length of cable and is usually made only on cable for operation above 4000 volts. It is made by applying a gradually increasing a-c voltage between the insulated conductor and water or other ground with an oscilloscope in the circuit. Any air entrapped at the surfaces of the insulation or within the insulation will ionize when a sufficiently high voltage is applied resulting in the formation of more active oxygen or ozone. These materials are detrimental to most organic insulations particularly when such insulations are under physical tension, and thus may cause premature failure of the insulation. This ionization is indicated by the appearance of high-frequency oscillations on the charging current trace of the oscilloscope. In actual practice, the voltage at which ionization is extinguished rather than initiated is determined. For long cable life, this extinction voltage should be at least 110 per cent of the rated voltage to ground.

Wire and cable specifications generally require that these tests be made on the completed product. High voltage and insulation resistance tests are usually also made immediately after the insulation has been applied and vulcanized. This is general insurance that cables passing the test will meet the requirements when completed.

become a nuisance around the house at about the age of six; it is not proper for us to allow them to go to work until they are about 22; so what are we going to do with them in the meantime? The Civilian Conservation Corps has been abolished—and anyway, that was a Roosevelt idea. Fortunately, there is the educational system. This is the answer to all our problems! We will put our children in the educational system and we will keep them there until the age of 22.

You may say: What are they going to do there? But what difference does that make? It will keep them out of trouble. You know—they will get to know people—to know one another—and you might teach them a few vocational ideas—but the main thing is that they will be relatively harmlessly occupied during a period when we do not know how to cope with them.

Education—or accommodation

This, of course, is not a system of education; this is a system of accommodation. And the role of a teacher in this system of accommodation is clear. The teacher is in a position analogous to that—let us say—of baby sitter. You might call the university professor, then, an adolescent sitter.

Now, this conception of education is, I am sure, quite foreign, and I hope quite shocking to you. After all, you went to Caltech. But I assure you that this system exists potentially in many places, and it exists actually in some. The aim of this educational system is not to educate, but to accommodate. The effects upon the status and the function of the professor, the effects upon academic freedom, are immediately clear.

For example, not long ago I met a very distinguished physician; it was during the fight about the loyalty oath at the University of California. He was from Los Angeles; I was from San Marino. We immediately got into an argument about the loyalty oath in California. He said to me, "Mr. Hutchins, if we are going to hire these people"—referring to the faculty of the University of California, which is almost as studded with Nobel prize winners as that of Caltech—"If we are going to hire these people to look after our children, we are entitled to know what their political opinions are."

This is adolescent sitting. If we are going to hire these people to sit with our children, we are entitled to know what their opinions are. Well, I suppose we are. Far be it from me to deny a mother the right to cross-examine a baby sitter about her political opinions. But this is not my conception of what a university professor is. My conception of a professor at a university is that he is engaged in independent thought and criticism, and that his role in education is to help young people to think for themselves.

Think for a moment of what is going on. The other day a judge went to conduct a seminar in a law school. The judge said, "Now, that we are all here together in the privacy of these four walls, we can discuss the administration of justice in Washington as it is at present, and I want to be sure that every one of you speaks up and expresses himself candidly. Let us pull no punches; let us really get down to business here and let us see if we can understand—"

"Just a minute, just a minute," said a boy sitting on the back seat. "Not a bit of it, your honor," he said. "You're not going to catch me that way," he said. "I am not going to express my opinions fully and frankly in this class. How do I know who is sitting here and what effect it might have on my career?"

At the YWCA at UCLA for many years legal groups of all kinds have traditionally held their meetings. But it is observed over there now that students do not attend the meetings of unpopular groups, and under cross-examination it develops that the reason they don't is that they believe that somebody will mark them down, and they may be marked for life.

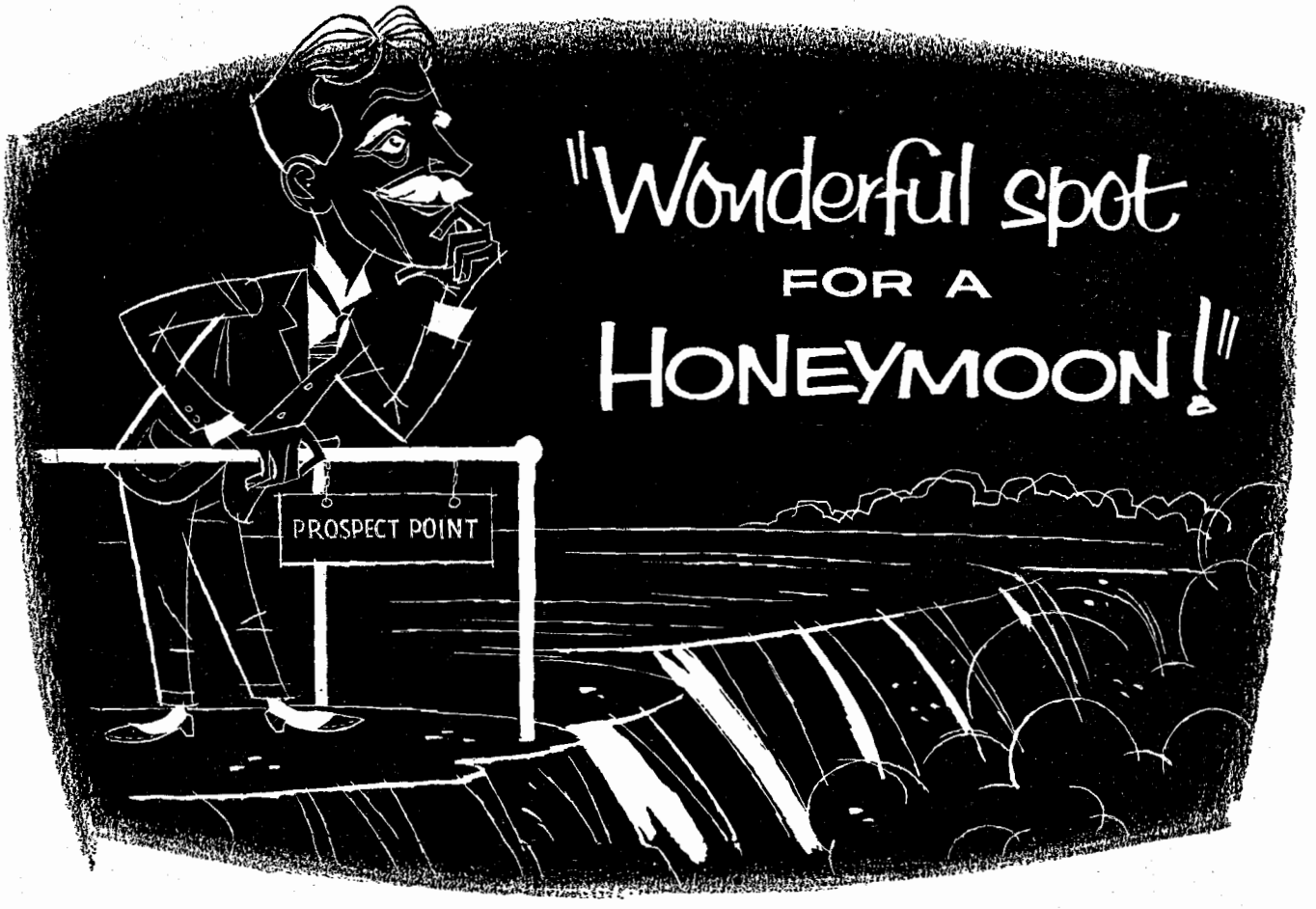
It would appear, then, that if we take discussion, argument, and the expression of different points of view as the only way of learning anything—the only way of making any progress in science—security and secrecy and conformity have the effect of actually weakening the country.

As for security, laws that forbid espionage and sabotage would appear sufficient. As to secrecy, you can find no place for it in a country that wants to make scientific progress. Conformity is in the last degree undemocratic and un-American.

The true sources of strength

The strength of a country depends on the character and intelligence of its people, and it is to these ends—the character and intelligence of the people—that the educational system is directed. To the strength of a country, scientific skill and technical knowledge are indispensable, but as you will see, they are not enough. Neither science nor technology can tell us how to use the power that they give us. It is through the other 25 percent that you learn at Caltech—the other 25 percent of the curriculum—that you learn, if you can, how to control and use the power that technology gives us. It is through the extra-curriculum activities that Hallett Smith has built up around the other 75 percent of the curriculum that you come to understand the role of science and technology in society.

It is through reflection—through what we have to call the humanities and social sciences, as the engineer and scientist see them, that you become at last more than scientists and engineers, that you become what you *have* become—citizens and men.

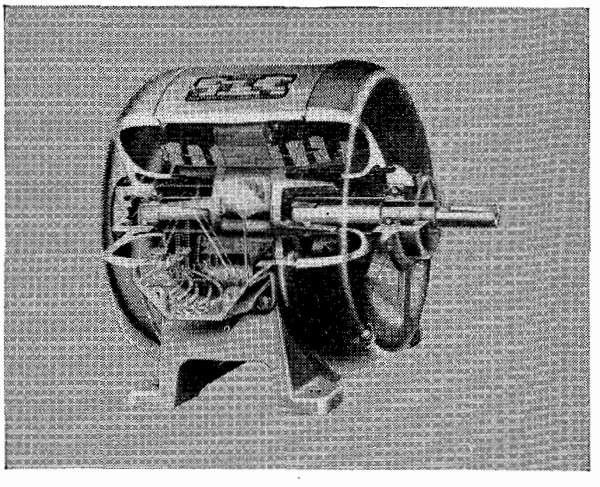


NIKOLA TESLA, THE MAN WHO HARNESSED NIAGARA

Water, water, everywhere — and no power. That was Niagara Falls when Nikola Tesla began work on its power system in 1888. Now Niagara is one of the world's largest electric power plants.

But to make the most of this power, many problems in electric motor design had to be overcome. New Departure ball bearings have helped solve many of them. For example, motors with New Departure self-sealed ball bearings may be mounted in difficult-to-reach locations because the bearings will operate for years without attention for relubrication or adjustments of any kind.

Highly important also are the facts that these ball bearings resist loads from *all* directions and, being grease-lubricated, permit motors to be applied in any position from horizontal to vertical without loss of efficiency or trouble from lubricant leakage. Whatever the loads, New Departure ball bearings maintain accurate rotor-to-stator relationship — are cool-running at all motor speeds.



New Departure ball bearings assure positive rotor support under all loads in this motor. Bearing seals, pioneered by New Departure, keep lubricant out of the motor. Shields on the reservoir side keep foreign matter out of the bearings.

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE •• DIVISION OF GENERAL MOTORS •• BRISTOL, CONNECTICUT

STRUGGLE FOR SURVIVAL

THE SOPHOMORE stumbled through the open door into his room. Gasping for breath, he slammed the door behind him. Acting with the desperate agility of a fugitive from justice, he closed the transom and fumbled frantically with the little transom latch until he was sure he was safe.

A moment later the pounding of feet down the alley to his door told him that he had been just in time. Someone outside in the alley was swearing at him splendidly. He had a moment of panic as he doubted whether his door was really locked as he had planned it to be; but it must be all right, for the knob was vibrating furiously, and the avenging frosh outside seemed unable to gain entrance.

