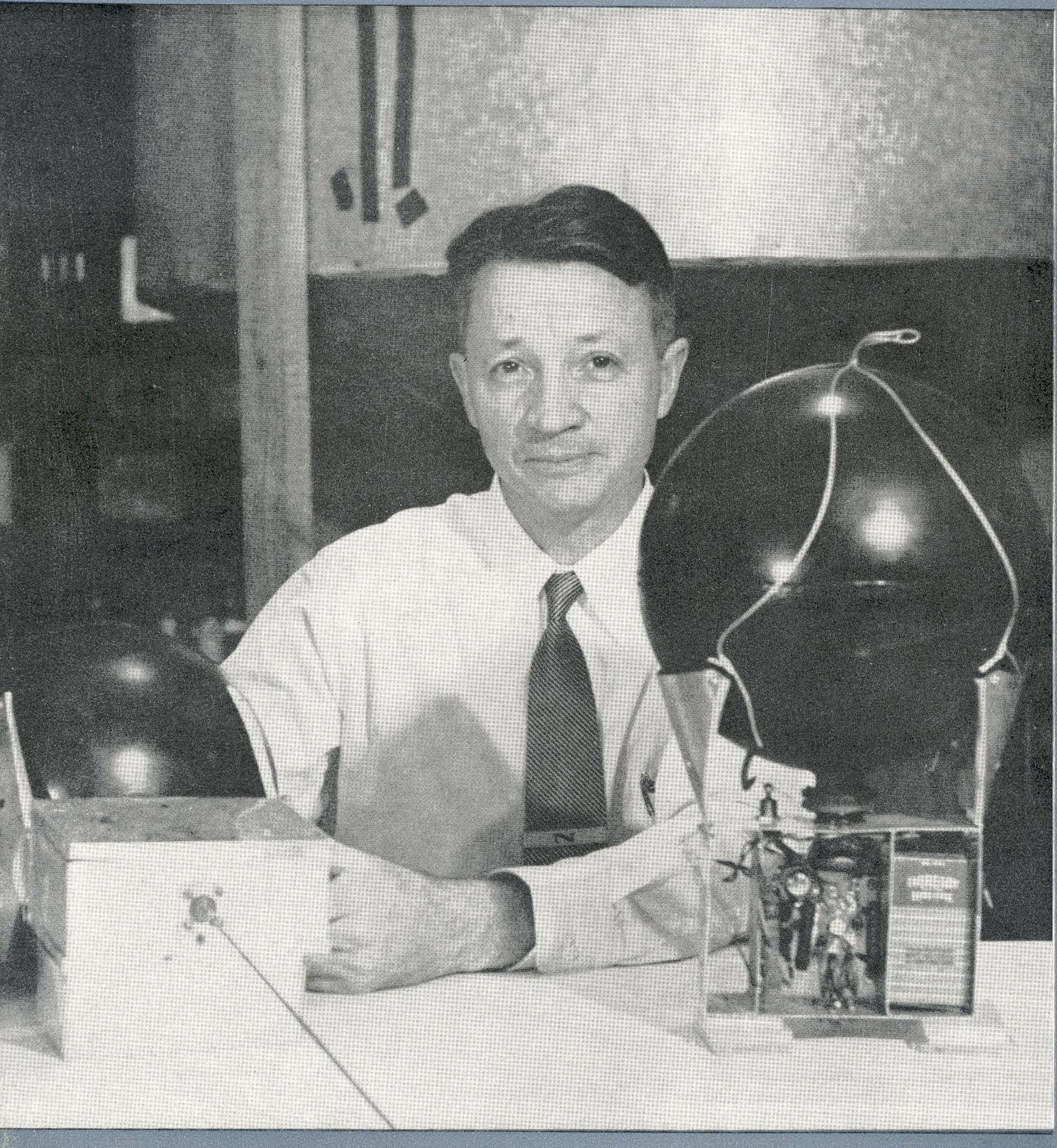
ENGINEERING | AND | SCIENCE

JANUARY/1956



Cosmic Rays . . . page 17

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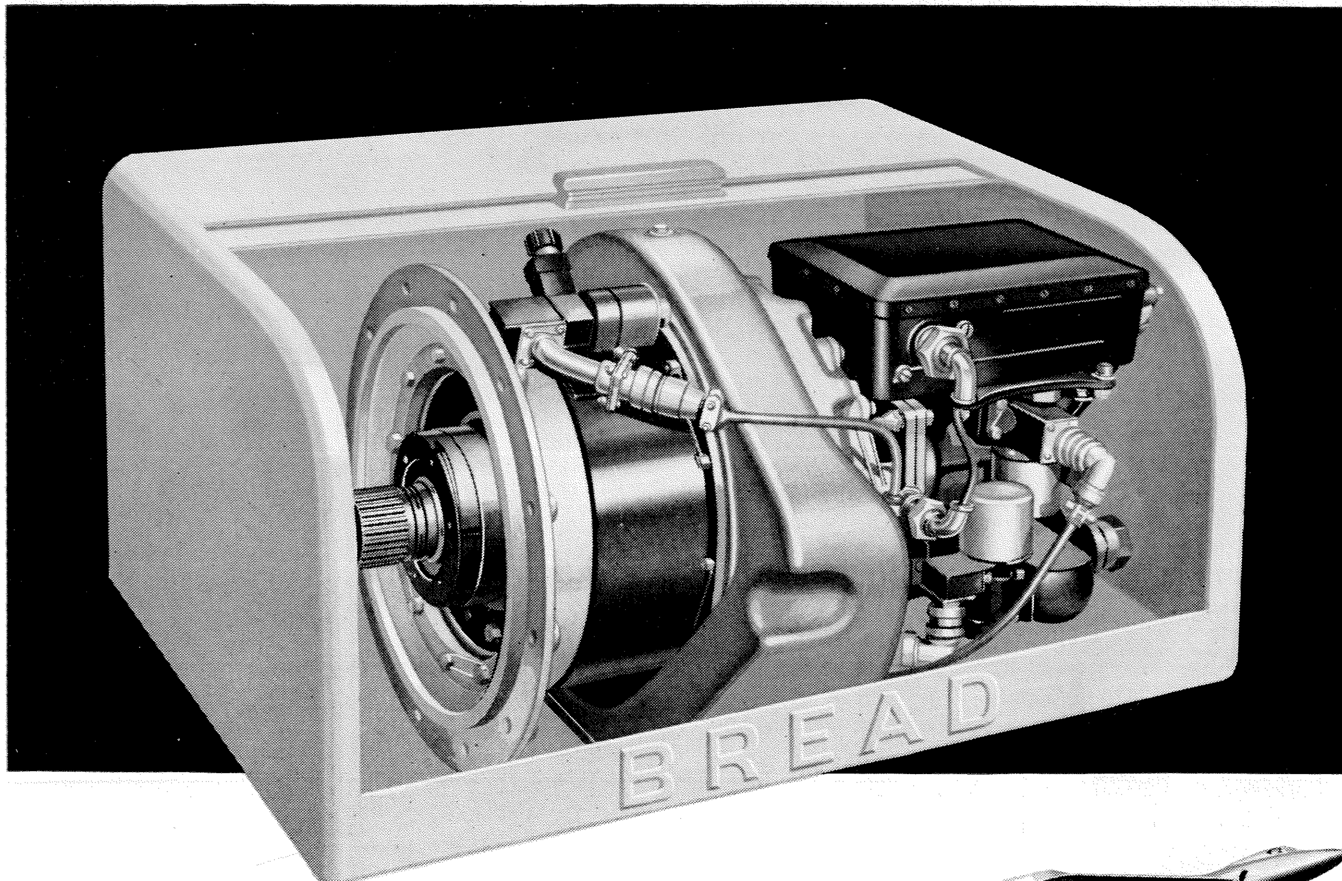

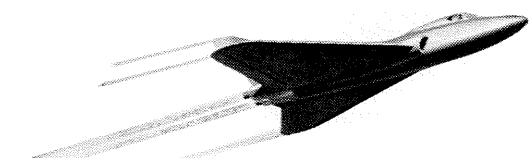

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Small enough to fit in a breadbox—yet powerful enough to start a giant jet engine. That's a nutshell description of this 79-pound jet starter developed by engineers at the Utica Division of Bendix Aviation Corporation in Utica, N. Y. The output of this little giant reaches 450 horsepower in three and a half seconds to direct crank some of our biggest jet engines.

This is but one example of how young Bendix engineers are working to solve the most severe problem plaguing the men who build today's (and tomorrow's) aircraft. Jet aircraft requirements call for more and more power in every new design. But with additional complex apparatus being jammed into every new plane that comes off the drawing board, extra power must be achieved without extra bulk. In fact, it is usually necessary to produce more power in a *smaller* package. That's when engineering skill which appreciates a real challenge comes to the fore.

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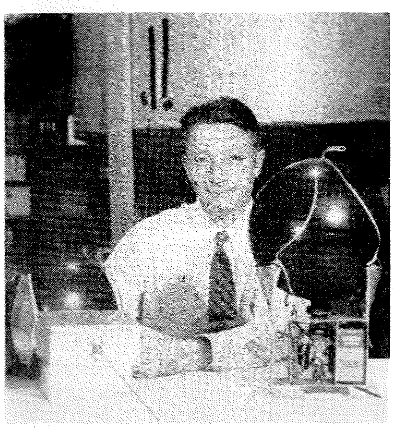
ENGINEERING AND SCIENCE

IN THIS ISSUE



On the cover—Dr. H. V. Neher, Caltech professor of physics, working in his lab on some of the telemetering devices he uses in high-altitude studies of cosmic rays. On page 17—a lively account of Dr. Neher's recent studies of cosmic rays near the North Pole.

Far from his Caltech lab now, Dr. Neher is on leave, helping to establish work in cosmic rays at the Physical Research Laboratory in Ahmedabad, India.

Back in his Caltech lab now is Alfred C. Ingersoll, assistant professor of civil engineering, after a year's leave spent with the Technical Cooperation Administration in India as an advisor on engineering problems. On page 13—his account of "Engineering Education in India." Below—Dr. and Mrs. Ingersoll in Calcutta, in Indian dress.

PICTURE CREDITS

Cover — George Stranahan
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JANUARY, 1956 VOLUME XIX NUMBER 4

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STAFF

Publisher........Richard C. Armstrong '28
Editor and Business Manager........Edward Hutchings, Jr.
Staff Photographer........Stuart Bowen '56
Editorial Consultant........George R. MacMinn
Professor of English, Emeritus

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LETTERS

A Report from the Representative at the University of London

Los Angeles, California

SIR:

You kindly asked me to give you a short account of my representation of the California Institute of Technology at the University of London on the Installation of Her Majesty the Queen Mother as Chancellor of the University.

When Dr. DuBridge suggested that I undertake this function I think he was surprised to find that I was not only willing but eager to have an excuse for a trip to London. In anticipation of participating in the celebration I arrived in London on November 10th, allowing myself a couple of weeks to become acclimated and to visit some of my old haunts, and call on old friends in the banking fraternity.

The first event was a very handsome dinner at the London School of Economics. There were about one hundred in attendance at this dinner and we adjourned promptly at 8:30 to the Senate House for a reception. There were about eleven hundred delegates present at this reception and they were divided into groups; I found myself in a reception room with about one hundred other "distinguished persons."

Promptly at nine o'clock the Queen Mother arrived with a couple of attendants and was preceded around the room by the Vice-Chancellor and the Principal of the University. A few persons in each room were presented to the Queen Mother and I was very happy to be one of these. She was very gracious and commented on the fact that I had come a very long way to participate in her installation. We passed a few pleasantries and I retired, and she proceeded on her way into another room. No one was allowed to leave the reception until the Queen Mother had left, which was about eleven o'clock.

On Thursday, November 24th, the Installation ceremony took place at the Royal Festival Hall at 10:30 in the morning and it was a very impressive sight, with all the pageantry which the English know how to use better than anyone else—trumpeters, mace-bearers, soldiers, sailors, and a few hundred educational people in the most fantastic academic robes. There were about eleven hundred universities represented; about thirty of which were from the United States, the remainder being from foreign countries, and the Dominions.

The Queen Mother was inducted promptly at eleven o'clock, read a speech, conferred five honorary degrees, and the ceremony ended exactly at twelve o'clock. She made a very fine appearance in her black silk academic gown, elaborately embroidered in gold lace, with a mortar board cap and gold tassel. She went through her part of the ceremony with great ease and dignity and without the least appearance of nervousness or hesitation.

From the Festival Hall we retired to the Guild Hall in the City of London, where the dignitaries were tendered a luncheon. The Queen Mother presided at the luncheon, offered a toast to the Lord Mayor, who in turn offered a toast to the Queen Mother and the University. There were speeches by Lord Salisbury and other notables.

The night of the 24th some of the delegates attended a dinner at the Imperial College of Science, at which the Rector referred in complimentary terms to the California Institute of Technology and the eminent place which it occupies in the world of science.

Promptly at nine o'clock the diners retired to St. James's Palace, where they were tendered a reception by the Queen Mother and where there were many notables—people from the political, educational and social world—present, and again we were presented, and were required to remain until the Queen Mother had left, which was about eleven o'clock.

Aside from the dignity and pageantry of the whole ceremony, the thing that impressed me most was the meticulous care with which all the details had been arranged. Nothing was left at loose ends. Everything went off exactly on time; wherever a delegate went, the host had taken the trouble to find out who he was and where he came from, and what his particular interests were.

I was greatly flattered to find that the California Institute was held in very high regard and that we were as well known as any institution represented at the Installation.

I returned to the United States on November 30th, with the distinct feeling that I had been a very welcomed guest. In addition to my participation in the official functions I was privately entertained on one or two occasions, which added to the feeling of being wanted, and showed that the hosts appreciated the trouble taken to have our Institution represented.

Altogether it was a most happy occasion for me as it gave me some good excuse to take a trip, and at the same time feel there was something serious to be accomplished.