Triumphantly the Sophomore pitched his empty water pistol onto his unmade bed, threw off his sopping T-shirt, and looked again at the door. He laughed aloud at the little streams of water dribbling ineffectually through the jamb. He was untouchable now; a man's room is his castle.

Outside, the alley was quiet now, and he deduced that the frosh had taken their mischief elsewhere.

Next time those guys play bridge on a hot day, they'll keep their door closed, he thought to himself with a smile that had just a bit of a swagger in it. He brushed off a momentary feeling of guilt that he might have ruined their cards.

This was third term, the way he liked it. Warm weather, water pistols, and walking around the courtyard instead of across it. Vengeance and counter-vengeance. Struggle for survival.

If things hadn't been silly enough before, the advent of daylight-saving time had been the final touch. When it had been almost dark after supper, you could force yourself to go to your room and study, or go see someone about a job to be done. Now, though, it was still broad daylight after supper, and who had the will power to study in broad daylight? Little groups of men hung around the courtyard for half an hour or more, talking and laughing and wasting time.

It was a good thing they'd had that week of bad weather, the Sophomore mused. If the weather had been sunny right straight through, he'd be so far behind now he'd never catch up. The showers that had washed April down the drain were a blessing in disguise, for that weekend he'd even gotten some things accomplished.

Not very many, he admitted quietly to himself.

Everyone was silly this time of year. Guys were talking double-talk (at one point "yes" and "no" became 'yaynsenyingyang" and "yamnoyingyang" but usually it wasn't quite that complicated) and guys were scuffling in the lounges and waltzing with each other in the courtyards and holding slingshot competitions in the alleys.

It was times like this that he enjoyed himself most. Sometimes, though, it would add to the after-dinner merriment if a handful of healthy young lasses were part of the fun! Such was not his lot, though. He had chosen education over co-education when he came to Tech (though he had not thought of it in those terms then).

At least he was getting around to a few dances and parties these days, and they served well to take the edge off his frustrations. The frosh-soph dance (his classmates gaily referred to it as the soph-frosh dance, which was only fitting) had been a huge success, and he supposed the junior-senior prom was as neat as ever. A couple of beach parties and a couple of exchanges had swelled his datebook and his self-confidence, too.

What was he looking for? More goofing off, more dates, more good time, less work. A passing thought struck him: he had spent four years of high school trying to be what he had thought was collegiate, and now he had spent two years of college trying to be what he had thought was high-school. It was a disturbing thought, and he brushed it aside.

A look at the calendar on his wall told him that in a few short weeks he would be home. Summer vacation!—when his mind went into hibernation, while his baser instincts took over. Summer vacation, a time without homework and without grades, a time of gaiety and variety and company.

His nose brought his attention sharply back to the present. Turning toward the door, he saw an evil cloud of yellow fumes creeping up from the crack at the floor.

Vengeance and counter-vengeance! Struggle for survival!

He whipped his windows wide open and then, holding his nose in defense against the unbelievably foul odor that inched toward the center of his room from the door, he threw open the door and kicked the little stink-bomb out into the alley.

I'll get even if it takes all year, he vowed wrathfully.

—Marty Tangora '57

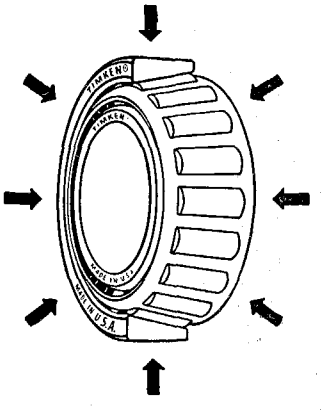
Another page for **YOUR BEARING NOTEBOOK**

How to increase gear life in a scraper

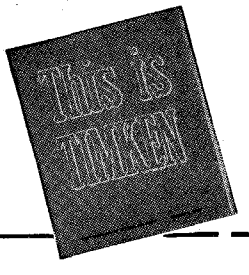
When this 13 cubic yard scraper, fully loaded, travels at 25 MPH over rough terrain, the gears in the differential, engine shaft and pinion get a workout. Realizing this, the engineers specified Timken® bearings for these vital applications. The tapered construction of Timken bearings lets them take radial and thrust loads in any combination. Gears are held rigidly in place. Perfect tooth-mesh is maintained. Gears last longer.

How TIMKEN® bearings hold gear shafts rigid

The line contact between rollers and races of Timken bearings gives shafts rigid support over a wide area. Shaft deflection is minimized. And the tapered design of Timken bearings permits them to be set up with the most desirable amount of end play or preload that gives the best performance.



Want to learn more about bearings or job opportunities?



Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, O.

TIMKEN
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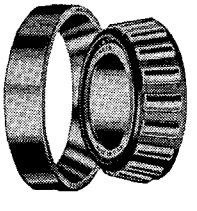
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃
BEARING TAKES RADIAL ⊕ AND THRUST ⊖ LOADS OR ANY COMBINATION ⊕⊖

THE MONTH

Theoretical Physicist

DR. MURRAY Gell-Mann, at 26 one of the outstanding young physicists of the country, joins the Caltech staff as Associate Professor of Physics this month.

Dr. Gell-Mann comes to Caltech from a position as Assistant Professor of Physics and member of the Institute for Nuclear Studies at the University of Chicago.

A native of New York City, he received his BS degree from Yale in 1948. Two years later, at the age of 21, he received his PhD at the Massachusetts Institute of Technology. He spent the following year as a member of the Institute for Advanced Study at Princeton, N.J., and joined the teaching staff of the University of Chicago in 1952. During the summers of 1951 and 1953, he was a Research Associate at the University of Illinois. From September, 1954, until the present, he has been on a leave of absence from the University of Chicago; he spent the 1954 fall term as Visiting Associate Professor of Physics at Columbia University, and since the first of this year has been engaged in research at the Institute for Advanced Study in Princeton.

In addition to teaching at Caltech, Dr. Gell-Mann will continue his research in nuclear physics and, in particular, his studies of the life-times, decay modes and other properties of various sub-atomic particles.

Murray Gell-Mann, Associate Professor of Physics

Commenting on his appointment, President DuBridge said: "Dr. Gell-Mann is one of those exceptional theoretical physicists who have attained great stature at a very young age. He has already made substantial contributions to our understanding of the theory of atomic nuclei and the basic particles of which nuclei are composed. He will be invaluable to our program of training new scientists and carrying on research at Caltech."

Academy Member

DR. HARRISON S. BROWN, Caltech Professor of Geochemistry, was elected to the National Academy of Sciences last month, bringing to 27 the number of Caltech staff members in the Academy.

The Academy, holding its 92nd annual meeting in Washington, D.C., also elected Dr. Saul Winstein, who is now Professor of Chemistry at UCLA and a Caltech alumnus (PhD '38), bringing alumni membership to 22.

Election to the Academy, one of the highest scientific honors in the country, is in recognition of outstanding achievement in scientific research. Membership is limited to 500 American citizens and 50 foreign associates.

Harrison Brown came to Caltech in 1951 to establish its geochemistry laboratories in the Division of the Geological Sciences after five years at the University of Chicago Institute for Nuclear Studies. Previously he had made key contributions to the atomic bomb, first on the Plutonium Project at Chicago and later as assistant director of chemistry at the Clinton Laboratories, Oak Ridge, Tennessee.

His special fields are investigation of the age of rocks, the abundance of elements in the universe, and the composition of the earth and of meteorites. These problems

AT CALTECH

involve the fields of chemistry, physics, astronomy and biology as well as geology, and his work has earned him the $1000 prize of the American Association for the Advancement of Science and the American Chemical Society Award in Pure Chemistry.

He received his BS degree from the University of California in 1938 and his PhD in 1941 from Johns Hopkins, where he spent a year as an instructor before entering war research. He was born in Sheridan, Wyoming.

He is the author of *The Challenge of Man's Future*, published last year, and *Must Destruction Be Our Destiny?* (1946).

Caltech staff members previously elected to the National Academy include:

Carl D. Anderson, Robert F. Bacher, Richard M. Badger, George W. Beadle, Eric T. Bell (emeritus), Hugo Benioff, James F. Bonner, Max Delbruck, J. W. M. DuMond, Lee A DuBridge, Paul S. Epstein (emeritus), Richard P. Feynman, Beno Gutenberg, D. Foster Hewett, Charles C. Lauritsen, Carl G. Niemann, Linus Pauling, H. P. Robertson, A. H. Sturtevant, Theodore von Karman (emeritus), Frits Went, Oliver R. Wulf, and Don M. Yost.

Mount Wilson and Palomar Observatories staff members include: Horace W. Babcock, Ira S. Bowen and Seth B. Nicholson.

Harrison Brown was also named last month to a new board of editors-at-large for the *Saturday Review of Literature*. He will contribute editorials and occasional articles to the magazine, along with author Joseph Wood Krutch, historian Walter Millis, opinion analyst Elmo Roper, author John Steinbeck, and art expert Francis Henry Taylor.

Cancer Grants

AMERICAN CANCER SOCIETY grants totalling $47,549 were made to five Caltech scientists last month. Dr. Renato Dulbecco received ACS support for the first time this year for his studies of tumor-producing viruses, and continuing grants were made to Drs. Henry Borsook, Arthur W. Galston, Herschel K. Mitchell and Frits W. Went.

In supporting research throughout the country, the American Cancer Society attacks the problem of cancer at both the clinical level—where researchers are trying to find cures for cancer—and at the basic level—where researchers are seeking the causes of cancer. The $47,549 granted to Caltech this year is entirely in support of fundamental research.

Dr. Renato Dulbecco, Professor of Biology at Caltech, and Research Fellow Harry Rubin are studying the viruses which are known to produce tumors in animals. They are investigating what viruses in general do to cells, and how tumor-producing viruses turn a normal cell into an abnormal tumor cell. This work may help answer the question of whether viruses play any significant part in human cancer. Plans include research with human tissue cultures. The project received a National

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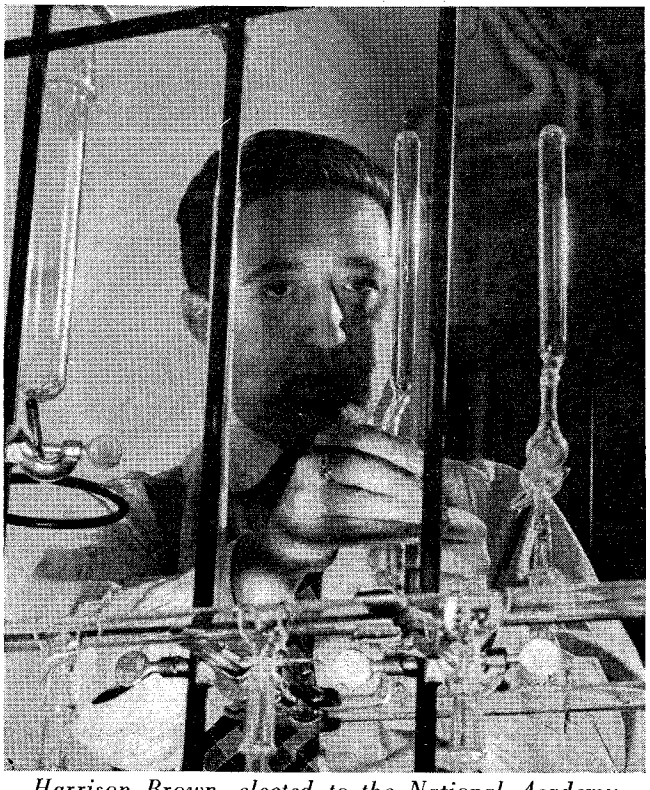
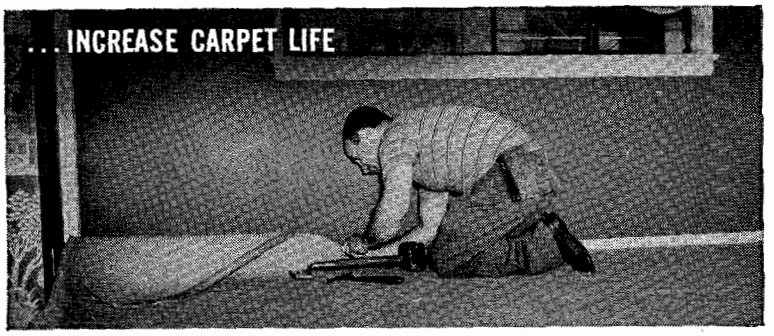


Harrison Brown, elected to the National Academy

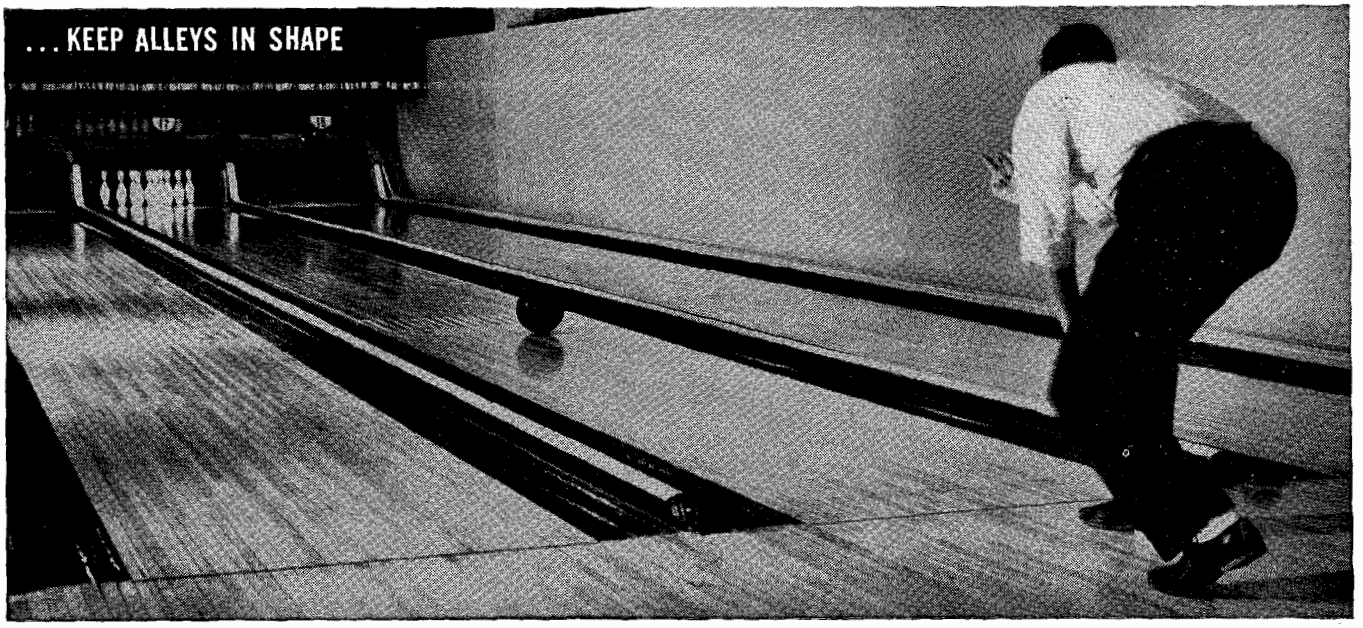
HOW HERCULES HELPS...



THE BACK COUNTS, TOO, in the manufacture of carpets. Hercules Dresinol® solvent-free resin dispersions used in conjunction with latex, starch and pigments, provide durable backings for popular-priced carpets. Dresinol furnishes either flexibility or stiffness; adds body to the carpet and improves adhesion of the backing for all types of cotton, wool and mixed fiber carpets.

NEW ANTHRACITE-BURNING BOILERS, clean and compact, make playrooms of basements the year round; even remove ashes automatically. Mining the millions of tons of anthracite used annually for residential, commercial and industrial uses would be impossible without explosives. For more than forty years, Hercules has pioneered in blasting techniques and equipment to increase the efficient and safe use of explosives in mining, quarrying, construction, and farming.

AIMING FOR THE "POCKET", this bowler wants the alley he uses highly polished and free of "ruts". That's why bowling alley surfaces are protected with nitrocellulose lacquer to keep them in top condition. The fastest drying protective coating known, lacquer makes it possible to put an alley back in play within hours after it has been refinished. This same tough finish protects bowling pins and other sports equipment.



HERCULES

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SYNTHETIC RESINS, CELLULOSE PRODUCTS, CHEMICAL COTTON, TERPENE CHEMICALS, ROSIN AND ROSIN DERIVATIVES, CHLORINATED PRODUCTS, EXPLOSIVES, AND OTHER CHEMICAL PROCESSING MATERIALS

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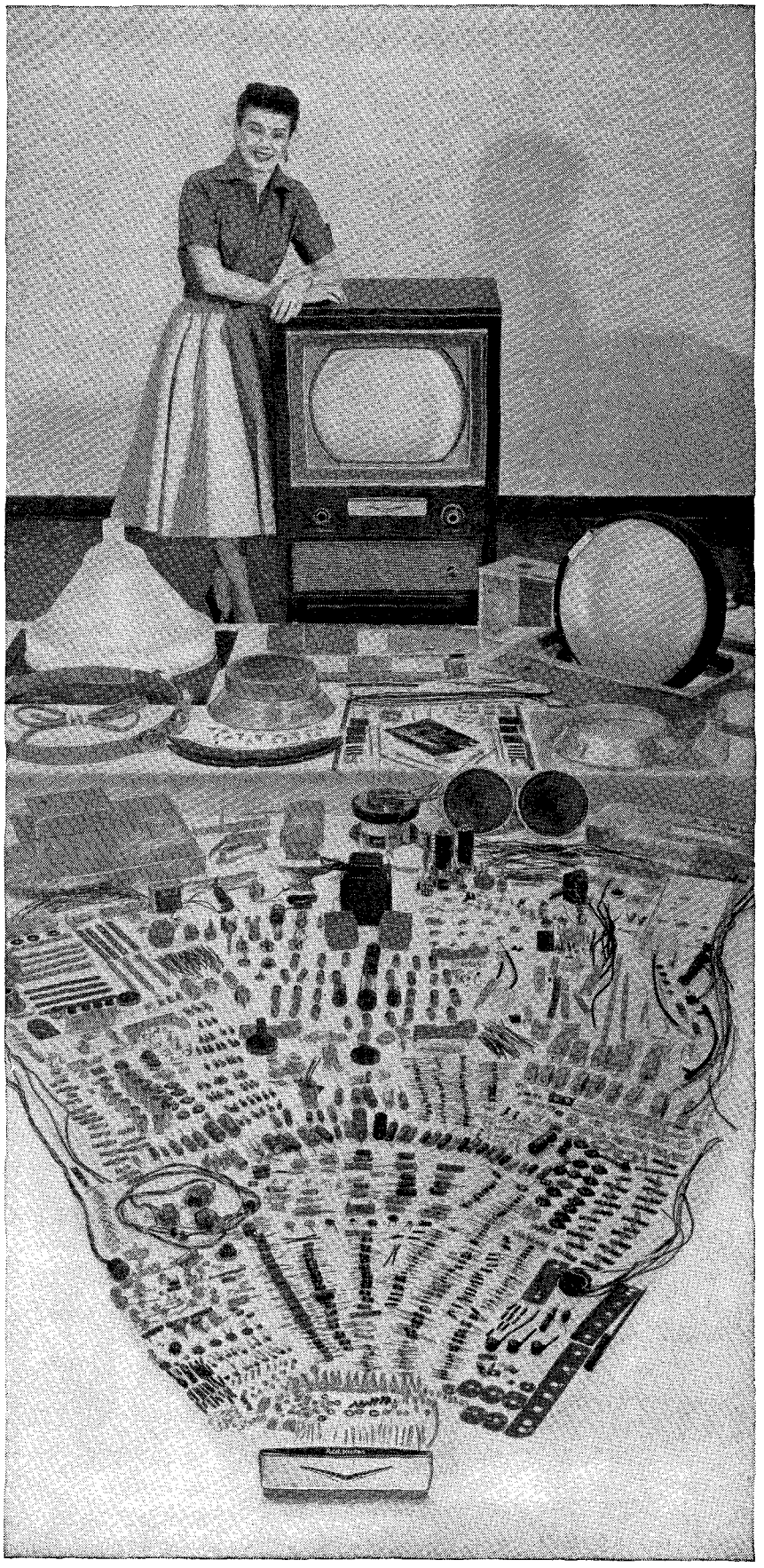


This picture shows how RCA helps small manufacturers grow

Today the inter-dependence between manufacturer and supplier is stronger than ever in the history of American business. For in the challenging new age of electronics, hundreds upon hundreds of component parts are needed in the manufacture of new products.

For example, the superb new RCA Victor 21-inch color TV set shown here contains 2,070 parts. These are made by 600 different suppliers, most of whom are small businesses.

Indeed, more than three-quarters of all RCA suppliers are small business firms that receive nearly one-half of RCA's purchasing dollars. They, in turn, have their suppliers of raw materials. Thus through a long line of cooperative effort, employment is provided for countless people in many fields—and an entire economy benefits.

RCA salutes its full roster of 7,500 suppliers, located in 43 states, for their inventiveness and resourcefulness that contribute so much to the quality and performance of its products. With these firms at our side, RCA continues to march forward, creating new and better "Electronics for Living"—electronics that make life easier, safer, happier.

WHERE TO, MR. ENGINEER?

RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or *Physics. For full information,* write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

RADIO CORPORATION OF AMERICA
ELECTRONICS FOR LIVING

grant of $15,000 from the ACS, and a California Division grant of $7,232.

One of the most important questions concerning the basic phenomena of growth involves the study of protein snythesis. Dr. Henry Borsook, Professor of Biochemistry, is in charge of continuing research at Caltech on the process by which proteins are made from amino acids. He and his colleagues are tracing the chemical reactions involved in this aspect of the growth process. The work received a $7,500 ACS grant.

Dr. Arthur W. Galston, Associate Professor of Biology, received a grant of $7,417 for his continuing studies of the action of enzymes in plant cell growth, with particular regard for agents controlling the cessation of growth. The enzyme peroxidase, which he is studying, affects this cell aging by destroying the growth hormone. Parallel findings in animals and humans with cancer indicate that the enzymatic action may be closely related.

Dr. Herschel K. Mitchell, Professor of Biology, was given $6,804 for his studies of how cells make nucleic acids—which are considered to be key substances in growth—and what chemical changes are produced in this process. The work may play a significant role in understanding cancer as a disease which alters the chemical production of cells.