James R. Page

Chairman, Finance Committee
Board of Trustees
California Institute of Technology

BOOKS

One by Life, another out of Time

THE WORLD WE LIVE IN
by the Editorial Staff of Life and Lincoln Barnett
Simon & Schuster $13.50

The World We Live In is made up of a series of 13 articles which ran in *Life* at intervals from December, 1952 to December, 1954. Individually, these articles were impressive; collected, they are awesome.

This is, in every way, an overwhelming book. Just to lift it (and children under 5 or adults over 75 should be discouraged from trying) is an experience. As a physical history of the world, it probably has more of everything than any other book on this subject ever had before—more photographs, more artwork, more color pages, more foldout panels. In fact, it's just about the richest dose of popular science ever offered in one container.

The lushness of the book is inclined to obscure the fact that there is some good reading here too, above and beyond the caption material. This text has been written by Lincoln Barnett (*The Universe and Dr. Einstein*), based on material collected by 10 researchers and checked by almost 250 authorities in various branches of science. It is a comprehensive and extremely orderly job of writing. The headings of the 13 chapters describe the scope of the book: The Earth is Born, The Miracle of the Sea, The Face of the Land, The Canopy of Air, The Pageant of Life, The Age of Mammals, Creatures of the Sea, The Coral Reef, The Land of the Sun (deserts), The Arctic Barrens, The Rain Forest, The Woods of Home (forests of the temperate zones) and The Starry Universe.

THE TIME BOOK OF SCIENCE
by Jonathan Norton Leonard
Random House, New York $3.95

As SCIENCE editor of *Time*, Mr. Leonard has recorded a lot of important scientific advances in the last ten years—and a lot of scientific trivia and exotica too. There are examples of all three in this collection of 152 of Mr. Leonard's stories from the science section of *Time*.

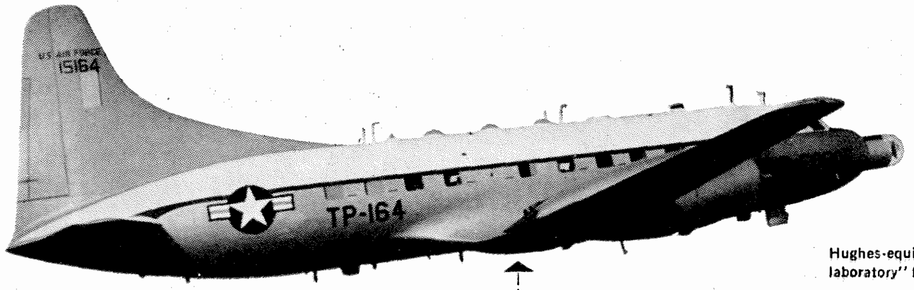
The stories appear here unchanged—just as they ran in the magazine at various times between 1945 and 1955. For some obscure reason, the stories are also undated, so that the general reader, coming up against statements like "A more conventional effort to map the Milky Way has just been completed . . . ", has the dubious privilege of making his own guess as to when, within a ten-year period, this effort was made.

Though there is no apparent attempt to organize these pieces chronologically, they are at least divided into five groups: The Behavior of Matter, The Stars and the Earth, A Gallery of Machines, The Living World, and the Story of Man—or, roughly, physics, astronomy, engineering, biology, and anthropology and archaeology.

It may be because there are so many bits and pieces here, but, at any rate, the book seems best—and certainly most solid—in its earlier sections, getting scrappier as it goes along.

The first section, for instance, on The Behavior of Matter, starts off with the story of the "Manhattan Engineer District," as revealed in the Smyth report in 1945; ultrasonics comes up next; then an early description of the action and effects of the atomic bomb on Hiroshima and Nagasaki; an account of how close the Nazis came to producing an atomic bomb during the war; an admirable explanation of relativity; an intimate report on the first nuclear chain reaction at the University of Chicago in 1942; and an essay on the rapid march of science in the 20th century.

Most of these pieces are extremely short, hovering around 750 words. This may be just the right portion of science to serve a newsmagazine reader who also has to work his way through a dozen other courses from Hemisphere to Cinema; readers of this book, however, may feel they are being offered slightly stale canapés in lieu of a good dinner.



Hughes-equipped T-29 "flying laboratory" for systems evaluation.

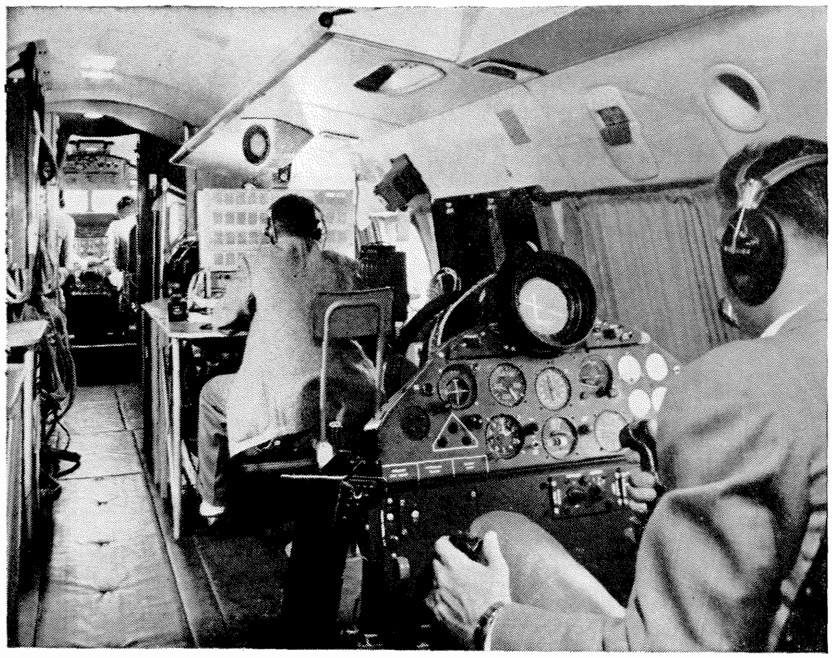
Flight evaluation of advanced interceptor electronic system uses unique approach.

T-29 "INTERCEPTOR"

THE DEVELOPMENT OF AIRBORNE ELECTRONIC SYSTEMS REQUIRES THOROUGH FLIGHT EVALUATION OF BREADBOARD AND PROTOTYPE EQUIPMENT PRIOR TO FINAL DESIGN. AT HUGHES, SYSTEMS FOR INTERCEPTORS ARE FIRST TESTED IN "FLYING LABORATORIES" IN WHICH THE EQUIPMENT IS READILY ACCESSIBLE TO SYSTEMS TEST ENGINEERS

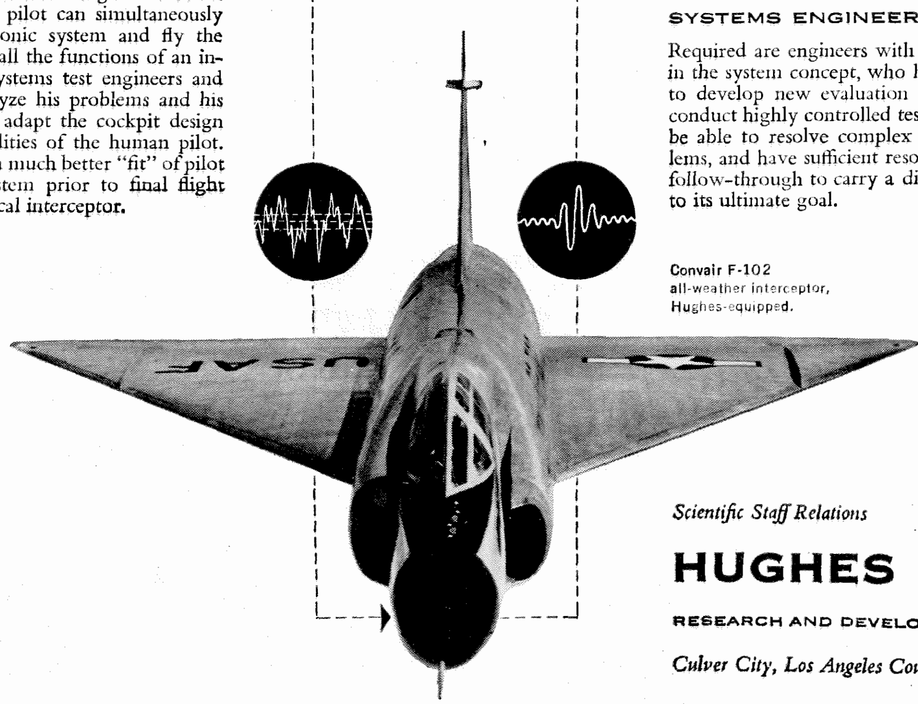
One interesting problem recently confronting Hughes engineers was that of evaluating the requirements imposed upon the pilot of a high-speed one-man interceptor. This arose in the development of a new integrated electronic system to control several phases of an all-weather interceptor's flight. Because of the great importance of providing the pilot with the optimum design and arrangement of displays and controls, it became necessary to determine accurately the pilot's work load during flight, and the human factors that affect his ability to carry out his task.

The solution was to install a complete mock-up of the actual interceptor cockpit in a large T-29 aircraft in which a breadboard model of the system was being tested. From this cockpit a test pilot can simultaneously operate the electronic system and fly the T-29, performing all the functions of an interceptor pilot. Systems test engineers and psychologists analyze his problems and his performance, and adapt the cockpit design to the natural abilities of the human pilot. The result will be a much better "fit" of pilot and electronic system prior to final flight testing in the tactical interceptor.



SYSTEMS ENGINEERS

Required are engineers with a basic interest in the system concept, who have the ability to develop new evaluation techniques and conduct highly controlled tests. They should be able to resolve complex circuitry problems, and have sufficient resourcefulness and follow-through to carry a difficult program to its ultimate goal.



Convair F-102 all-weather interceptor, Hughes-equipped.

Scientific Staff Relations

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

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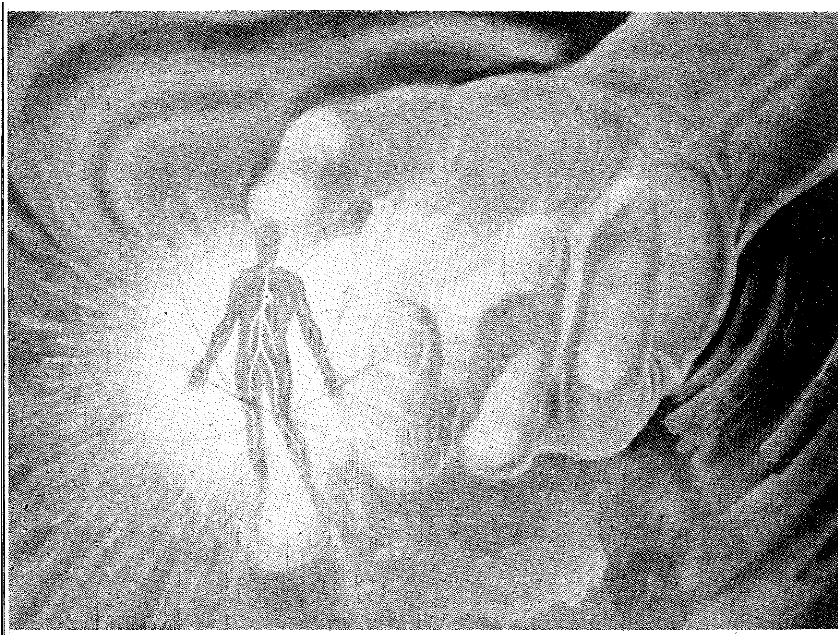

RADIOISOTOPES — Union Carbide's Divisions are leaders in the field of nuclear research and development. One Division, Union Carbide Nuclear Company, operates for the government Oak Ridge National Laboratory, the Nation's chief source of radioisotopes. In medicine, radioisotopes are used to investigate the human bloodstream —how it supplies nourishment, defends against disease, or becomes diseased itself.

TITANIUM — Electro Metallurgical Company is rapidly completing a new plant to produce titanium, the wonder metal whose strength and lightness are combined with resistance to heat and corrosion. The new plant will use a process developed by Union Carbide research, and will have an annual capacity of 7,500 tons of crystalline sponge —half again as much as the total United States production in 1954.

THE HORIZONS ARE UNLIMITED *for engineers, chemists, physicists, and business and liberal arts majors. Union Carbide offers many opportunities to explore those horizons.*

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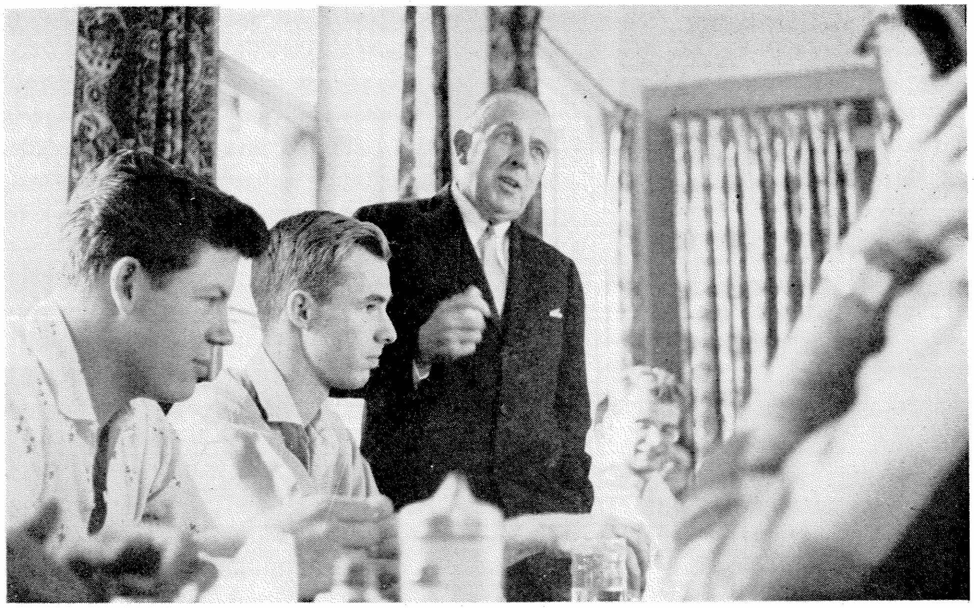


Paul Hoffman addresses students during his recent visit to the Caltech campus

WORLD AFFAIRS ARE YOUR AFFAIRS

By PAUL G. HOFFMAN,
Chairman of the Board
Studebaker-Packard Corporation

BEFORE DISCUSSING WORLD AFFAIRS, I should, I believe, confess to you that I started out in life as both an insulationist and an isolationist. That is partly because I was born within the shadow of the Chicago *Tribune* Tower, and partly because in my boyhood days I used to hear William Hale Thompson, the mayor of Chicago, boast that if King George of England ever dared enter our fair city, he would "poke him in the snout." At the time this seemed to me to be true red-blooded Americanism. It took World War I to convince me that we could not live alone, no matter how much we might like to do so. Strangely enough, some people remain unconvinced of the correctness of this viewpoint even after two world wars.