Dr. Frits Went, Professor of Plant Physiology, was granted $3,596 for his research concerning the differentiation of living plant tissues of various specialized organs. The work is important to the study of cancer because malignant tissue loses its ability to function in its normal individual pattern. Instead, the malignant tissue grows in a disorganized fashion, without pattern, crowding out the healthy tissue and eventually destroying the organism.

Harvey Mudd

HARVEY SEELEY MUDD, vice president of the Caltech Board of Trustees, died of a heart attack on April 12 at his home in Beverly Hills. He was 66 years old. Mr. Mudd had been a member of the Board since 1929, serving on the finance committee and, later, on the executive committee. Mudd Laboratory, on the Caltech campus, was given to the Institute by his mother, in memory of his father, the late Col. Seeley W. Mudd.

Born in Leadville, Colorado, Harvey Mudd came to Los Angeles with his family in 1902. He went to Stanford for two years, then transferred to Columbia University, where he received the degree of mining engineer in 1912.

In 1918 Mr. Mudd became president—and later, chairman of the Board—of Cyprus Mines Corp., succeeding his father. As head of this corporation, he developed and managed copper mines in the Mediterranean area, an iron mine in Peru, and oil properties in the United States. He served as president of the American Institute of Mining and Metallurgical Engineers, and was given a scroll by the Engineers and Architects Association for his outstanding achievements in engineering. In 1949 the Columbia University Engineering School Alumni Association awarded him its Egleston Medal for distinguished engineering achievement—the highest honor in the field of engineering.

For more than 25 years Mr. Mudd was an outstanding Los Angeles civic leader. At his death he was chairman of the Board of the Southern California Symphony Association, the Welfare Federation of Los Angeles, and Greater Los Angeles Plans, Inc. Among his other cultural activities, Mr. Mudd was a trustee and former president of the Southwest Museum, a member of the Board of Governors of the Los Angeles County Museum, a member of the advisory committee of the Henry E. Huntington Library and Art Gallery, and chairman of the Board of Fellows of Claremont College.

Mr. Mudd's will leaves $50,000 to Caltech for research on the genesis of ore deposits.

Commencement Speaker

CLARENCE B. RANDALL, chairman of the Board of the Inland Steel Company, will deliver the Commencement address at Caltech on June 10.

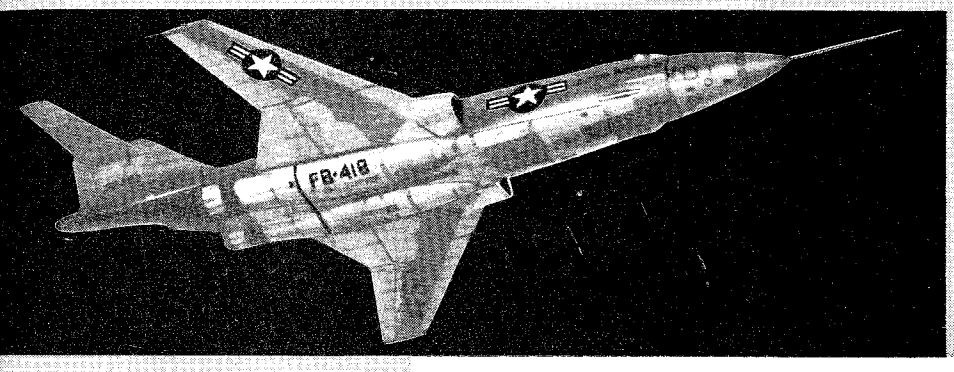
Mr. Randall organized and headed the Commission on Foreign Economic Policy which drew up the tariff plan presented to Congress in 1953. Since that time he has served as a foreign economic consultant to President Eisenhower.

A 1912 graduate of Harvard, Randall received his law degree there in 1915. After practicing law in Michigan for ten years, he joined the Inland Steel Company in 1925, and served as its president from 1949 to 1953.

Mr. Randall is the author of "A Creed for Free Enterprise" and "Freedom's Faith," books dealing with the role of business and industry in present-day America. He is also active in the field of education; now a trustee of the University of Chicago, he has served as a trustee of Wellesley College and as a member of the Harvard Board of Overseers.

Guggenheim Fellows

DR. JOHN D. ROBERTS, Professor of Organic Chemistry, and Dr. Robert L. Walker, Associate Professor of Physics, were awarded John Simon Gug-

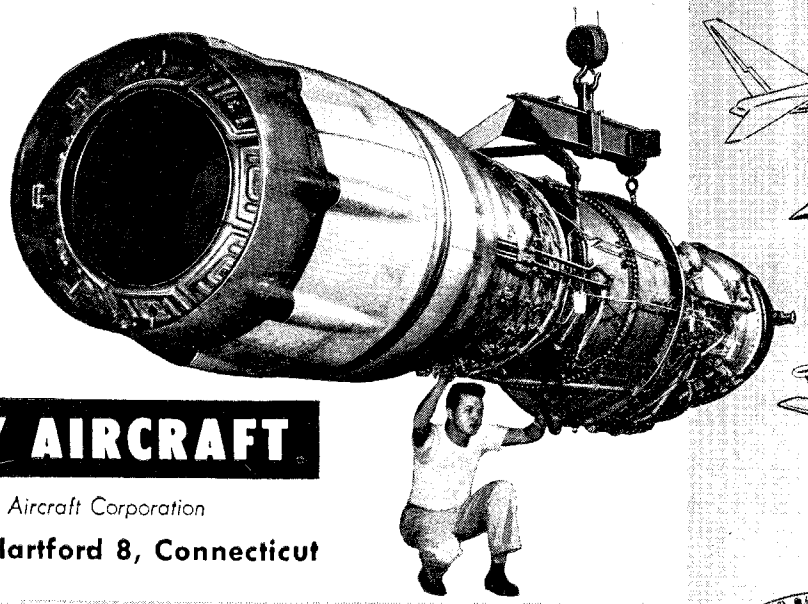


10,000,000 horsepower for America's defense . . .

Two years ago we announced the world's most powerful production aircraft engine.

Since then, the J-57 turbojet has been selected by many top airframe manufacturers to power their most outstanding new designs. For these fighters, bombers and transports, we have built over 1000 complete engines — the equivalent of more than 10,000,000 horsepower.

Today the J-57 is still unmatched anywhere — an important factor in this country's supremacy in the air.



PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

genheim Fellowships last month to carry on studies in their special fields of research.

Dr. Roberts intends to study the possibility of fixing molecular nitrogen under mild conditions with organic reagents, in hope of providing reasonable chemical models for mechanical considerations involving biochemical systems.

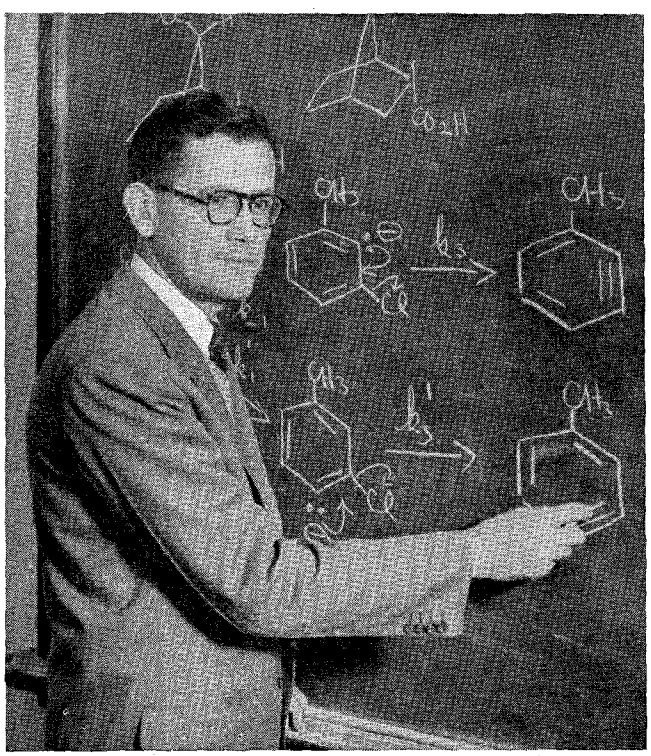
Dr. Walker will study the interpretation of experiments in high energy physics.

AAAS Meeting

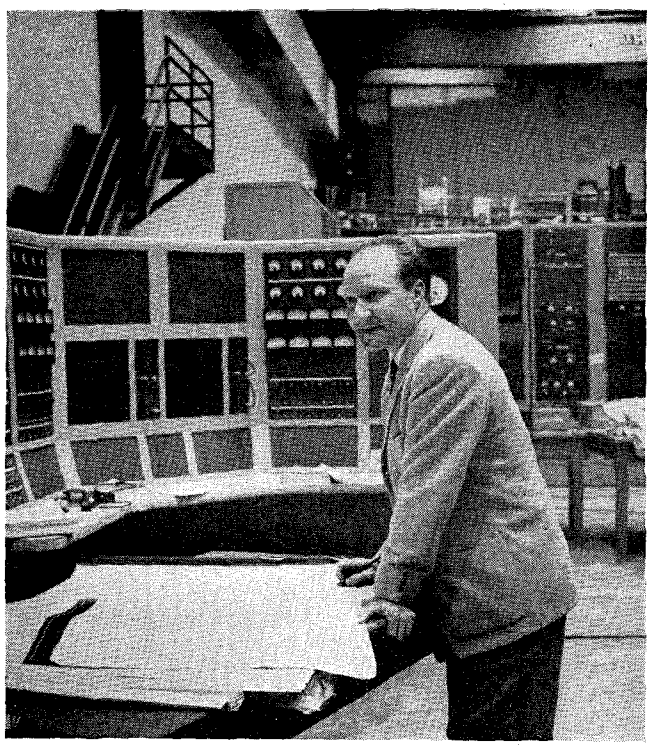
CALTECH plays host next month to the Pacific Division of the American Association for the Advancement of Science, which will be holding its 36th annual meeting here from June 20 to 25.

This will be the largest scientific gathering ever held at Caltech. More than 1000 delegates from the western states, British Columbia, Hawaii, and Alaska are expected to attend the meeting, at which 25 societies affiliated with the AAAS will present programs covering current developments in astronomy, biology, botany, chemistry, geology, physics, physiology, psychology and zoology.

The major lectures to be given at this meeting will be open to the public—including an address on "The Support of Ideas" by Dr. Dean Rusk, president of the Rockefeller Foundation, and a Sigma Xi lecture by Dr. Linus Pauling, Nobel Laureate and chairman of Caltech's Division of Chemistry and Chemical Engineering.



Dr. John D. Roberts, Professor of Organic Chemistry, and recipient of a Guggenheim Fellowship.



Dr. Robert L. Walker, Associate Professor of Physics, awarded a Guggenheim Fellowship.

Dr. George W. Beadle, chairman of Caltech's Division of the Biological Sciences, and national president of the AAAS, will also speak.

General chairman of the meeting is Dr. Arthur W. Galston, Associate Professor of Biology at Caltech.

Tuition Goes Up

STUDENT TUITION FEES at Caltech will be raised next year from $600 to $750. This increase—long considered—has finally been dictated by the need for additional income to meet the growing costs of the educational program, and particularly the need to continue to make selective salary increases to faculty and employees.