My first real immersion in international affairs came in 1942, when I was asked to take the national chairmanship of United China Relief. I demurred, saying that I had plenty to do at home, and that China was a long, long way off. Vincent Sheean, who was one of the group trying to interest me, answered by remarking: "Some day you will find out that the Yangtze River flows down Main Street." And not too many years thereafter I did find out; China became a very personal place to me, because my youngest son was an officer of the United States Army stationed in Chungking during the last year of World War II.

Actually, if we face up to the historical facts, we realize that happenings in faraway places have affected your lives and mine more vitally than most events here at home.

I am not sure as to just who did what to whom in Europe prior to 1914 to bring on World War I. Nor am I certain that historians are correct when they say our failure to stop Japanese aggression in Manchuria in 1931 was responsible for World War II. The hotter fuse that we let burn may have been Mussolini's drive into Ethiopia, or Hitler's brazen grab of the Saar.

The one thing of which I *am* certain is that happenings far away from Pasadena brought about my brother's enlistment in the Army in 1917, and his two years of service in Europe; and that it was a series of events in remote parts of the world that made it necessary, beginning December 7, 1941, for some of you or your older brothers to leave home—in many cases not for months, but for years—to take part in military actions all over the earth.

A further fact of which I feel certain is that World War I and World War II were not of divine origin. They were the result of things men did or did not do, both over the years and at moments of crucial decision. They could have been prevented if men, human beings such as you and I, had acted with sufficient intelligence at the right times.

Even after two world wars, as I have observed, we still find some people who believe we can fence off the United States and live in comparative isolation. They say we can make ourselves self-sufficient. These people are apt to think of themselves as being hard-boiled and realistic. They are not. They are just the opposite. They are dangerous dreamers. *Realistic* Americans today know very well that the United States is not self-sufficient, and is growing less self-sufficient each year.

I could use up my full time with proof that we are living in an interdependent world. But I am sure that that is not necessary. If I read the signs of the times correctly, most of the American people and all college students are well aware of the futility of attempting to go it alone. However reluctantly, they accept American participation in world affairs as a practical fact of life.

Objective viewpoint

I should like to offer two suggestions as to the basic attitude we ought to prescribe for ourselves in our consideration of international affairs.

First of all, with the responsibilities now resting on us, we dare not let our emotions prevent our giving *objective* consideration to the *facts* in any given situation. We are the most powerful nation in the world today and therefore our judgments are world-shaking in their impact. We can contribute much to the stability of the world by being sure that when an issue reaches a head and final decisions are necessary, our judgments will be mature, enlightened and aimed objectively at what is best for America and the world in the years ahead. We need to get all the facts, pro and con, and face those facts squarely. We must not shut off debate by name-calling or taboos. We must encourage it. By no other means can we obtain all the information that must be weighed.

For example, let's talk about the turbulent issue of whether Red China should be admitted to the United Nations. I do not believe she should, and I have good reasons to support that belief. Nevertheless, I hope that I could achieve sufficient objectivity to listen attentively to the arguments of those who believe she should be admitted.

In essence, my first point is that, when we are forming a judgment, we must get all the facts, or the facts will get us.

The second basic attitude we should hold is that we want peace, and are willing to wage the peace with the same patience, imagination and dedication we always employ in waging war. Peace is not simply a vacuum left by the absence of war. It is not something that comes to us automatically, or through the strategies of a small circle of government representatives sitting in conference rooms here and there. Certainly least of all is it one of the American dreams that wishing will make come true. We can win peace only by waging it, individually and collectively, with constant devotion and effort.

The Summit Conference

We must not only want peace, but, if we are to meet our responsibilities to the world, we must make the peoples of all nations understand how deeply we yearn for peace. President Eisenhower did us and the free world a service of pervasive significance by the results he achieved at the Summit Conference in Geneva. I was greatly concerned prior to Geneva because of the growing feeling throughout Europe that Russia was earnestly seeking peace and we were dragging our feet, and the even more dangerous feeling in Asia that we were actually throwing road blocks in the way of peace. In four days President Eisenhower, by both words and deeds, made America's position so clear that today world opinion recognizes that if anyone is blocking peace it is not America but Red Russia. No man ever accomplished so much in so short a time.

In the year of 1951 I published a book, *Peace Can Be Won*. At the time I didn't realize that since the beginning of time people have been writing on this subject, and that several thousand years ago a treatise appeared in which views similar to mine were expressed. I hardly need to tell you that in the centuries since that treatise appeared it has been war—not peace—that has been the lot of man. Despite that, I still hold the view that peace can be won.

In an effort to appraise present prospects for peace, I recently spent some time in Europe. I wanted to find out, if I could, what the new Russian leaders are up to. What's behind the smiles? Is their changed attitude a result of economic or political unrest? What concessions are they willing to make to put an end to the tensions which are responsible for what we call the cold war?

I discussed this subject with many of Europe's outstanding leaders, a number of whom are very knowledgeable as to the situation within Russia. Here is what I learned.

Speaking first of the situation within Russia itself, the reports all indicate that while the Russian people are, according to our standards, poorly housed, poorly clothed, and poorly fed, they are considerably better off under the new regime than they were under Stalin. On the political front Russia is still, of course, a police state, but several hundred thousand political prisoners have been released and there has been some let-up in the activities of the internal police. As a consequence, the general attitude of the Russian people can be best expressed by the phrase, "They never had it so good." No one seemed to feel that there was any basis whatever for any hope of internal revolt. One interesting fact was reported by a number of my informants—that Stalin has now become a bad name in Russia. What a country!—a demigod one day, a devil the next.

As far as the Russian leadership is concerned, the consensus is that it rests securely in Khrushchev and Bulganin. They have always operated as a team and are operating as a team today, with Malenkov, who resigned his prime ministership of his own free will, a trusted adviser but not a policy-maker. Molotov and Zhukov seem to be regarded solely as technicians in their respective fields.

I heard no comment that would indicate any change in basic goals so far as the present leadership is concerned. A Communized world under the control of Mother Russia is still what they are striving for.

Russia's younger leaders

Several of my informants who have spent much time in Russia recently felt that they detected among the younger leaders a somewhat different attitude toward world Communism from that which holds in the case of the present leadership. These young leaders do not have the same deep distrust of the West nor the revolutionary zeal of the present leaders. They apparently are much more interested in making a success of the Communist experiment within Russia than in imposing the Communist way of life on the rest of the world. This might well mean that if they came into power they would be much more amenable to a basic shift of policy.

What has happened is a change of tactics. Stalin, in his plans for world conquest, relied upon the basic technique of divide and conquer, of splitting off one nation after another from its alliance with the free world. So do Russia's new leaders, but, whereas Stalin relied upon scowls, threats and peripheral military actions, such as those in North Korea and French Indo-China, to accomplish his purpose, the new leaders are relying upon smiles and alluring trade offers.

They are pointing out to Germany the fact that her prosperity is the result of her not having to carry the burden of a military establishment and they are urging that she resist militarization and instead devote herself to the arts of peace, indicating the great potentialities which lie in a program for modernizing industry in Red China. They are saying, "Join us in the greatest adventure of all times."

They are saying to Greece: "All your financial troubles stem from the fact that 40 percent of your budget goes into the military. The reason for this largely lies in your fear of Bulgaria. We will arrange a non-aggression pact with Bulgaria which will guarantee your security. Turn your talents to the arts of peace and we will buy all your surplus products."

Dangerous phase in the cold war

If my European informants are correct in their analysis of the present status of the struggle between the Kremlin and the West, we are definitely entering into a new and more dangerous phase in the cold war. Honey has always attracted more victims than vinegar, whether it is flies or nations we are talking about.

Does this mean that the outlook is bleak and that we have nothing to look forward to except a drift from a cold war to a hot war, and then into World War III? Definitely not, in my opinion, for several reasons. In the first place, neither the people of Russia nor the leaders of Russia want a general war. As far as the leaders are concerned, this is not the result of any moral scruples, but simply because it does not fit into their program.

Furthermore, we have made progress toward peace, a progress made possible because the free world has been blessed with leaders who are wise enough to see that to win the peace we have to wage it with as much boldness, daring and imagination as we would apply to waging war. We are winning the peace because these leaders worked together with vision, transcending purely national interests, and saw to it that nothing was allowed to keep the free nations from waging the peace with a common strategy. As proof of our progress, I call attention to the following events which have taken place since 1946:

- Forcing the Soviet army to evacuate Iran: May 1946.
- Economic recovery of Europe through U.S. aid: April 1948 to date.
- Survival of Yugoslavia outside the Soviet orbit with Western aid: June 1948 to date.
- Breaking the Soviet blockade of Berlin by airlift: June 1948—August 1949.
- Creation of NATO: April 1949.
- Defeat of the Communists in Greece: October 1949.
- Settlement of the Dutch-Indonesian war: November 1949.
- Halting aggression in Korea: June 1950—July 1953.
- Settlement of the Kashmir war between India and Pakistan: August 1953.
- Cease-fire in Indo-China: July 1954.
- Settlement of Trieste dispute: October 1954.
- Agreement on rearmament of West Germany: May 1955.

We must not only keep on waging peace, but we must wage it with new intensity and with a new program that takes full account of the fact that the cold war has entered upon a new and more dangerous phase.

First, however, as I have already said, the basic Russian tactic is to divide and conquer. The Russians will, in the future, as they have done in the past, try to create divisions *within* each free nation and *among* the free nations. We must see that they do not succeed in either endeavor.

Here in America we must close ranks. We must not permit self-seeking politicians to create an impression that there is any division in America on the subject of Communism. Not too long ago they had the peoples of the world outside America believing that tens of millions of Americans were Communist sympathizers. This is, of course, flagrantly untrue. Never have our people been more united than in their opposition to this weird ideology. Out of our 163 million people only a handful of treasonable or maladjusted individuals—perhaps some 25,000—want any part of it.

The need at this moment is to intensify those activities which have so far brought us limited success. The free world must continue to make a common cause of waging peace, and, furthermore, the peace must be waged in the only way that can bring continued success, and that is simultaneously on four fronts—the military, the economic, the psychological and the political. Only by such action can the Kremlin be brought to a point where it will yield something more than a change in tactics; namely, a change of policy to one of "live and let live."

Buying time

We must maintain sufficient military strength to prevent any encouragement to aggression. NATO, the North Atlantic Treaty Organization, which became a living force under President Eisenhower and has been further nurtured by General Alfred Gruenther, should be strengthened, not weakened. We should encourage in every way possible, as President Eisenhower is doing, progress toward universal disarmament. We would, in my opinion, dissipate our chance to make progress in this area if we permitted any deterioration in our present military strength. We know that that strength does nothing but buy us time, but it is time we need in which to try to win the peace by peaceful means.

On the economic front the Western world should join forces and extend help to those new democracies in the Far East which are struggling desperately to achieve self-sufficiency. These new democracies are in competition with Red China. The question of whether they remain free depends on whether they are able to compete successfully with Red China in bettering the lot of their peoples economically, socially and educationally. We of the Western world must not only help them to help themselves—we must accord them the respect due sovereign nations, and, above all, avoid any insistence that they develop along patterns preconceived by ourselves.

On the psychological and informational front we must increase our efforts to promote understanding among all the free nations, particularly as between the free nations of the West and of Asia. Independence has come to these new nations only within the last few years, but their wisdom can be counted in centuries. Conversely, they have much to learn from us. Perhaps the most important thing they have to learn is that the West has progressed because the West has provided a climate in which men as individuals can grow, develop and reach real stature, that the true values of Western civilization lie in the realm of the intellect and the spirit—material welfare is a by-product.

Winning the peace

This strengthening of the ties between the West and East is one of the political goals we should seek. We stopped the march of Communism in Western Europe because the nations of the Western world were united in their battle for freedom. The need now is to make common cause with Asian free nations. This does not mean that we should try to force them to choose sides. At this time the important goal is to promote the kind of understanding which will bring us together in spirit.

The emphasis I am putting on promoting closer unity among the free nations does not mean that we should not work diligently for a better understanding as between the free world and Russia. The more those young Russian leaders see of the West, the more certain we can be that if they gain power, their influence will be toward really important concessions for the relief of tensions. We, too, will gain by travel in Russia because we must acquire a much wider knowledge of Russia and her people if our planning for peace is to be realistic.

In this program for an intensified waging of the peace the United States has a vital role to play. We are the strongest free society in the world. We must remain so and grow stronger. We can best accomplish that aim by holding fast to the concepts of freedom and justice which are our great heritage. We must strive to make our Bill of Rights a living document and to see that equality of opportunity for everyone, regardless of race or creed or color, is a fact rather than a pious hope.

We must follow the lead of our President and dedicate ourselves anew to making in America a demonstration of a free, just and unafraid society at work. No police system could keep the news of this demonstration from reaching the peoples of the world, even those behind the Iron Curtain. Such a demonstration can be America's unique contribution to the winning of the peace. It would come close to assuring the building of a world opinion which in time would force the Soviet leaders, whoever they might be, to a genuine change of policy—a policy which would give the satellite countries the right to choose their own form of government and would enable the nations of the world—even those with different ideologies—to live together amicably. It is not too much to hope that it could shape the beginnings of the first durable peace that men have ever built.