At $750, Caltech tuition fees are still low. Pomona College recently announced an increase to $800. MIT tuition, which has been $900, will go to $1,000 next fall. Princeton will also charge $1,000, and practically every other major private institution is charging between $750 and $1,000.

Caltech tuition fees would have to be far greater than $750 if it were not for the fortunate fact that the Institute's endowment yields an income more than twice as great as that which is provided by student fees, and the Institute receives gifts and grants whose total is almost as large as the endowment income.

A 25 percent increase in scholarship funds will match

Systems Development and The Ramo-Wooldridge Corporation

The Ramo-Wooldridge Corporation (except for the specialized activities of our subsidiary, Pacific Semiconductors, Incorporated) is engaged primarily in developing—and will soon start to manufacture—systems rather than components. For military customers our weapons systems responsibilities are in the fields of guided missiles, fire control, communications, and computers. Our non-military systems activities are in the general area of automation and data-processing.

Emphasis on systems development has consequences that profoundly affect all aspects of an organization. First, it demands an unusual variety of scientific and engineering talent. A single systems development project often requires concurrent solutions of challenging problems in the fields of electronics, aerodynamics, propulsion, random phenomena, structures, and analytic mechanics. In addition, the purely technical aspects of a systems problem are often associated with equally important non-technical problems of operational, tactical, or human relations character.

Therefore, competent systems development requires that a company contain an unusually large proportion of mature, experienced scientists and engineers who have a wide range of technical understanding and an unusual breadth of judgment. Further, all aspects of company operations must be designed so as to maximize the effectiveness of these key men, not only in the conduct of development work but in the choice of projects as well.

At Ramo-Wooldridge we are engaged in building such a company. Today our staff of professional scientists and engineers comprises 40% of the entire organization. Of these men, 40% possess Ph.D. degrees and another 30% possess M.S. degrees. The average experience of this group, past the B.S. degree, is more than eleven years.

We believe the continuing rapid growth of our professional staff is due, in part, to the desire of scientists and engineers to associate with a large group of their contemporaries possessing a wide variety of specialties and backgrounds. It is also an indication that such professional men feel that the Ramo-Wooldridge approach to systems development is an appropriate one.

We plan to continue to maintain the environmental and organizational conditions that scientists and engineers find conducive to effective systems development. It is on these factors that we base our expectation of considerable further company growth.

POSITIONS ARE AVAILABLE FOR SCIENTISTS AND ENGINEERS IN THESE FIELDS OF CURRENT ACTIVITY:

Guided Missile Research and Development
Digital Computer Research and Development
Business Data Systems Development
Radar and Control Systems Development
Communication Systems Development

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the 25 percent increase in tuition fees for the coming year, so that students who qualify for scholarship aid may receive larger grants than before.

New Honors

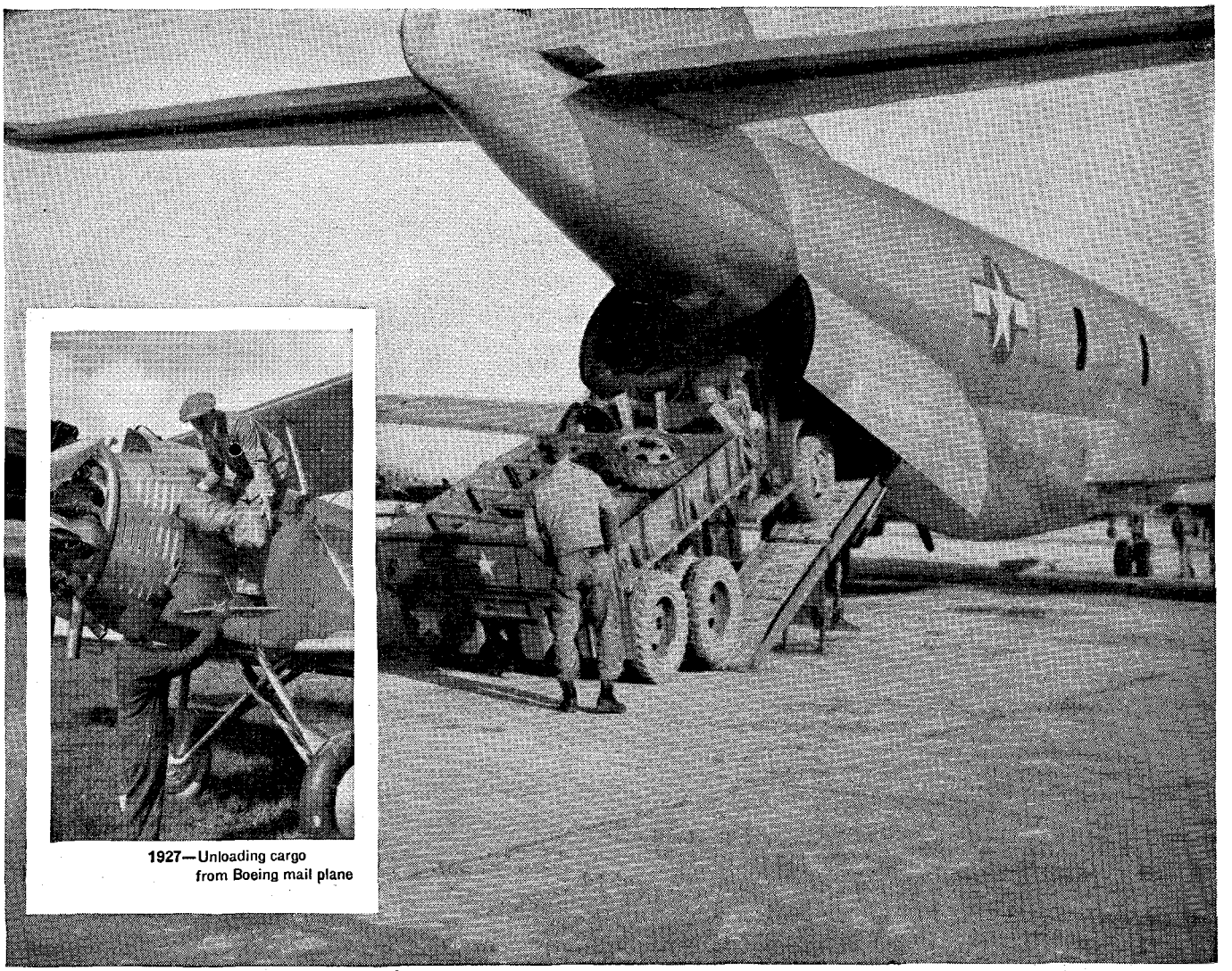
SCARCELY A MONTH goes by now that Dr. Theodore von Karman, Caltech Professor of Aeronautics Emeritus, isn't awarded new honors for his distinguished contributions to aviation. Latest additions: The Exceptional Service Award, the highest award presented by the Air Force to a civilian; and nomination by Pope Pius XII to membership in the Pontifical Academy of Sciences.

The citation accompanying the Air Force award reads: "For more than a decade Dr. von Karman has served Air Chiefs Arnold, Spaatz, Vandenberg and Twining as chairman of their scientific advisory organization . . . giving sound imaginative advice on technical problems when such counsel was desired . . . Throughout this work Dr. von Karman's management of this scientific effort has been of the highest order and by his exceptionally farsighted vision and personal dedication to Air Force interests he has effected great contributions to the achievement of the advanced weapons systems that now characterize the United States Air Force."

Counselors

DR. ROBERT F. BACHER, chairman of Caltech's Division of Physics, Mathematics and Astronomy, has been appointed to serve on a new committee set up by the National Academy of Sciences to "counsel" with the government on its policy with regard to relationships between questions of loyalty and the awarding of government grants and contracts in support of unclassified research.

The committee, formed in response to a request from the Eisenhower administration, is headed by J. A. Stratton, vice president and provost of MIT. In addition to Dr. Bacher, its members are: Laird Bell, Chicago attorney; Wallace O. Fenn, Professor of Physiology, University of Rochester; Robert F. Loeb, Professor of Medicine, Columbia University; E. Bright Wilson, Jr., Professor of Chemistry, Harvard University; and Henry M. Wriston, president of Brown University.



1927—Unloading cargo from Boeing mail plane

1955—Loading Boeing C-97 Stratofreighter

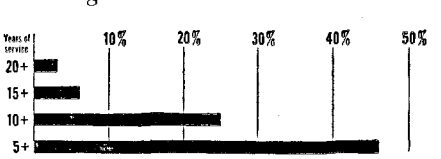
There's plenty of variety in Boeing engineering careers

America's pioneer passenger-cargo aircraft, the 40A, was a Boeing. So is the Air Force's versatile tanker-transport, the C-97 Stratofreighter shown above.

During the company's 38-year history, Boeing engineers have blazed new trails in the design of aerial freighters and tankers, commercial airliners, flying boats, fighters, trainers and bombers. Today Boeing continues to offer engineers a wide variety of opportunities in Research, Design and Production.

Students sometimes are surprised that Boeing's engineering staff includes those with civil, electrical, mechanical, aeronautical and other engineering degrees. Yet all find application in aviation. For example, the civil engineer may work on airframe structure or stress. Electrical engineers find challenge in the complicated electrical and electronic systems of modern jet bombers and guided missiles. Other engineers will find similar application for their talents.

The high degree of stability in careers at Boeing is reflected in this chart.



It shows that 46% of Boeing engineers have been with the company five or more years; 25% for 10 or more years, and 6% for 15 years.

Boeing promotes from within, holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

Current Boeing programs include: six and eight jet bombers; America's first jet transport—the 707; F-99 Bomarc pilotless interceptor (guided missile)—and advanced projects such as the application of nuclear power to aircraft.

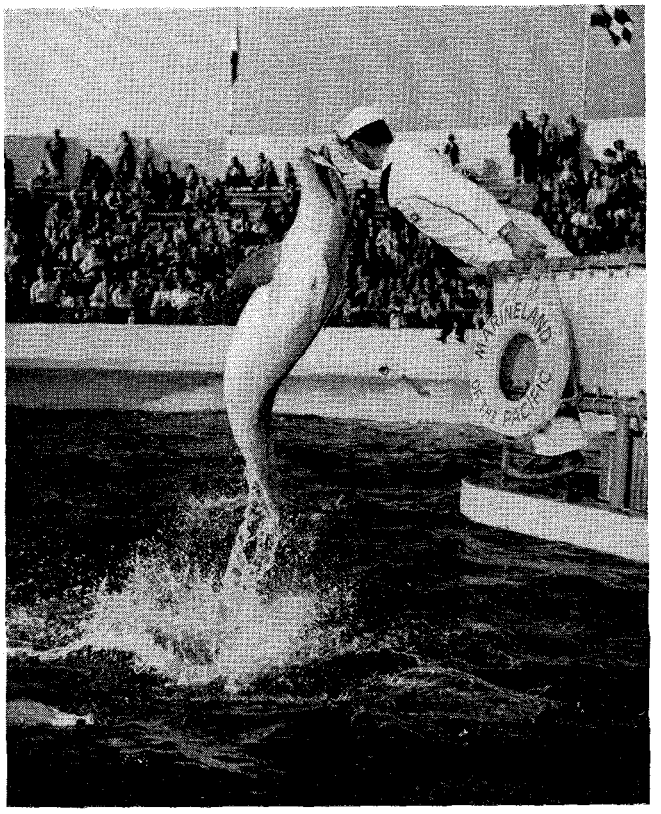
For further Boeing career information consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING

SEATTLE, WASHINGTON WICHITA, KANSAS

ALUMNI NEWS



Trained porpoises, which jump high out of the water to take food from their feeder's hand are the stars of the Marineland show.