COSMIC RAYS AT THE NORTH POLE

Cosmic rays have been studied at the earth's surface, at the bottoms of lakes and mines, and high in the atmosphere. Now Caltech researchers are studying them at the north geomagnetic pole.

by LYMAN FRETWELL '56

COSMIC RAYS are invisible but powerful charged particles that constantly bombard the earth's surface. They are so numerous that at sea level about 10 particles will pass through a person each second. Their energy is so great that they are found even at the bottom of the deepest mines, having penetrated hundreds of feet of rock.

The most powerful of these rays has a thousand billion times as much energy as is released from a single uranium atom in an atom bomb explosion. Our biggest accelators today produce particles of about five billion electron volts, but cosmic rays have energies as high as a billion billion electron volts. In fact, the energy reaching the earth in the form of cosmic rays is roughly equal to that reaching the earth as starlight (excluding our own sun, of course). Geological evidence indicates that cosmic rays have continued their bombardment of the earth for at least 35,000 years, and studies of meteorites indicate that they have been bombarded by cosmic rays for hundreds of millions of years.

Cosmic rays have been studied, however, only for about the last 50 years, and Millikan, Anderson, Pickering and Neher at Caltech have figured prominently in much of this work. Cosmic rays have been studied at the earth's surface, at the bottoms of lakes and mines, and high in the atmosphere by means of airplanes, balloons and rockets. In recent years Dr. H. V. Neher, Caltech professor of physics, has been studying them at the north geomagnetic pole.

The particles originally entering the earth's atmosphere from outer space are known as primary cosmic rays. But very few of these primaries ever reach the earth's surface; they interact with the atoms in the earth's atmosphere, producing other particles known as secondaries. The primaries are known to consist of about 88 percent protons (hydrogen nuclei), 10 percent alpha-particles (helium nuclei), and the remaining 2 percent heavier nuclei such as oxygen, nitrogen, carbon and on up to at least iron, following roughly the abundance of the elements in the stars as determined by astronomers. This might lead one to wonder if cosmic rays originate in the stars. Some cosmic rays are in fact known to come from rare solar flares, but the majority do not seem to originate in the sun. Just where they do come from and how nature accelerates them to such high energies remains a problem to be solved.

Studies of individual cosmic ray particles in Wilson cloud chambers have resulted in the discovery of the positron, of mesons, and of many other particles believed to relate to the nucleus and what holds it together. Studies of this type have established cosmic rays as a source of particles of extremely high energy, through the use of which fundamental nuclear processes can be examined—just as they are with a high energy particle accelerator.

No less important for our knowledge of nature is our understanding of the cosmic ray particles themselves, and their effects upon our atmosphere and upon us. Much is to be learned from studying large groups of particles rather than individual particles; this is usually done by means of ionization chambers and Geiger or scintillation counters.

One of the properties of cosmic radiation is the so-called latitude effect, which describes the variation in the energy and intensity of cosmic rays with geomagnetic latitude. The earth's magnetic field interacts with cosmic rays approaching the earth just as a magnet will act on any charged particle passing near it. This makes the particle move in a curved path, the radius of the curve being smaller as the energy is less. Thus a particle coming toward the earth will be deflected and may even be sent back into space if it does not have sufficient energy to penetrate to the earth's surface. This bending effect is least at the geomagnetic poles and greatest at the equator (in fact, at the equator a particle must have an energy of at least 10 to 12 billion electron volts in order to reach the earth's surface). Thus, studying cosmic rays in different places seems to be such a good way to locate the geomagnetic poles and equator that a plane is now being equipped to do just this.

Only at the geomagnetic poles can cosmic rays of low energy come near reaching the earth—and even there, only to the top of the earth's atmosphere. It is to study these low-energy cosmic rays at high altitudes that Dr. Neher has been making trips during the past few years to the region of the north geomagnetic pole. In the summers of 1951, 1954 and 1955 he made trips to northern Greenland, where his main base of operations was Thule, a small spot in the northwest corner of Greenland only a few hundred miles from the north geomagnetic pole. Neher made all his cosmic ray observations last summer at Thule itself, since previous observations had indicated that cosmic rays behave essentially the same there as at the pole.

Life on an icebreaker

Neher was taken to Thule on the *East Wind*, a U.S. Coast Guard icebreaker. Since Thule is well above the Arctic Circle, one must get used to a land where the sun never sets, but the ever-present light, of course, did not keep the Coast Guard from maintaining a strict schedule aboard ship; breakfast was served between 7:00 and 8:00, lunch at 12:00 or 12:30, and dinner at 5:30. Then a movie was usually shown in the "evening."

The food and living accommodations aboard ship were quite good; it was not too difficult getting used to the continuous sunlight and the roll of the ship, and a good night's sleep was just as easy to obtain aboard the *East Wind* as at home—except when the ship was plowing through ice, that is.

The charging, the grinding halt as the ship rose up on the ice, the slow return to the sea, then the backing up to start over—this was something Neher never did learn to sleep through.

Icebreakers are a sturdy lot, with rounded bottoms and carefully braced sloping hulls to withstand the terrific impacts with the ice. This special construction is necessary because of the way an icebreaker makes its attack; it backs off, gets a running start, and slides up on the ice. The weight of the ship then breaks the ice, and the ship settles back into the water. Because this method of icebreaking puts a terrific stress on the hull, the ship is divided into water-tight compartments. In fact, the ice struck back at the *East Wind* in 1954 and punched a large hole in her, so that the expedition was forced to turn back to Thule a good deal sooner than it had planned.

The perils of research

Neher was glad that the *East Wind* had a rounded hull when, during the trip north of Thule in 1954, ice began to jam together around the ship. The force of the wind-driven ice would crush the hull of a normal ship, but the icebreaker's rounded bottom merely caused it to be lifted high and dry. The *East Wind* was trapped this way for three days. All aboard calmly got off the ship and proceeded to explore the ice sheet mashed together around them; it was easily solid enough to walk on, being eight to ten feet thick. They knew that there was nothing they could do but wait for the wind to change, as it inevitably must. And surely enough, on the third morning they awoke to find no trace of the ice that had held them captive the two previous days; it had blown away and out of sight during the night.

(A rounded bottom has its evils, too; Neher vividly recalls the time the ship was rolling 30 degrees each way from the vertical. But this was nothing to the crew, who had experienced a 60-degree roll—and even less to the ship's builders, who had designed the ship to take an 87-degree roll without capsizing).

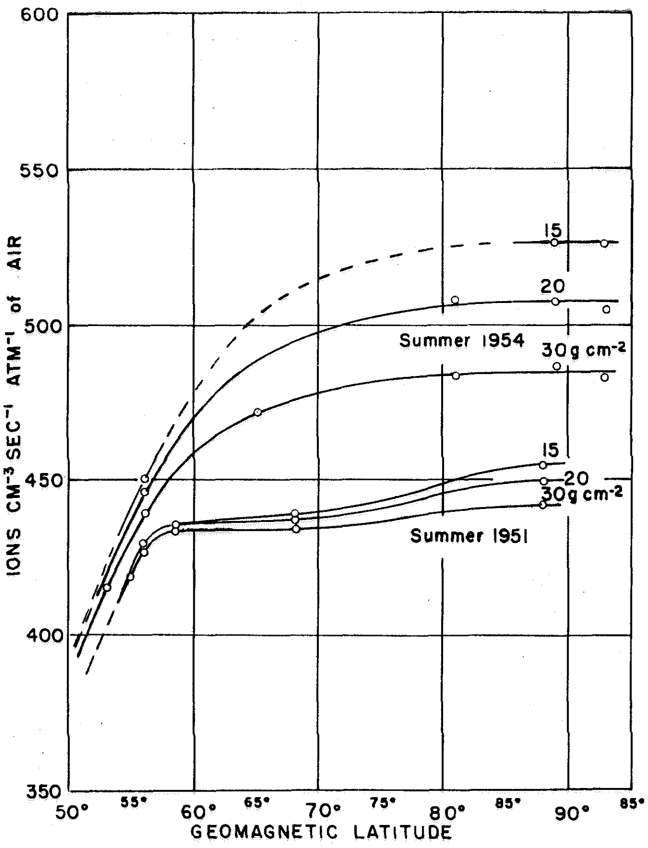
To measure the cosmic ray intensity at high altitudes Neher uses an ionization chamber. In this type of instrument the gas ions produced by the cosmic rays discharge a gold-plated quartz fiber, just as a familiar gold-leaf electroscope can be discharged by X-rays. In its discharge this fiber eventually makes contact with a second plated quartz fiber connected to the grid of a vacuum tube. This causes a radio pulse to be sent back to the recording device and at the same time deposits a new charge of electricity on the movable quartz fiber. Thus the frequency of pulses sent back is a measure of the rate of discharge of the electroscope, and therefore of cosmic ray intensity. Neher's equipment can measure the intensity to an accuracy of a few tenths of a percent. In addition to this information, other signals are sent out, giving the temperature and the atmospheric pressure around the device. The whole unit—transmitter, ionization chamber and power supply—is attached to a helium-filled balloon and is sent aloft; last summer one of the balloons reached a height of almost 24 miles before bursting.

In 1954 Dr. Edward Stern, then a graduate student, went along with Dr. Neher to Greenland. At the same time that Neher was making his flights, two other graduate students, Alan Johnston and Robert Morris, sent up similar flights at Bismarck, North Dakota, for purposes of comparison.

Some of the results of Dr. Neher's trips are shown in the accompanying diagrams. The one at the right shows that there was not much difference in the cosmic rays at Bismarck (55°N.) between 1951 and 1954, but there was quite a difference near Thule (88°N.). Since the weaker cosmic rays could not reach the earth at Bismarck because of the earth's magnetic field, but could reach the earth near Thule, this curve seems to indicate that much more low energy cosmic radiation was present in 1954 than in 1951.

Weaker cosmic rays would also be more strongly absorbed in the upper atmosphere than their more powerful relatives. The diagram below shows that the ionization (and hence the number of cosmic rays) was greater in 1954, and the upward swing of the 1954 curve toward the left indicates the presence of relatively more low energy rays in 1954 than in 1951. Hence it appears that low energy radiation reached the earth in considerably greater quantities in 1954 than in 1951.

Why should this be so? According to Neher, the explanation that seems most plausible at the moment is one that has been blamed for everything from the weather to politics—the sunspot cycle. In 1951 there was a fair amount of sunspot activity; 1954, on the other hand, was the quietest year for sunspots in 24 years. It is known that when sunspots occur, large amounts of matter may be shot out from the sun. These clouds of ionized gas could possess fairly strong electric and magnetic fields, and thus prevent some of the weaker cosmic rays passing near them from reaching the earth.



Recordings at Bismarck (55° N.) and Thule (88° N.) show more low energy cosmic radiation in '54 than in '51.

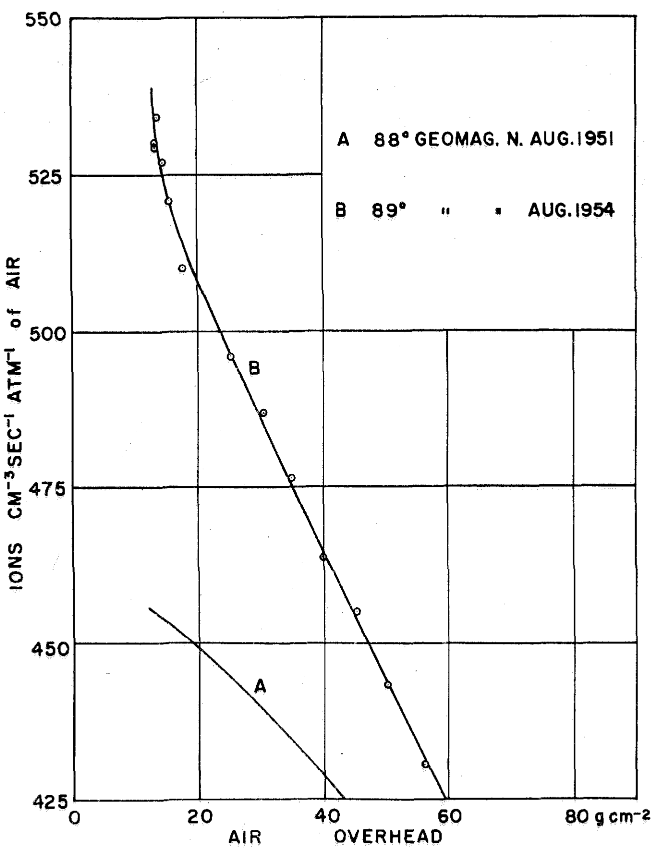
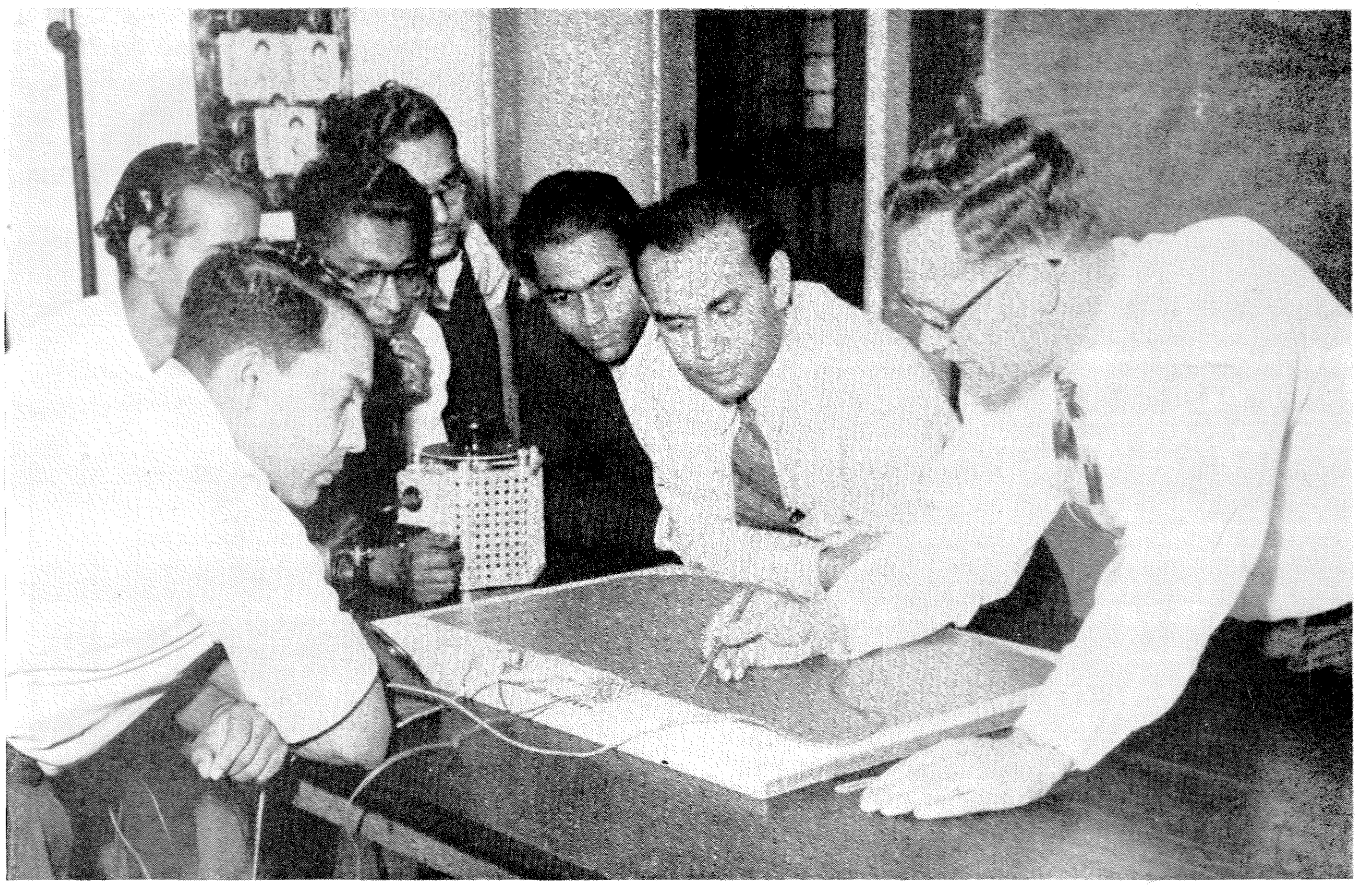


Diagram shows that the ionization (and hence the number of cosmic rays) was greater in 1954 than in 1951.

If this is the correct explanation, we might have expected to find more variation in the day-by-day cosmic ray intensity in 1951 than in 1954, due to the random nature of the sunspots and the matter they emit. Just such a difference in the variation was actually observed to exist.

It is still too early to evaluate the results of last summer's work, other than to say that it seems to agree with the solar-cycle hypothesis in a general way. It must still be shown conclusively that the cosmic ray curves tie in with sunspot intensity, and it must also be ascertained that there are not other factors contributing to this change in low energy cosmic radiation (for instance, contrary to supposition, cosmic radiation from outer space may not be constant). But it does seem that low energy cosmic rays may provide a valuable tool for studying the regions of space in the planetary system, and they may provide some clue as to the origin of cosmic rays. Only time can tell just how important they may be to interplanetary studies. And even when this last summer's work has been fully analyzed and interpreted, the final chapter to this story will not have been written, for Dr. Neher is planning to go back to Greenland again next summer and to the Antarctic the following winter.



As guest professor at Bengal Engineering College, Dr. Ingersoll demonstrates an analog field plotter.

ENGINEERING EDUCATION IN INDIA

INDIA STANDS TODAY as the unparalleled challenge of the free world—one-seventh of the earth's population on a land area of less than half that of the United States, having an average living standard which is about the lowest in the world. Whether India's democracy stands or falls in the face of Communist pressure in Asia will depend on whether it can deliver the goods; that is, whether it can produce a rise in the standard of living comparable to or better than that reportedly taking place in countries such as Communist China. To utilize the relative abundance of natural resources and unskilled labor to raise the standard of living of the masses, to feed, house and clothe India's 380 millions is largely an engineering task. It must be accomplished almost exclusively with the products of the engineering education system in India, and thus this system merits careful scrutiny by all of us who are counting so heavily on India to make a success of her democracy.

Engineering schools in India date back almost as far as our own, with the establishment of Thomason College of Engineering (now the University of Roorkee) in 1847, and Bengal Engineering College in 1856. The graduates from these and later engineering schools of British India, however, were utilized mainly in the government supervisory posts for doing routine work of operation and maintenance.

Thus, engineering education in the past did not suitably equip the trained men to initiate new designs or projects. The real engineering work was consistently done in the home country, England. The fruits of this system, eight years after independence, are still much in evidence in India today. American guest professors in India generally agree that the qualities which Indian students lack most are initiative and imagination. It is a part of their unfortunate heritage of two centuries of subjugation.

Immediately upon independence the Government of

To feed, clothe and house India's 380 millions is largely an engineering task. Here is how India is meeting her need for engineers.

by ALFRED C. INGERSOLL

India took bold steps to improve facilities and instruction for the training of research scientists, high-grade engineers and technologists. The Central Government appropriated some $4,000,000 for new building and research equipment in 40 existing institutions, and provided another $500,000 annually for aid in employing qualified staff.

There are today some 49 engineering colleges and technological institutions in India offering courses in many branches of engineering and technology. About 30 of these offer the bachelor of science degree—on a par with our own—and, of these 30, about 14 are equipped to give graduate training and research, some leading to the master's degree and a very few to the PhD. The remaining institutions offer diploma courses, something like a junior engineering course, requiring only high-school preparatory standing.

The geographical distribution of these institutions is fairly representative of India's urban population distribution. Everything having to do with education, science, engineering or the like is conveniently divided into four regions in India—northern, southern, eastern and western—with the big cities of Delhi, Madras or Bangalore, Calcutta and Bombay, respectively, the focal points of these regions. Thus, the northern region has nine colleges of engineering and technology located in Delhi, Banaras, Kanpur, Aligarh and Roorkee. The eastern region has six institutions, three in Calcutta and two in Bihar, plus one more that will presently deserve special mention. The southern region has some 13 institutions, located in Bangalore, Madras, Hyderabad, Waltair, Trivandrum and Mysore. (One of the southern schools, in Bangalore, deserves special mention for the length of its name—Sri Krishnarajendra Silver Jubilee Technological Institute). The western region has four schools, located near Bombay and in Nagpur.

The total enrollment in 31 engineering colleges and engineering courses of arts and science colleges in 1951-52 was 12, 293 men and 11 women. The output in that year was 2,205 bachelor's degrees and 1 master's degree. In addition to this upper echelon we must add 27 colleges offering the diploma course, with an enrollment of 8,094 men and 3 women: the output being about 2,000 diplomas in that same year.

The total number of engineering students of India is on the order of 22,000. This works out to about one student of engineering for every 17,000 of population, just about one-tenth the corresponding ratio in the United States.

On the supply side, almost every college reports that there are from two to three times the number of qualified applicants as there are spaces available in the school. Those desiring to study engineering, but inadequately prepared, number still more. At Bengal Engineering College there are annually about 1200 applicants for admission. A competitive entrance examination is given at the college over a three-day period in the spring, and about 180 students are selected for admission.

As to demand, the employment picture is not as rosy as it is in the States, where each graduate can choose from among several opportunities, but unemployment of graduate engineers who have completed some practical training is negligible. This is in marked contrast to the overall picture of college graduates in India, among whom there is a great deal of unemployment (to some extent self-imposed, since most college graduates will accept only certain kinds of jobs—usually the ones we designate as white collar jobs). Referring to the class of 1955, the principal of one college reported that there were once again as many openings in civil engineering as the college could supply, half again as many in mechanical engineering, and not quite enough jobs immediately available in electrical engineering.

As India's industrialization proceeds through the various five-year plans in progress, the need for engineers will, of course, increase. The demand for engineers in private industry is largely a matter of educating the employer to the advantage of using engineers. This, however, depends in turn on one ingredient of the Indian mixed economy which is not present in any noticeable strength—competition. Until the Indian industrialist realizes that he can use engineering skills to turn out a product which is better or cheaper than that of his competitor, the employment of engineers in Indian industry will always lag behind that in the United States and similar competitive enterprise countries.

The development and improvement of technical education in India are guided by a body called the All-India Council for Technical Education. On this council are representatives of education, industry, legislators and specialists. The body has eight Boards of Study and four Regional Committees.

One of the most interesting developments, growing out of a recommendation of a committee of the Council, has been the establishment of the first Central Government higher technological institute, called the Indian Institute of Technology. This school is located in Kharagpur, near Calcutta, on the grounds of what was once an American air base (in fact it was the western terminus of the Ferry Command-run over the Himalayas, known as "the Hump").

I.I.T. is patterned after the Massachusetts Institute of Technology, which Indians consider the world leader in the business of engineering education. The first four-year class of students graduated this year. I.I.T. has an active graduate study and research program in eight fields, ranging from production technology and electrical communications to combustion engineering and applied geology. The estimated expenditure of establishing I.I.T. was $6,000,000. The institute will cater to 1,320 undergraduates and 400 post-graduate students and research workers.

Other central government institutes are proposed for Bombay, Madras, and Kanpur. This will round out the program of having a center for advanced engineering work in each of the four sectors.

Graduate students only

The Indian Institute of Science in Bangalore is a Central Government project (originally private) of a special sort. No undergraduate work is given at all, and only the upper crust of students with bachelor's degrees from other schools in India can come for graduate study and research. The Institute awards no advanced degrees, only associateships in science and diplomas in engineering. The student works under his major professor on a research project, but his thesis is frequently submitted to specialists abroad before it is approved, and the degree, if any, is granted by his mother institution. They are already recognizing a certain amount of difficulty with this complicated system, and at least some departments may eventually be set up on an advanced-degree basis.

On a pure research level, we should mention the Central Government Research Laboratories in physics, chemistry, metallurgy, fuels, glass and ceramics, drugs, foods, roads, buildings, electronics, electro-chemistry, salt and botany. These have all been initiated since independence, and will presumably direct the nation's efforts in her technological advancement through the various five-year plans. Furthermore, they will also absorb a good part of the graduate-student output while private industry is still learning the value of hiring engineers with graduate degrees.

In 1951-52, the year for which enrollment figures have previously been mentioned, the average annual cost per student in India's 31 engineering colleges was $194—67.4 percent of this coming from government funds (either state or federal), 22.9 percent from student fees, 1.6 percent from endowments and 8.1 percent from other sources. In the 27 engineering schools offering diploma courses the annual cost was only $103 per pupil, this derived about 75 percent from government funds and 25 percent from fees.

At Bengal Engineering College the fees for one academic year are as follows: tuition—$34 for students in the first two years, $42 for students in the final two or three years; dormitory—$10 for a double room, $20 for a single; meals — $70; incidentals — $10. These amounts would seem reasonable enough to us as *monthly* charges, but we must remember the enormous ratio of per capita incomes between India and the United States, which is 27 to 1. This means that a year in college would cost a senior student in India an apparent $3,900.

Faculty salaries

On the other side of this ratio matter, we can take a look at faculty salaries, which range from around 300 rupees per month for a demonstrator or instructor to Rs. 1,500 or better for a professor. Consider an assistant professor at Rs. 1,000 or $210 per month. To the American, his salary looks like $210 times 27 or $5,700 monthly—but remember that on this same scale a refrigerator would cost $8,500 or a small Hindustan automobile, $60,000! Either one is generally out of the question for a college professor.

At Bengal Engineering College, which is representative of the conventional type of engineering college in India, the curriculum is not greatly different from that in our own colleges insofar as courses and material covered is concerned. The student is supposed to be well grounded in physics, mathematics and chemistry from his intermediate science work before he ever comes to B.E. College. In contrast to a school like Caltech, however, the physics department is a relatively minor adjunct to the engineering groups, and there is no provision for a post above that of assistant professor. The work of the physics department is principally in the communications field.

In the senior year, about 35 percent of the student's time is devoted to his project work, which may be the design of a bridge or structure, including detailed drawings which are far more elaborate than the writer has seen at engineering colleges in the States. The reason for such specialization was once explained by the head of the civil engineering department this way: "Our problem is different from yours. In the U.S.A. an engineering graduate can go to work in an engineering office where he learns the business while he is working. In India, on account of the shortage of trained engineers, the fresh graduate may often be placed in a position of considerable responsibility, with nobody to supervise his work. He has to produce reliable work right away."

There are between 80 and 100 civil engineering students in any normal class. They meet together for lecture classes in the theoretical subjects. For tutorial or computation sessions they divide into four groups. The student is expected to attend class 36 hours per week, there being 7 class periods per day on Monday, Tuesday, Thursday and Friday, and 4 each on Wednesday and Saturday. Generally a student sits in lecture classes nearly every day from 7 to 11 a.m. After an hour and a half break for lunch he is back for tutorial, laboratory or project work until 3:30 p.m. Athletics will consume another two hours or so and then, after tea, the student may be able to study for a couple of hours before dinner at about 8:30.

Formal Classes

We see, then, that the Indian engineering student spends about 50 percent more time in formal classes than does his American counterpart. Specific homework assignments, with certain problems to be worked out and handed in each period, are few and far between in the traditional British teaching system.

Students are rarely sent to the blackboards to work problems in class. By and large there are no textbooks as we know them. The library may have 10 copies or so of a book that is recommended by the professor, and these must be shared among 80 students. Most of the student's time in lecture classes is spent copying into his notebook material which the professor puts on the blackboard. From earliest school days, lots of emphasis has been placed on memory work, so the student is likely to do a pretty good job at reproducing what he has written in his notebook on an examination later (and all are closed-book exams, incidentally).