Alumni Picnic

THE OCEANARIUM at Marineland of the Pacific will be the feature attraction of the Annual Picnic on Saturday, June 25. Located on Palos Verdes Drive South between historic San Vicente Lighthouse and Wayfarer's Chapel, commonly called the glass church, Marineland offers a snack bar for refreshments, and luncheon or dinner at the smart Marineland Restaurant on the cliff. You can bring the family and stay all day for they are now constructing a seaside picnic area on the point where we intend to set up headquarters for the Alumni Picnic.

The day is planned and budgeted to appeal to the entire family. The feature attraction is the marine zoo which never fails to fascinate young and old for several hours, and we qualify for the reduced group admission rate and the privilege of re-entry. Families may bring their own lunch, beer, soda pop, and whatever else

they wish for their enjoyment; or if they prefer, they can take advantage of the restaurant facilities of Marineland. The details will be covered in the reservation bulletin to be mailed out to all alums late in May.

The Oceanarium is constructed of steel and finished in gunite, like a giant swimming pool. Holding over 1,000,000 gallons of sea water, the Oceanarium includes two tanks, one circular, 80 feet in diameter and 22 feet deep, and an oval tank 100x50x22.

Through viewing windows at three different levels, spectators may view formidable sharks, Moray eels, playful porpoises, sun fish, varieties of bat rays, sting rays, eagle and electric rays, giant sea turtles, king-sized groupers and hundreds of colorful species engaged in their dramatic struggle for survival in an immense dry land ocean. Marineland of the Pacific and its Florida counterpart, Marine Studios, differ from other aquaria in that the specimens are not segregated but placed together as they are found in the ocean.

Stars of the Marineland show are Frankie and Floyd, the trained porpoises which jump high out of the water and take their food from the feeder's hand. These clever mammals are amazingly intelligent and delight in performing for the amusement of their audience. The porpoises find the sea bass a delicacy and will tease the sharks into nervous breakdowns. The night-preying Moray eels and the game tuna and dolphin fish decimate the schools of mackerel and sardines, while the rays, giant groupers and sharks carry on the eternal fight for existence.

Invading the eerie aquatic world, Marineland divers descend to the Oceanarium floor. Looking like men from Mars in their diving suits and grotesque helmets, they bob about the tank feeding specimens by hand. The individual feeding method is designed to restrain the predatory instincts of the fish and thus prolong their life span. The mortality rate is still sufficiently high to keep the Marineland collecting crews busy bringing in fresh replacements.

Special jewel aquariums feature colorful displays of sea horses from Florida, California lobsters, Hawaiian fish, octopi, deep sea anemones, lion fish from the Indian Ocean, and tide pool collections.

RESERVE THE DATE—Saturday, June 5!

—Edward P. Fleischer, '43
Chairman, Annual Picnic

PERSONALS

1923

Joseph R. Alcock, an inspector for the Los Angeles County Air Pollution Control District, reports that he is also in business —in a small way—with his wife, selling a childrens' reading game that she invented. The Alcocks recently became grandparents when their daughter had a son.

1931

Walter L. Dickey is still with the Bechtel Corporation in San Francisco, only his job has changed from that of chief structural engineer to chief civil and structural engineer of the Power Division. Walter is designing power plants primarily—but is also concerned with other industrial activities. His work involves a good deal of traveling to the Philippines, Hawaii, Alaska, Texas—and other smaller states. However, he still finds time to serve as vice president of the Structural Engineering Assocation of Northern California.

1932

C. Fred Hamlin writes: I have been living here in San Luis Obispo for five years with my wife and children—of whom there are now four. The oldest is 15 and attends Rosemary Hill in Connecticut.

"I am the managing partner, with my father, of the Bailey Equipment Company, which we formed about eight years ago. Until I resigned in 1950 from the California Bridge Department, I was a senior bridge engineer and had been with the State Division of Highways for nearly 15 years. Our business is a little unusual in that we rent bridges for temporary spans. For this we use portable Bailey bridges, which attained fame during the war. We also purchase and move steel highway or railroad bridges to new locations."

1933

Ygnacio Bonillas, MS '35, is manager of the Richmond Petroleum Company of Colombia, and also of the Richmond Oil Company of Peru, so he does quite a bit of traveling between the two countries. Both these subsidiaries of Standard Oil Company of California are in the exploration stage, and as yet are not in active production. "However," Ygnacio remarks, "We have faith in our ability to succeed in the search for 'black gold'." He and his wife are now living in Bogota again, after an absence of over nine years—seven of which were spent in Venezuela, and two in Peru.

1934

John F. Pearne, who has been practicing patent law, has announced his partnership in the new firm of Ely, Pearne & Gordon in Cleveland. John and his partners are specializing in patent, trademark and copyright law. John was previously a partner in the firm of Evans & McCoy, also of Cleveland.

1936

Simon Ramo, PhD, is chairman of the 1955 Electronics Components Conference being held in Los Angeles on May 26 and 27.

1939

Paul O. Engelder, MS '40, has a new daughter, born last June. Her three brothers are now 11, 7, and 5, respectively. Paul, who was recalled to the U. S. Marine Corps in July 1950, was discharged in 1953, and is now the systems head at the Electronic Defense Laboratory, Mountain View, California. His work is concerned with electronic counter measure development.

1941

Stanley Sohler reports that his Paramount Business Service and Thoroughbred Business Service in San Jose now has five employees, and is struggling to keep the gross income above the overhead. Stan's hobbies keep him busy; he is a member of the Board of Directors of the American Sunbathing Association, and is also fighting City Hall on a magazine-censorship law. His three sons are now wearing Caltech T-shirts and are looking forward to swimming in the Alumni Pool.

Frank G. Casserly, Lt. Col. in the USMC, is now stationed in Pearl Harbor where he is Assistant Communications Electronics Officer for the Fleet Marine Force Pacific. Frank's entire career has been spent in the Marine Corps, except for a short hitch at Lockheed after graduation, and he has been sent to school at Harvard, MIT, and the Naval Postgraduate School at Annapolis—the latter resulting in an MS in EE. He is married and has three children—a son 11, and daughters aged 8 and 2.

1942

Murray L. Lesser has joined the staff of the IBM Research & Development Laboratory in San Jose, California.

Kenneth D. Schureman is the project administrator and assistant secretary of the Baruch Corporation, a large construction firm in Los Angeles, known for the construction of such projects as UCLA, the Hollywood Bowl, and the Cedars of Lebanon Hospital. Ken started with Baruch in 1950.

1943

John Martin French, MS '44, died suddenly last March 26 at his home in Sierra Madre, of a heart attack. After receiving his MS he was associated with a Naval Ordnance Project at Caltech and later was a civil design engineer for the U. S. Naval Ordnance Test Station in Pasadena. He was 33 years old.

Charles L. Schneider, MS, PhD '49, who is an MD in Dearborn, Michigan, specializing in obstetrics, came to California on April 12 to speak before the San Diego Medical Society. His wife, Ruby, (also a doctor) and the two oldest children, ages 4 and 5, accompanied him on his trip. The Schneiders have one other child, 3 years old.

1944

Fred W. Morris, Jr., when last heard from in 1953, was participating in the establishment of the Electronic Defense Laboratory at Mountain View, California. Now Fred brings us up to date with the following: " . . . I have set myself up as an electronics engineering and management consultant and have been serving clients (for a little over a year) including: Bomac Laboratories, Inc., Instruments for Industry, Inc., Massachusetts Institute of Technology (Heaven forbid!!) and the Remler Company.

"With MIT I had the pleasure of serving

PERSONALS . . . CONTINUED

as a member of the consultant staff of Project 'Lamp Light', a study project advisory to the Secretary of Defense. At Remler I am acting as the associate director of a newly established research and development division of the company called Gray Scientific Division. . . . All seems to be going well, but I can't manage to find the twenty-fifth hour of the day!

"My wife Nancy and I are planning to move into our new home overlooking the Los Altos Country Club here on the San Francisco Peninsula in the very near future."

1945

James A. Seneker, MS, was recently named a technical service engineer for the West Coast section of General Electric's Chemical Materials Department. Jim, who is living in Anaheim, was previously associated with the Ditzler Color Division of the Pittsburgh Plate Glass Company and Sherwin Williams Company.

1946

Fred Robins is an instructor in math and engineering at the College of Sequoias, Visalia, California.

1947

Arthur S. Bolles, who is employed by the Arabian American Oil Company in Dhahran, Saudi Arabia, will be returning to the States in the fall of this year for a three month vacation. His wife and two children will be along. At present Art is a pipeline engineer.

Edward B. Winters, vice president of the Peletz Company, Inc., of Santa Rosa, California, reports the arrival of a son, Michael, last October.

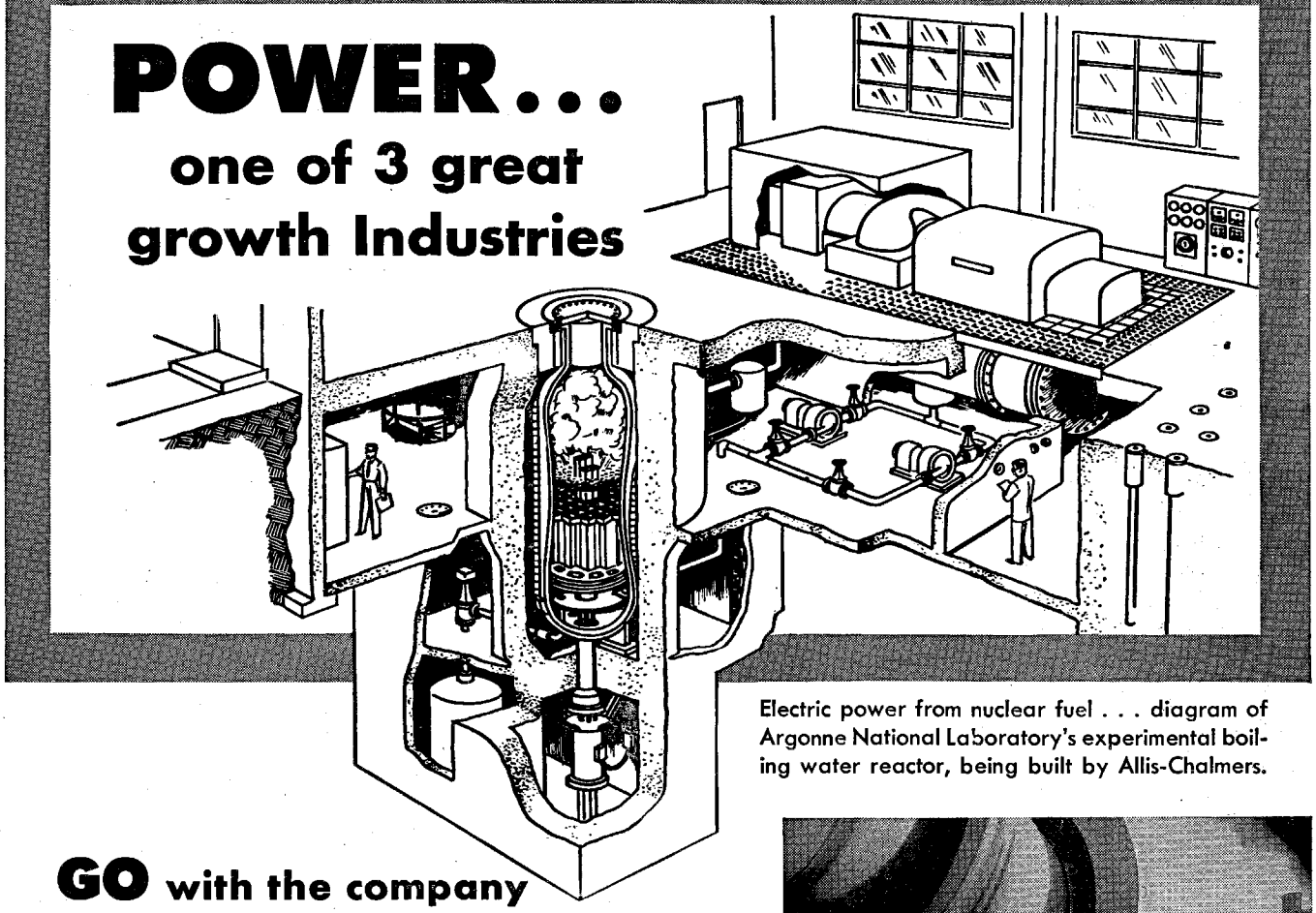
Richard M. Roehm has been promoted to special representative in the life insurance department at IBM, with offices at the western headquarters. Dick has been with IBM since 1950, when he joined them as an assistant sales representative in Los Angeles. He has been transferred to different divisions, and most recently was a mathematician in the product planning department at Poughkeepsie, N. Y.