The Bengal Engineering College gives three required examinations per year in each subject. These are generally three hours in length, and are of about the same caliber as our quarterly exams. The questions are set by the instructor who teaches the course and the same person marks the papers. A student must have a satisfactory record—roughly 40 percent—on these examinations before he is permitted to take the University of Calcutta examinations, which come principally at the ends of the second and fourth years. A student's passing and official grades are determined almost entirely by the results of these examinations.

A sidelight of the examination system that is hardest for Americans to believe is the secrecy in which the results are held until the right time. At the end of his third year, for example, the student takes certain University exams which pertain to courses he has completed but he is not allowed to know the results of these exams until more than a year later, when the results of his fourth year exams are also made known!

These all-important University examinations are given in two parts. The internal part is usually made up and graded by the instructor who gave the course. The other part is set and graded by an external examiner, usually a professional man who has been in practice a number of years. The idea behind this is laudable, to keep the college from becoming inbred in its teaching, much in the manner that we employ for professional registration exams. In practice, however, it is frequently difficult to find a practicing engineer who has kept in sufficiently close touch with modern developments to make up a creditable set of questions. It is very common, therefore, to farm out the external examiner work to professors of other schools. The questions are set with no more knowledge of the courses involved than that given in the syllabus printed in the catalogue.

Following his four academic years at B.E. College, the student then puts in a year of practical training as a sort of apprentice engineer, either in government service or industry, during which time he is paid practically nothing. The bachelor's degree is granted by the University of Calcutta in January following the year of practical training (for which there is no exam). Thus, although the engineering course is considered a four-year affair, the student cannot obtain his degree in less time than five and one-half years after he enters the college as a freshman!

The Indian engineering student engages in a more extensive athletic program than does his average American counterpart. Group games such as soccer—which they call football—cricket, basketball, and field hockey, are played daily, according to the season of the year, and there is smart competition between the teams of Bengal Engineering College and those of other schools or organizations nearby. Indians are also strong on tennis, badminton, and track events, and once each year the alumni gather on the campus for a big track meet and other festivities such as intercollegiate debates and the like.

Social life

Social life as the American student of engineering knows it, however, is non-existent in India. Although there are plenty of colleges for women in the Calcutta area, the idea of a dance, or even a co-educational picnic, would be unthinkable. A student may occasionally bring his sister on the campus on a Sunday afternoon, but even such visits are rare. This taboo stems from the traditional concepts of marriage, either Hindu or Muslim, in which the bride and groom meet for the first time at the wedding, all the preliminaries having been arranged by the families beforehand.

The big events are the holidays, which come with alarming frequency for an American. There are some twenty-five holidays listed in the prospectus of B.E. College, and even these are only about half of the ones they used to have! On the principal holidays the students gather for some type of convocation or ceremony in the morning, usually followed up by a social function in the evening, including music and refreshments.

The gayest holiday of the year is Holi Day or the festival of the colors. The students start early in the morning squirting each other with dye of various colors. They then come systematically after all the professors who have not had the prudence to leave the campus for the day. The refreshments in the evening are financed from the ransoms offered by the bedraggled faculty members in exchange for reasonably gentle treatment.

The writer must remark on one of the most spirited meetings of the students which he attended. It had all the flavor of an athletic contest among American students, including cheering, stamping of feet, a professional referee, and even various expressions of disapproval. The contest was not athletic, however, but rather competition in the reading of Bengali poetry!

Engineering educators in India, when asked what they considered to be the major problem facing engineering education in India today, invariably reply, "Teachers!"

We saw earlier that the ratio of engineering students to total population in India is about one-tenth what it is in the U. S. When we now consider that the teacher-student ratio in India is perhaps one-fifth what it is in the States, we have the interesting summary that the ratio of engineering teachers to population in India is about one-fiftieth of what it is in the States. This means that if India is to think in terms of building her economy and living standard to the ultimate level of the western world, she should be thinking in terms of expanding her teaching and research staff in engineering about fifty times or 5,000 percent! This points up the critical shortage of engineering teachers. It is a staggering task, and one in which the technically advanced countries of the world can participate for the next several decades before the supply is in any way adequate.

Attracting teachers

The only way that the needed teachers can be attracted into the profession is to offer them salaries, security and working conditions on a par with those obtainable in Indian Civil Service or private industry. This requires new sources of money for engineering schools. In this it is to be hoped that India will follow the lead of Australia, where private industry has recognized its obligation to engineering education and is supporting research and teaching in significant amounts.

In some of the problems of engineering education, India is receiving significant help from the various international aid programs. The American Technical Cooperation Mission, for example, involves not only some 40 American specialists at various schools in India but, more important, a like number of Indian faculty members who are getting advanced training in the United States for a year or more.

Several engineering schools have visiting professors sponsored by UNESCO, these men being predominantly German and English. Still others are provided by ECAFE (U.N. Economic Commission for Asia and the Far East) and the Colombo Plan, in which Canada is so active a participant.

Of the Indian participants who have come to the U. S., some are taking advanced degrees in institutions here. Others are engaged in programs of visiting many colleges and participating in seminars and the like. All of them are getting good opportunity to travel around the country, observing engineering works. It was originally hoped that more of them could be stationed as observers in various industries, from which they have so much to learn, but the strict security regulations on almost all U. S. industries have prevented this program from materializing.

Facing the responsibility

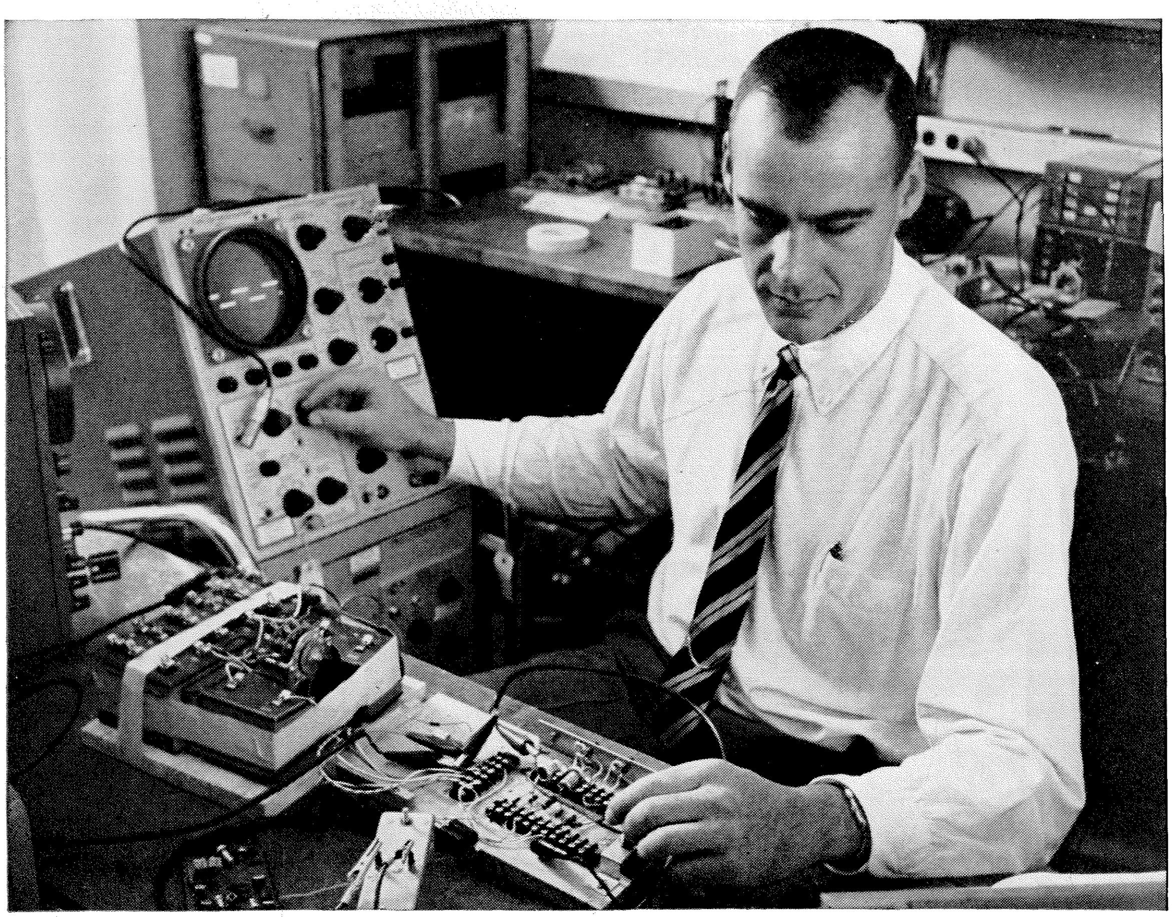
At some engineering schools in India programs are underway which clearly show the extent to which India is facing her responsibility in being a leader of the other free nations of Asia and Africa. Take, for example, the University of Roorkee, where there was inaugurated just last month the first Asian-African Training Center in Water Resources Development. Engineers from countries all over Asia and Africa are meeting there for a year's time in which they pool their experience and technical knowledge in the management of water resources to advance their countries toward total self-sufficiency. In this program, too, guest specialists are being provided through the TCM program, the U.N. Technical Assistance Board, and ECAFE.

At Roorkee, too, another experiment is underway, called *Shramdan*, which involves the students and staff working together with their hands, using their engineering principles to build structures which will be of service to the campus and community. In this way, students and staff have constructed a swimming pool, an open-air theatre, and a substantial addition to the students club building. Similarly, students at I.I.T. are constructing their own swimming pool, while at B.E. College the more socially conscious students have built a small bridge over a canal in a village not far from the campus. They undertake a different community service engineering project of this sort every year.

Another worthwhile program at Roorkee which deserves mention is that of Refresher Courses for Serving Engineers. These courses, which run about three months each, are designed to bring engineers serving in various parts of the Government up to date on recent developments in engineering.

These examples serve to show that engineering education in India is dynamically developing its own characteristics of service to the community, the nation, and even to the family of nations in Asia and Africa. While it keeps these lofty goals amidst the tribulations of severe shortages in funds and manpower, we of engineering education in the western world can be proud of our participation in it.

A Campus-to-Career Case History



Dick Abraham of Bell Telephone Laboratories, here experimenting with closing the loop on a transistor feedback amplifier.

"I'm working with top names and top talent"

That's one of Richard P. Abraham's comments about his career with Bell Telephone Laboratories in Murray Hill, N. J. "In 1954, after I'd received my M.S. from Stanford," Dick continues, "I was interviewed by a number of companies. Of these I liked the Bell Labs interview best—the interviewer knew what he was talking about, and the Labs seemed a high-caliber place.

"The Labs have a professional atmosphere, and I'm really impressed by my working associates. As for my work, I've been on rotating assignments—working with transistor networks and their measurement techniques, studying magnetic drum circuitry, and doing classified work on Nike. This experience is tremendous.

'In addition to the job, I attend Lab-conducted classes on a graduate level several times a week. Besides that, the Labs are helping me get a Ph.D. at Columbia by giving me time off to get to late afternoon classes. That's the kind of co-operation you really appreciate from your company.

"What are important to me are the opportunities offered by the job and the work itself. My wife and I own a house near Murray Hill, and we've found a lot of friends through the Labs. All in all, I think I'm in the right kind of place."

Dick Abraham is typical of the many young men who are finding their careers in the Bell System. Similar career opportunities exist in the Bell Telephone Companies, Western Electric and Sandia Corporation. Your placement officer has more information about these companies.

Bell Telephone System

World's most powerful production aircraft engine
The J-57 axial-flow jet engine with afterburner, designed and developed by Pratt & Whitney Aircraft.

THE MONTH AT CALTECH

Ford Foundation Grant

Caltech has been awarded a $1,229,990 grant from the Ford Foundation which is specifically designed to increase faculty salaries. The grant is part of a $260,000,000 gift by the Foundation to 615 colleges and universities.

Each grant is to be invested as endowment and the income used for faculty raises, which, in Caltech's case, would be an increase of about 4 percent. The grant will be given in two installments over a period of two years.

AUFS Correspondents

On January 9, K. H. Silvert arrived at Caltech to give a series of lectures and informal talks to the faculty and students on current conditions in Central America. On January 23, Edward A. Bayne will be on campus to report on Italy, Iran and Israel.

Both men are representatives of the American Universities Field Staff, an organization set up by Caltech and seven other educational institutions in this country in 1951 to send qualified young men out to foreign areas to study current conditions, problems and personalities. Besides reporting regularly by mail, these correspondents visit the campuses of each of the sponsoring institutions every two years to make comprehensive reports in person.

Dr. Silvert has been a close student of Guatemalan affairs since 1951, and is the author of a two-volume work, *A Study in Government: Guatemala*. He recently returned from a summer spent in Guatemala, El Salvador and Costa Rica.

E. A. Bayne, an economic administrator, has been closely associated with international development programs for a number of years. During World War II, he served in West Africa as a representative of the Board of Economic Warfare, in Italy as administrative officer of a combined British and American economic intelligence agency, and in China (where he remained from the end of the war until 1948) as economic advisor to the prime minister of Nationalist China. Prior to joining the AUFS in 1953, he was director of the Foreign Operations Administration's economic aid program in all European colonial territories.

In February, two more AUFS correspondents are due on campus—Richard D. Robinson, from Turkey, who arrives on February 6; and A. Doak Barnett, from China and southeast Asia, who will be here on February 20. Both men were at Caltech, as AUFS representatives, in 1953.

Richard Robinson was graduated from the University of Washington in 1942, and received an MBA degree from the Harvard Graduate School of Business Administration in 1943. He then enlisted in the Army, and was trained in military government and Far Eastern studies. In 1947 he left government service and traveled to Turkey, where he taught for a short time at Robert College. Later, as a fellow of the Institute of Current World Affairs, he lived in central Anatolia for nearly a year to study Turkish provincial life. Thereafter he established a base in Ankara.

A. Doak Barnett was born in Shanghai and spent his first 15 years in China. He was graduated from Yale in 1943 and, after wartime service as a Marine officer, returned to receive an MA in international relations at Yale. He joined the Institute of Current World Affairs in 1947, and has served as a correspondent for the AUFS since 1952.

AFROTC Discontinued

The Air Force ROTC unit at Caltech, which has been active since 1951, will be discontinued after July 1, 1957. Caltech is one of the 25 institutions (out of 188) in which the units are being discontinued.

In a recent reappraisal of all AFROTC units, David S. Smith, Assistant Secretary of the Air Force, reported that one of the requisites in a continuance of the program was the necessity of obtaining at least 25 cadets annually for flight training. Although the quality of the ROTC program at Caltech has been excellent and the caliber of the students good, said Smith, not enough cadets have applied for flight training. For instance, out of 37 graduating students in the unit who were commissioned last year, 28 were assigned to duty in the technical and scientific divisions of the Air Force; the remaining nine volunteered for flight training.

Present freshmen may continue the basic phases of their training until the end of their sophomore year,

sophomores may continue training through the current year, and juniors and seniors who are now in the advanced phase of their training are obliged by their contracts with the government to continue training until their graduation, when they will be eligible, as before, for commissions in both technical and flying service.

Research Center

CALTECH'S INDUSTRIAL Relations Section, which has conducted studies and courses in the field of personnel administration since 1939, has now set up a Benefits and Insurance Research Center to deal with the phenomenal growth of employee benefit plans in the U.S. The center will make a long term study of the benefits and insurance of employees.

Dr. Michael T. Wermel, research director of the center, has joined the Caltech staff as a research associate in economics and insurance. A prominent actuary and authority on social insurance, Dr. Wermel received his PhD in economics at Columbia University in 1939 and subsequently taught in a number of colleges and universities. He has served as consultant to the Department of Employment of the State of California and has worked for the Social Security Administration and the Bureau of Employment Security. Dr. Wermel is vice president of Woodward & Fondiller, Inc., consulting actuaries.

Although Caltech is providing space, utilities and basic services for the new center, salaries and expenses will be carried by 45 contributing business organizations, most of them with headquarters or branches in California.

Honors and Awards

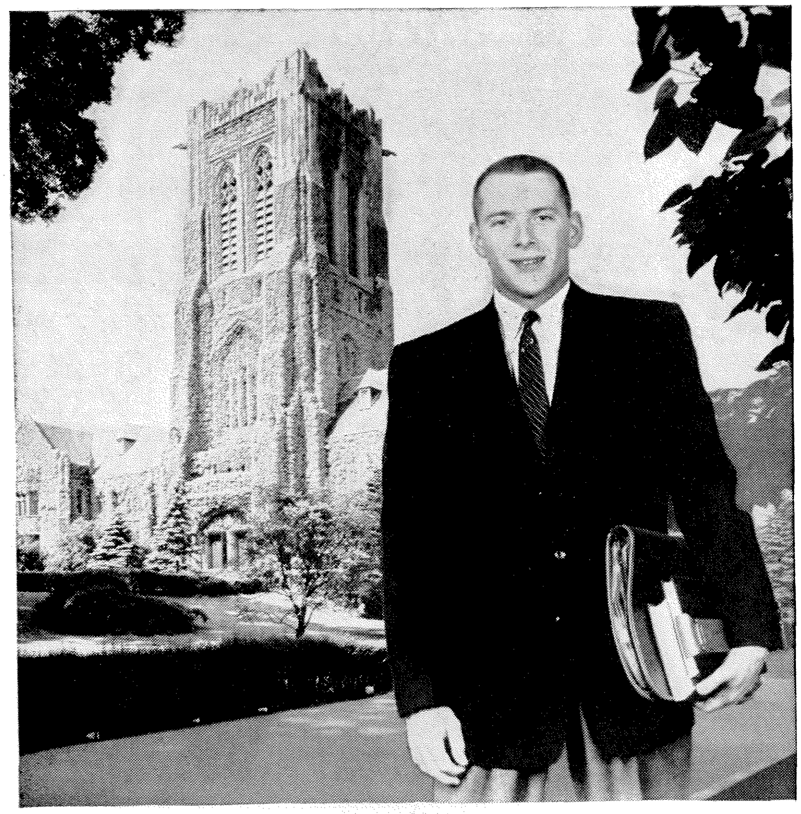
DR. THEODORE VON KARMAN, professor of aeronautics emeritus, last month received the Federal Grand Cross for Merit with star, one of West Germany's highest decorations, at a ceremony in Duesseldorf.

LINUS PAULING, chairman of the division of chemistry and chemical engineering, received an honorary doctorate degree from the Polytechnic Institute of Brooklyn in November at their centennial anniversary celebration.

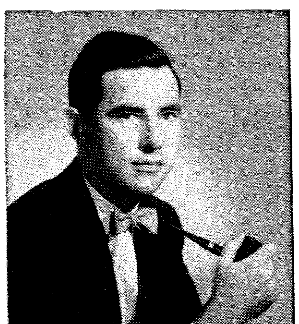
DR. FRITS W. WENT, professor of plant physiology, has been elected president of the board of governors of the Los Angeles State and County Arboretum at Arcadia.

George Lincoln asks:

What do metallurgists do in a chemical company?



GEORGE M. LINCOLN, JR. expects to receive his B.S. in metallurgical engineering from Lehigh University in 1957. George is active in sports, vice president of his junior class, and a participant in many other campus activities. He's starting his employment investigations early, for he feels that the selection of an employer is one of the most important decisions in a man's career.



CHARLES I. SMITH, JR. received his B.S. Ch.E. from V.P.I. in 1943, served in the Navy as an engineer officer, and joined Du Pont's Engineering Department in 1946. Since then he has advanced steadily through a number of interesting assignments at various Du Pont plants. Today Charlie Smith is technical superintendent of Du Pont's Newport, Delaware, Plant, Pigments Department.

Charlie Smith answers:

They have an almost endless variety of interesting problems to face, George. As a student of metallurgy you know that about two-thirds of all known chemical elements are metals. Many of them are revealing valuable new applications, when highly purified on a commercial scale. Du Pont is greatly interested in several metallic and semi-metallic elements.

My own experience at Du Pont ranges from work on titanium pigments, to metallic titanium production, and to the ultra-pure silicon used in transistors. You can appreciate some of our metallurgical problems when I point out that impurities in transistor silicon have to be below one part in 100 million. That's equivalent to one pound of impurities distributed through a train of ore cars twenty miles long!

Some of our metallurgists carry out fundamental research on new metals, and, in the development stage, they frequently operate pilot plants for producing them. Other metallurgists study problems relating to engineering materials used in construction, carry out research on intergranular corrosion, or investigate fatigue relationships encountered in dynamic, high-pressure operations.

You'll find many challenging opportunities in every phase of metallurgy at Du Pont, George.

Metallurgists and Metallurgical Engineers can find some of Charlie Smith's challenging new problems described in "Engineers at Du Pont." For a free copy of this booklet write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

WATCH "DU PONT CAVALCADE THEATER" ON TV

It Seems There Were Three Techmen . . .

FINALS AT TECH burst upon us with the same newness each term. The Caltech Student Body Protective Association, a fiction that stands for a spirit that pervades the Houses, springs into action as finals close in. The medium-fair students settle down to their role of average-boosting by snaking alone, while the dull boys and the bright boys work feverishly at salvaging the former's 1.9's for another term while pulling down the latter's 4.0's.

The freshmen bow under their first dose of this tri-annual measure of virtue and accomplishment; they begin to talk louder and louder as excitement wells.

The sophomores let off their tension by playing loud frittering games in the courtyards. This serves the dual purpose of releasing steam and guaranteeing that no one will slit your throat by studying while you're plugging up the air with noise.

A fifth-year senior explains his agony thus: "When I was a kid I was smart, but I get dumber and dumber and dumber. At the end of five years at Tech I'll be an average human being."

Sleep, milk, fruit and Wheaties—all the folderol of a training athlete becomes important as we try to create a best human within ourselves, to be measured as our average. It all seems a little ironic to the students at this shrine of measurement that we're actually being measured to four significant figures.

Ice cream bar sales soar in the Houses, and the sound of puttering in the alley kitchenettes rises as the time burnt in Pasadena hamburg palaces is sublimated by feelings of guilt into time burnt in the kitchenettes. Coffee breaks are taken hastily in the lounges at clammy samovars. (Samovars designed to decant only the sludge at the bottom of the pot, which plummets down your gullet to carom off your stomach wall and modify the nature of your alimentary community for days. It's less risky to make tea with tap water if you can outguess the cycle of the steam plant.)

Apparently we split into three broad groups for finals. We react to this biggest stress of our lives in different ways. Let's look at Techman$_1$. His is the broadest group. He knows he'll do even worse on this test than ever before. His work isn't done yet, so he works along till the last gun is fired, even learning a bit new during the exam while thumbing through the text in open-book tests. He is as tense going into a final as an athlete before the big game. His main effort and all conscious thought go into juggling the symbols on his paper and twirling his slide rule. (We don't have to apologize to anyone for mastering the slide rule, although we could be a bit more discreet about wearing them attached to our loincloths out in the open. A six-inch tool in the breast pocket is quite adequate for computing. Those who want something more in a slide rule can cart an electric sign that bleats: "Look, guys—I'm neat; that is, I'm an *engineer*—and that *is* neat, isn't it? *Isn't it?*")

Techman$_1$ learned in high school that science is nice and got a little self-confidence in the bundle, so he puts forth his best without flying into a tizzy and accepts his marks with a minimum of post-morteming and bitching to his instructors. He knows that finishing at Tech and learning at his own rate will be adequate for a job in business. Maybe it took two years to get his own rate to begin to coincide with Tech's rate (and that was painful) but his junior and senior years began to be productive.

Techman$_2$ can't take it. He lasts about two years before "financial reasons," or some such alleged force, forces him to get his bearings or carve a niche in some other part of society. As the finals draw nigh his burning interest in a local girl or the House Spirit or some hobby looms large in his mind to take all his snake time. It's just as well, because snaking at this stage—for him—is futile. He has let it go all term, hanging around the lounge. Maybe his energies got channeled into making the adjustment to college life or city life or just having freedom.

We are all plagued by this or something similar, coming to Tech. It's just a matter of proportion. For him they loom large enough to nudge him to the fringes. Perhaps lack of communicative skill made it hard for him to get the word, get his sense of proportion and scale and perspective knocked back into line in bull sessions, so he's finally nudged to the outermost limbo, called: "OUT OF IT." Man, he just doesn't dig this the most. Hence another engineer, physicist, pre-law or pre-med student is flushed down Tech's tubes.

Techman$_3$ is a noxious paragon. He is always up to date going into finals week. Hence, his last weekend of snaking holds the luxury of three hours in Pasadena's fine frittering dens, the movie parlors. It's only one movie, yet it seems like the height of conspicuous waste of time to my humbler species.

Actually, Techman$_3$ gives away even more time playing professor in the valuable exchange of knowledge that arises from the Student House system of free tutoring.

Student Life . . . CONTINUED

$Techman_3$ has a clearer understanding of the guy who comes to him with a problem than a professor does. He doesn't have the age or pomposity barrier surrounding him. He understands whether there is time enough and value enough in going back to first principles, or whether it is better to merely solve the problem by crank-out techniques.

$Techman_3$ can insult the guy he is helping because the guy (generally $Techman_1$) is not paying a cent for the service and is, in fact, soaking up $Techman_3$'s snake time. This prod can be effective, and can be used by him more and more, without being mistaken for something else.

Don't misunderstand! I'm only suggesting that a professor may be construed wrong, though he may have the purest of motives. The truly effective professors in my book get there by being what we know the student tutors are: friends interested in the growth of their charges.

The energy-savers

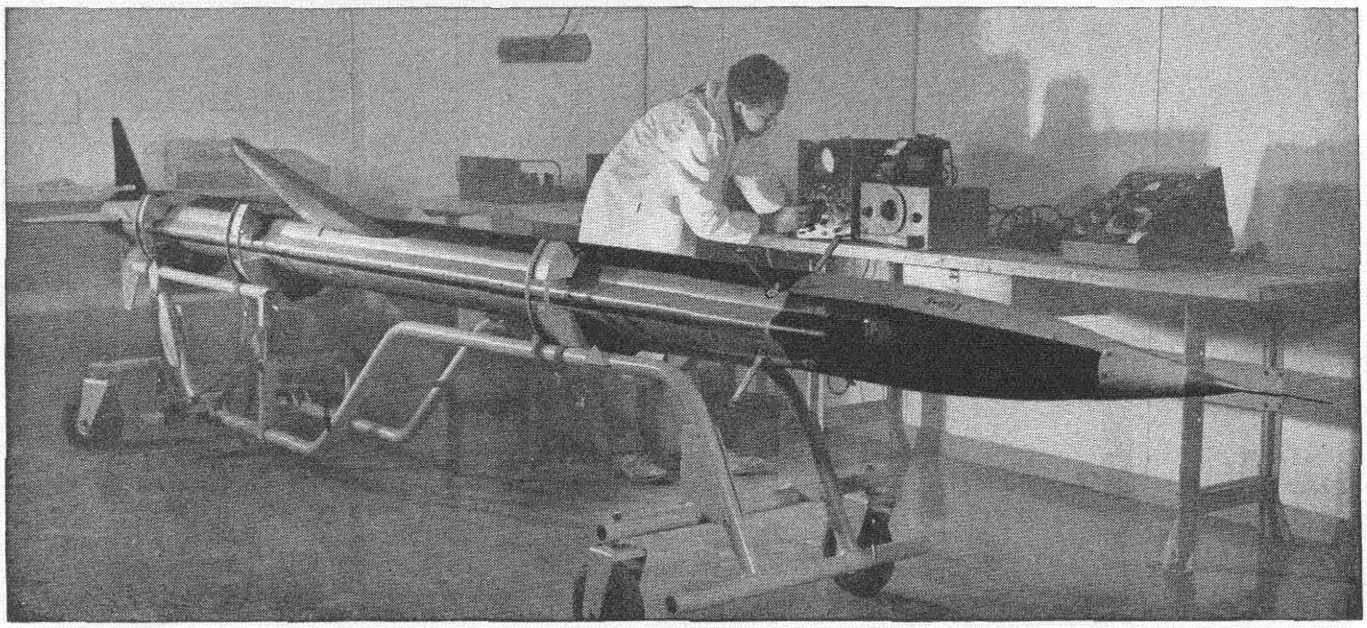
Wisecracks fill the exam room. ("Handing out a UCLA application for those who don't complete the first four questions?") So we end up taking our exams in our room to escape the phoney tension. The panting and sighing and moaning is just too, too dramatic. And some of us like to do our unconscious dramatics in the privacy of our own boudoirs so as to waste no energy being self-conscious and fretting about disturbing others with an occasional, fervent "Crap!"