1948

Harvey K. Holm, a project engineer at Hiller Helicopters, is presently in charge of their Ramjet-powered "Hiller Hornet," which is about 75 percent through CAA certification. Harvey is living on a half-acre homesite in Los Altos, California, with his family: wife, four-year-old daughter Christine, and four-month-old son Jimmy. The family picture is completed by a boxer dog and a Siamese cat, complete with kittens.

Warren A. Christopherson has been transferred from IBM's San Jose Laboratory to their New York Office, as assistant to the director of Advanced Development Engineering. He and his wife Vi, and

POWER...
one of 3 great growth Industries



Electric power from nuclear fuel . . . diagram of Argonne National Laboratory's experimental boiling water reactor, being built by Allis-Chalmers.

GO with the company that's strong in all three!

Hitch your future in engineering to the growth of the U. S. A.—and to a company that supplies the basic needs of growth!

This nation is growing at the rate of 50,000 people every *week!* To supply the needs of these people:

Electric power generation will double by 1965.

A multi-billion dollar program of new highway construction is planned within the next ten years.

Manufacturing output will have to increase by $3.5 billion by this time next year.

And Allis-Chalmers builds major equipment for all of these growth industries! Some examples are pictured here.

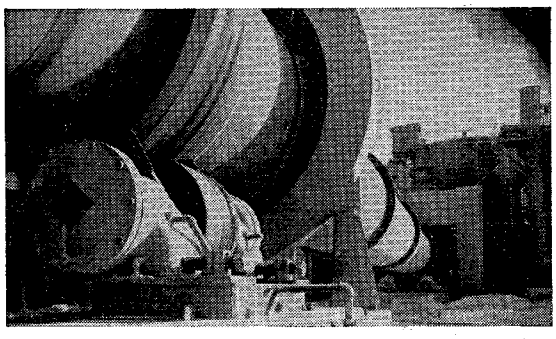
Here's what Allis-Chalmers offers to Young Engineers:

A graduate training course that has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

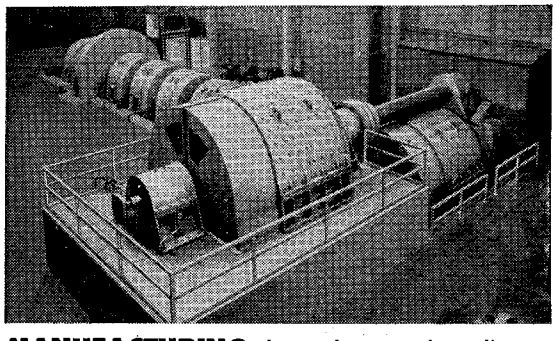
There are many *kinds* of work to try: design engineering, application, research, manufacturing, sales. Over 90 training stations are available, with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write direct to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.



CONSTRUCTION demands the vast tonnages of cement produced with Allis-Chalmers rotary kilns and other processing machinery.



MANUFACTURING depends upon the reliable power of electric motors—like these 5000 hp Allis-Chalmers giants powering a rolling mill.

ALLIS-CHALMERS

A-4683

PERSONALS . . . CONTINUED

daughter Cindy, now have an apartment in Yonkers. Warren reports that *Arthur Critchlow*, '47, is a staff engineer and systems planner at IBM in San Jose. Art and his wife Georgia have three children.

Richard F. Johnson, MS, is living in Mexico with his wife and three children, and writes: "For five years now, I have been with my father's organization, Electronics, S.A., working as sales representative for companies engaged in the manufacture of materials for transmission and distribution lines, and as distributors for the Hoover Company. Right now Hoover is going to establish a large manufacturing plant in Mexico, and I have been invited to take over as general manager of this operation."

Robert P. Crago is the manager of "Project High" at IBM's Poughkeepsie Engineering Laboratory. Bob is directly responsible for all research and development activities related to IBM's Project High contract with the U.S. Air Force. He's been with the company since 1949, and before this assignment was the manager of engineering design.

Frank F. Scheck and his wife Jane report the birth of their first child—Christopher Garret—last October. Frank is secretary-treasurer of the New York Alumni Chapter.

1949

William Houghton and wife Carolyn have adopted a daughter, Luanna Rae, born last February 7. Bill is employed by North American Aviation.

H. Hugh Woodbury, PhD '53, is planning a June wedding to Miss Joyce Nicholes in her home town, Provo, Utah. At present Joyce is an art supervisor in the Troy, N.Y., elementary school system, and Hugh is employed as a research associate in Schenectady. After their wedding they plan to live in Schenectady.

1950

David C. Oakley, MS '52, who is working at the University of California Radiation Laboratory in Livermore, is looking forward to receiving his PhD from Caltech this June. Dave and his wife, Bernice, now have a daughter, Renee Mae, born last December.

Floyd B. Humphrey and Susan Clapp of Meredith Neck, N.H. are planning a June wedding. Susan, a graduate of Pomona, is doing grad work at the Boston University School of Social Work, and Floyd is studying for his PhD here at Caltech.

Captain Amos L. Wright, MS, finished a tour in Korea and is now in Japan with an Engineer Construction Battalion, of which he is operations officer. The Battalion is constructing storage areas and pavement, and Amos reports it is interesting work. His wife and two daughters are also with him in Japan.

1951

Col. John R. Jannarone, U.S. Army, MS, has been serving as head of the Corps of Engineers inter-agency office at Tulsa for the AWR (Arkansas-White Red River basin) committee. The committee, which was set up by the federal government, has been making a study of Oklahoma and parts of New Mexico, Colorado, Arkansas, Kansas, Louisiana, and Missouri to determine the soil rebuilding and industrial potentialities in this area. John, who graduated first in his class at West Point in 1938, has now received orders to report to the Army War College at Carlisle, Pennsylvania.

Robert J. Kurland was recently awarded a $6000 Post-Doctoral Fellowship by the Board of the National Academy of Sciences, National Research Council. The fellowship carries a post-doctoral research assistantship with the National Research Council-National Bureau of Standards. Bob is now in his fourth year of graduate study in chemistry at Harvard.

1952

Donald L. Lamar sends in a condensed version of recent events: "I'm now out of the Army and living in La Habra, California. I'm doing graduate work in geology at UCLA, and my wife is working as a technical writer for Beckman Instruments. Have a job doing field work for Standard Oil this coming summer. I hope to receive my MA in June, 1956."

George S. Stranahan is now at the Radar School at Fort Monmouth, New Jersey. George and his wife are living in Sea Bright, N.J., and have a four-month-old daughter.

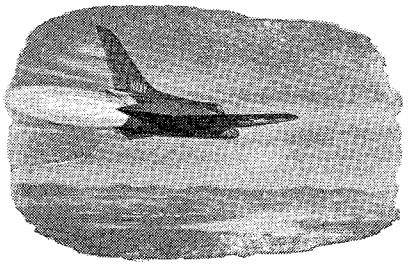
1953

Lt. Cmdr. Caesar Fernandez, USN, has been transferred to Edwards Air Force Base to serve as Naval liaison officer, after a year in the Far East. While serving overseas, he took part in the Tachen Islands evacuation operation last February and flew night combat patrols, leading a detachment of night fighters (F2H-3 Banshees).

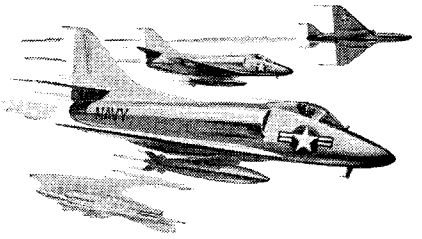
Stuart Lennox, MS, is now living in Surrey, England. "Since leaving GALCIT eighteen months ago," Stuart writes, "I worked for a year with Handley Page Ltd., and am now working on helicopter development with British European Airways. Sometimes yearn for some California sun and should be pleased to hear from Caltech friends."

1954

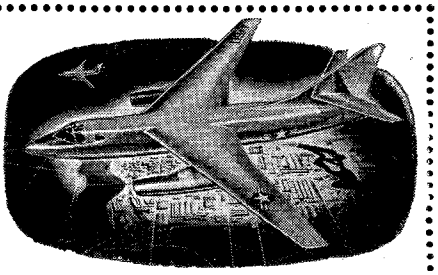
Tom Tyson is now a rocket engineer at North American Aviation in Los Angeles, and is working in the engine division. Tom's brother, *Howell N. Tyson, Jr.* '50, became a father for the second time when his second daughter, Carol Susan, was born last March 22.



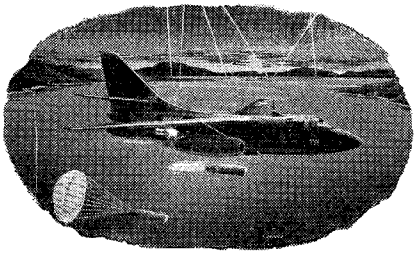
F4D, "SKYRAY"— only carrier plane to hold official world's speed record



A4D, "SKYHAWK"— smallest, lightest atom-bomb carrier

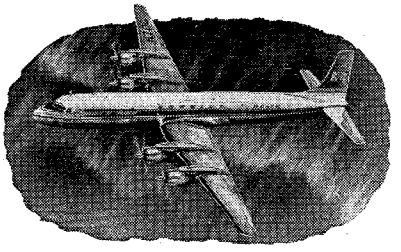


RB-66 — speedy, versatile jet bomber



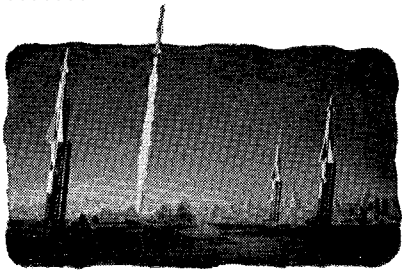
A3D, "SKYWARRIOR"— largest carrier-based bomber

C-124, "GLOBEMASTER"— world's largest production transport

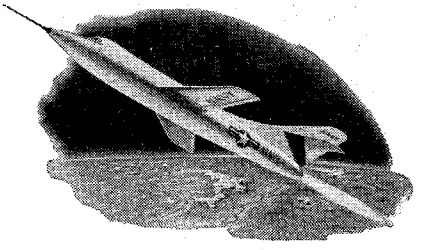


DC-7 "SEVEN SEAS"— America's finest, fastest airliner

Engineers: join this winning team!



"NIKE"— supersonic missile selected to protect our cities



D558-2, "SKYROCKET"— first airplane to fly twice the speed of sound

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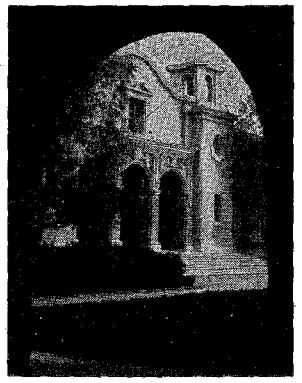

CALTECH CALENDAR

May, 1955

ALUMNI CALENDAR

June 8 ..... Annual Meeting
Elks Club — Pasadena

June 25 ..... Annual Picnic
Oceanarium — Palos Verdes Peninsula

ATHLETIC SCHEDULE

May 14—
BASEBALL ..... Redlands at Caltech
SWIMMING ..... Conference finals at Caltech
TENNIS ..... Conference at Pomona

May 17—
TENNIS ..... Occidental at Caltech

May 18—
BASEBALL ..... Cal Poly at Caltech

May 20—
GOLF ..... All-conference at Claremont

May 21—
BASEBALL ..... Caltech at Occidental

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

May 20—
Radar in Peace and War ..... Dr. Lee A. DuBridge

May 27—
Proteins and What They Are ..... Dr. Henry Borsook

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Fraternity Club, 345 Bush St., San Francisco.

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State Water Project Authority, Sacramento
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University Club, 1319 K St., Sacramento

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Program Chairman Herman S. Englander '39
U. S. Navy Electronics Laboratory

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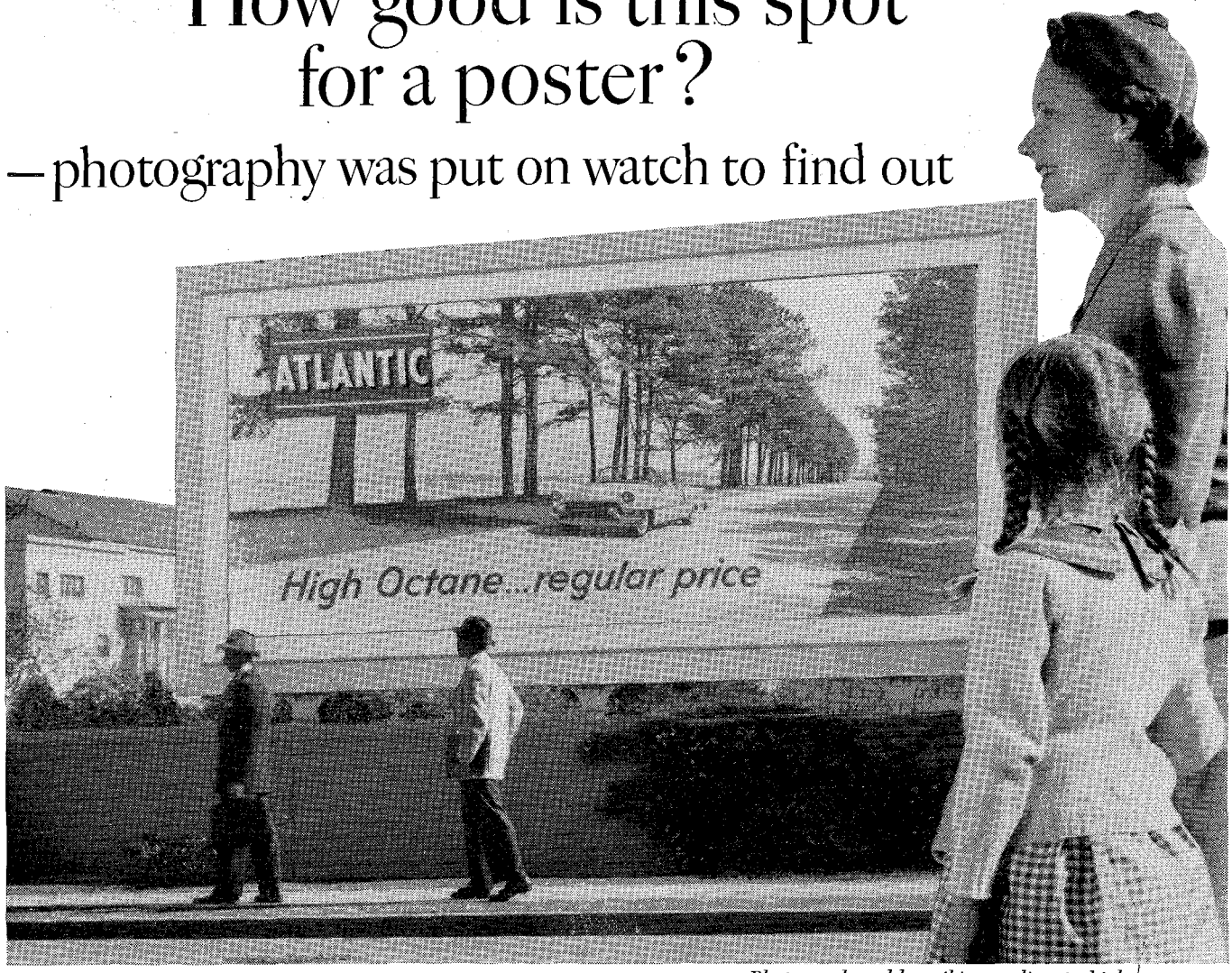
How good is this spot for a poster?

—photography was put on watch to find out



Photography adds striking realism to highway poster.

In the hands of Alfred Politz Research, Inc., camera and film sampled the traffic, spaced test periods, stayed on the job, never got tired and reported with complete accuracy.

You can gauge a magazine's readers by its circulation—or a newspaper's by its daily sales. But how can you measure the potential audience of an outdoor poster?

Alfred Politz Research, Inc. worked out an answer. Figuring that anyone the poster can "see" can see the poster, they set up an automatic camera which recorded periods of passing traffic at regular intervals. Counting the people and cars on the film records gave accurate figures on the viewers of the poster and made it possible to compute its gross man-hours of exposure.

Counting people comes as easily for photography as counting phone calls, metal rods or tons of coal. It is one of the many ways it is serving all kinds of business and industry. In small businesses and large it is helping to save time, cut costs, reduce error, design new products and improve production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning serviceman, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

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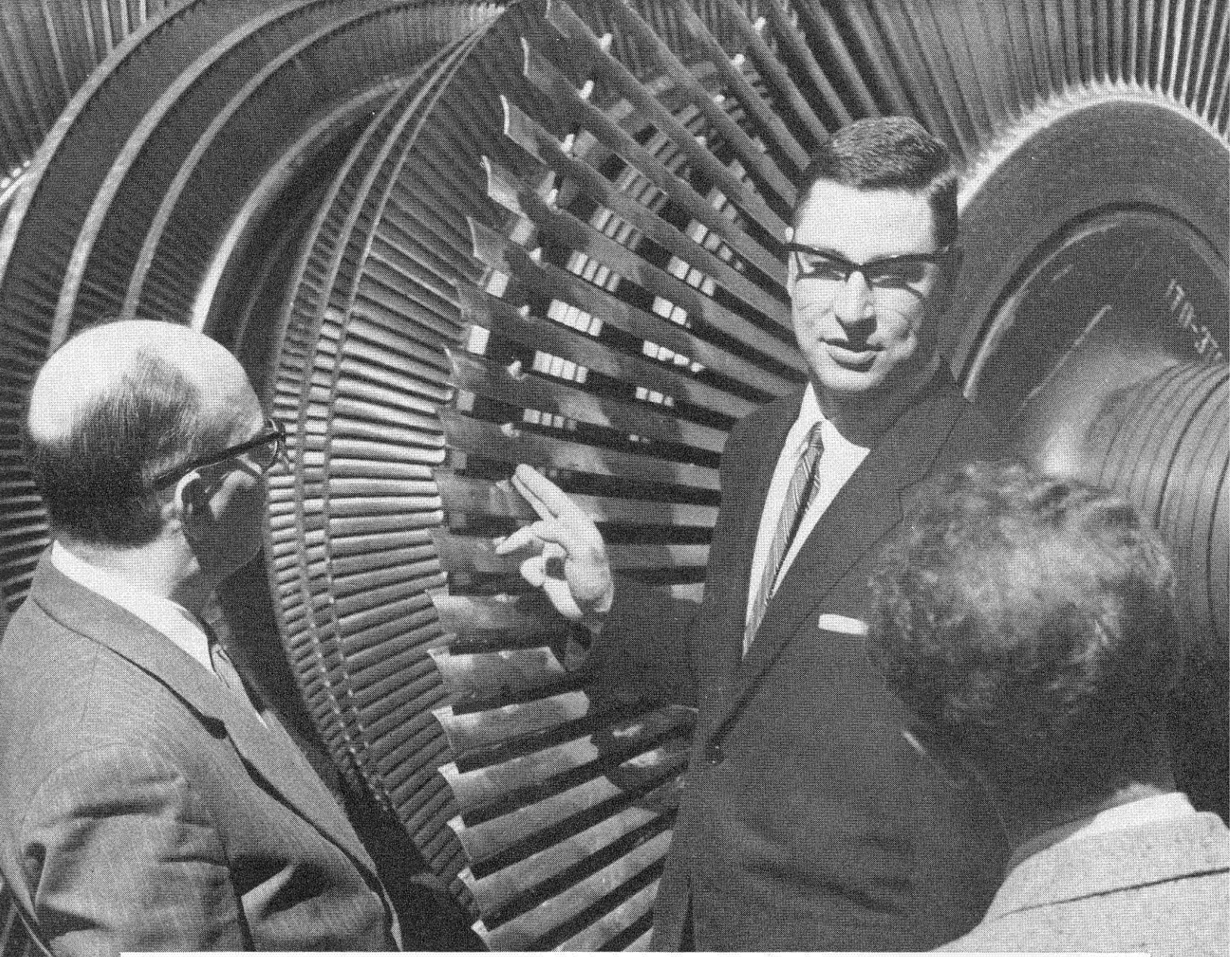

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*ILLUSTRATION: *Sales Engineer and customers discuss turbine rotor construction. Glasses are factory safety measure.*

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