Then home for Christmas. We return home to get a job to pay for the ticket that got us home to the job. I find a Mechanical Engineering background permits me to get my teeth into the fundamentals of soda jerking. I can see Boyle's Law in action as the pin-points of carbonation expand as they rise in the seltzer under decreasing pressure. The notions of science and the urge to sell an extra pound of candy go hand in glove as I chirp, "May I help you, ma'am?" during the Christmas rush at the drugstore.

We return home to a holiday of fuzzy thinking and saying what must be said, hoping that people will psyche out what we actually mean, while they say what they must, assuming that we will know just what should be interpreted—in a human and practical way, of course. Numbers get tossed around with a freedom that would cause an ardent Techman to writhe at every such sacrilege of the faith he's picked up. So we shift into the real world level of fuzziness—not necessarily better; just more human. If you tell a customer at the drugstore his bill is "about 69 cents to two-figure accuracy," he'll take his trade elsewhere, muttering, "What do you mean 'about'? They're numbers, aren't they? What a way to do business . . . mumble . . . mutter . . . "

Maybe we should rehabilitate the Techman before turning him back on the world?

—Russ Hunter '57



ALUMNI NEWS

Dinner Dance

THE 20TH ANNUAL semi-formal dinner and dance of the Caltech Alumni Association will be held on the evening of February 4 at the Oakmont Country Club in Glendale. A prime-rib dinner will be served at 8 p.m. and dancing to the music of LaVerne Boyer begins at 9 p.m. All reservations should be in the Alumni Office by Thursday, February 2.

Sorensen Fellowships

EARLY IN 1950, under Howard Vesper's leadership, a small group of interested alumni contributed nearly $3,000 to establish the Royal W. Sorensen Graduate Fellowship in Electrical Engineering. This was timed to recognize the retirement of Dr. Sorensen who, as we all know, has played a leading role in Institute life for more than 40 years and has been an inspiration to all who have had the privilege of working with him in engineering. The first recipient of this scholarship was Jerome K. Delson, MS '50, PhD '53, who received $900 per year for two years.

The concept of such a fellowship was so well received that early in 1954 it was decided to set up a sponsoring committee of alumni to aid in the establishment of a permanent endowment for this scholarship. The first notice to the alumni of the goal for a permanent endowment of about $25,000 was made in June, 1954, and during the first year contributions and pledges totaling about $7,700 were received.

The total amount of contributions and pledges has now risen to about $11,500, which is a little less than one-half the minimum amount required to establish a permanent endowment sufficient for one scholarship per year.

It is not considered desirable to grant any more fellowships until the endowment figure has been obtained and it is therefore urgently hoped by the committee that the second half of the required amount can be obtained within the next two years at the very latest, since a Sorensen Scholarship has not been given since 1953.

Dr. Gilbert D. McCann, professor of electrical engineering, is acting as secretary-treasurer of the sponsoring committee and contributions should be sent directly to him in care of the California Institute of Technology, Pasadena, California. Checks should be made payable to "California Institute of Technology—Sorensen Fellowship Fund."

It should be emphasized that pledges over a period of years will be most welcomed, and that the contributions are deductible for income tax purposes.

—G. D. McCann

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Secretary-Treasurer Donald E. Loeffler '40
Shell Oil Company, Martinez, Calif.
Meetings: Informal luncheons every Thursday.
Fraternity Club, 345 Bush St., San Francisco.

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Calif. Board of Equalization, 1020 N Street, Sacramento

Vice-President Herbert H. Deardorff '30
State Division of Highways, 1120 N Street, Sacramento

Secretary-Treasurer Wayne MacRostie '42
State Water Project Authority, Sacramento
Meetings: First Friday each month at noon.
University Club, 1319 K St., Sacramento

SAN DIEGO CHAPTER:

Chairman Maurice B. Ross '24
3040 Udal Street, San Diego 6, Calif.

Secretary Frank John Dore, Jr. '45
Consolidated Vultee Aircraft Corp., San Diego

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

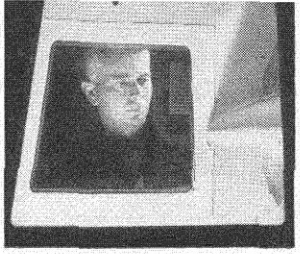
Chapter Notes

TWENTY SEVEN MEMBERS of the San Francisco Chapter attended a dinner meeting at the Fior d'Italia restaurant in San Francisco on December 2nd. Our speaker was a member of our own chapter, Harold Johnston, PhD '48, who is now an associate professor of chemistry at Stanford University. He discussed smog and the various theories of its origin, and the subject was received with great interest by this group of ex-Pasadenans .

—Don Loeffler, '40, Secretary

A MEETING of the New York Chapter will be held on Thursday, February 2nd. All details of the meeting place and exact time will be available from the American Physical Society at Columbia University, N.Y.C.

—Frank F. Scheck '48, Secretary



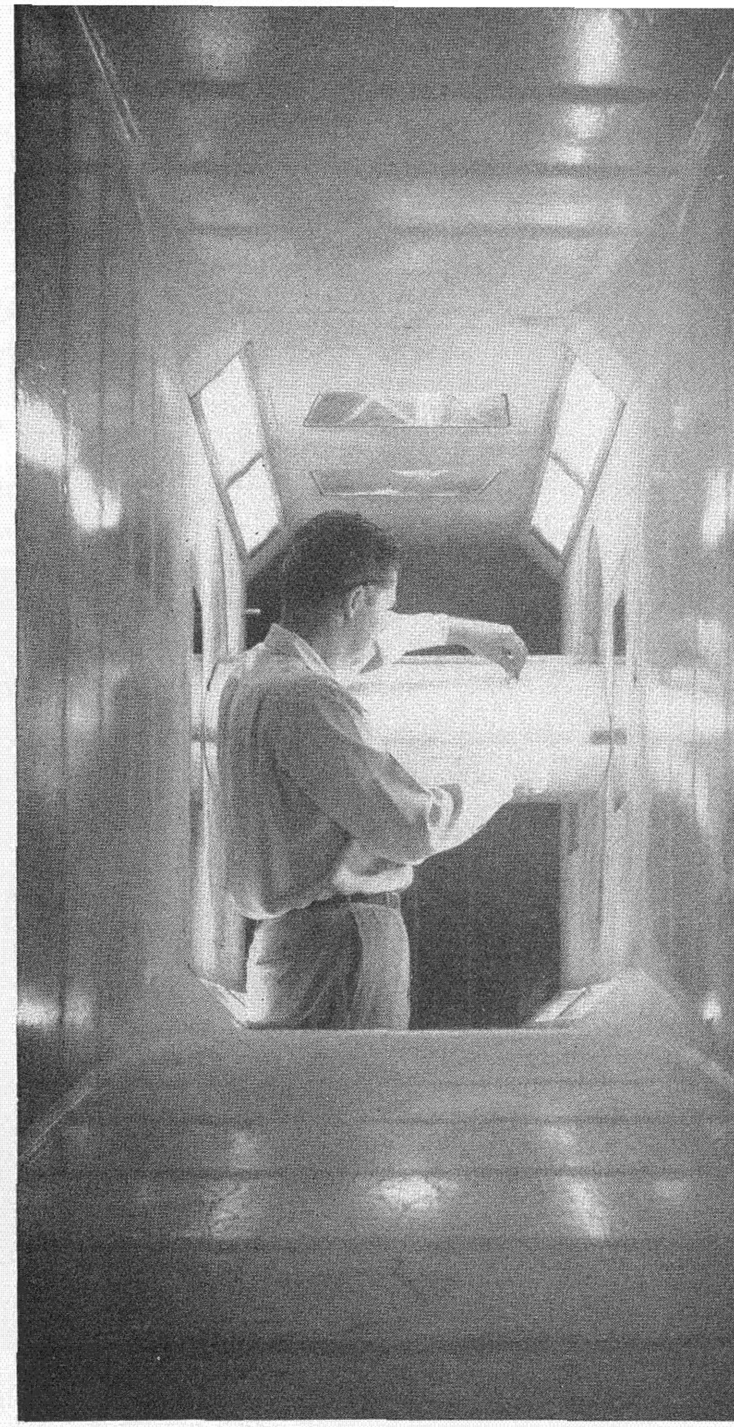
Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of —40° F. to +150° F. and maximum air speed of more than 270 mph.

Icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's icing research tunnel provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; *distribution of ice; rate of temperature* changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw and Thermodynamicist Tom Sedgwick. The report was in their hands *only two days* after it was decided to conduct the test.



C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

Thermodynamics career opportunities

Increasing development work on nuclear energy, turbo-compound, turbo-prop and jet transports, radar search planes and supersonic aircraft has created a number of positions for Thermodynamics Engineers and Thermodynamicists.

You are invited to contact your Placement Officer for a brochure describing life and work at Lockheed in the San Fernando Valley.

LOCKHEED
AIRCRAFT CORPORATION
California Division
BURBANK
CALIFORNIA

PERSONALS

1922

Howard G. Vesper, vice president of the Standard Oil Company of California, was honored by the American Petroleum Institute at its annual meeting in San Francisco in November, when he received a Certificate of Appreciation for his outstanding work for the Division of Refining during the years 1949 through 1954.

1924

Paul L. Magill, senior scientist with the Stanford Research Institute, has been named U.S. technical representative to the new Central American Institute for the Investigation of Industrial Technology in Guatemala City.

Vladimir A. Kalichevsky was recently named as the winner of the American Chemical Society's 1955 Southwest Regional Award. One of America's top authorities on petroleum refining, Dr. Kali is now a consulting chemical engineer for the Magnolia Petroleum Company in Beaumont, Texas.

1925

Robert W. Fulwider, senior partner in the patent law firm of Fulwider, Mattingly & Huntley in Los Angeles, recently rounded out a year as president of the Los Angeles Patent Law Association and chairman of the California State Bar Conference on Patent, Trademark, and Copyright Law.

1928

Arnold O. Beckman, PhD, president of Beckman Instruments, Inc., and the first Caltech alumnus to be elected a trustee of the Institute (in 1953), has been nominated for the 1956 presidency of the Los Angeles Chamber of Commerce.

1930

Fred R. Groch has become head of the rate department of the Portland, Oregon, General Electric Company which is now being expanded to include research as well as rates.

Captain Perry M. Boothe, MS '32, who is with the Civil Engineer Corps in the Navy, stationed in the Hawaiian Islands, writes that "my job as Assistant Director for Planning and Design in the Office of the Director, Pacific Division, Bureau of Yards and Docks, requires a lot of traveling in the Far East. I made three trips to Japan, Okinawa, the Philippines and Guam last year and am expecting to leave in the middle of January for Thailand, Cambodia, and Viet Nam, returning by way of the Philippines and Japan. My son Allan, 18, is a plebe at the U.S. Naval Academy and stood fourth in the country in his examination for the Presidential Appointment; my daughter Lorraine, 14, is in the 9th grade; and Thomas, 6, is in the first grade."

1931

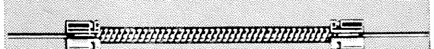
George Langsner, who has been working for the California Division of Highways since 1931, is now district engineer in charge of operations for District VII. George has been responsible for the design of many of the Los Angeles freeways, as well as the Pasadena and Terminal Island Freeways. He lives in Arcadia with his wife, son and daughter.

1935

Chester A. Davis writes that he has been Cuyama district superintendent of the


Precision, high-speed winding equipment for IRC elements

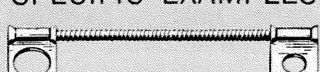
IRC WINDING SKILL OFFERS REALISTIC SAVINGS TO INDUSTRY



BASIC TECHNIQUE

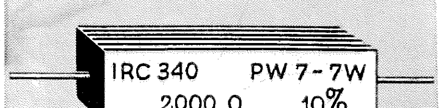
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

SPECIFIC EXAMPLES


IRC Type AW Wire Wound Resistors


IRC Type BW Insulated Wire Wound Resistors

IRC 4-watt Insulated Power Wire Wounds



IRC 7 and 10 watt Power Wire Wounds

. . . another reason why engineers specify IRC Resistors

Savings in the initial cost and assembly of component parts are an increasingly important factor to electronic engineers. That's why they depend upon IRC for their resistor requirements. IRC's mastery of winding wire elements—dating back more than 25 years—today provides a wide variety of unique units that offer realistic possibilities for savings.

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Richfield Oil Corporation since 1952. Chester and his wife have three children —Linda, 16, Phil, 13, and Patty, 6.

Jesse E. Hobson, PhD, resigned his post as director of the Stanford Research Institute last month after eight years with the organization.

1936

Paul Hammond, vice president and controller of Pasadena's Holly Manufacturing Company, was elected 1956 national chairman of the Wall and Floor Furnace Division of the Gas Appliance Manufacturers Association at their national convention in Palm Springs last fall.

Dr. Paul J. Schneider reports that he is still busy doing plastic and reconstructive surgery in Oakland.

1937

Ralph S. Benton writes from Bombay that he has been in India for 8 years now with Ingersoll-Rand, and has had a total of 19 years with the company. "The job is most interesting," he says, "as is the country, in spite of many complications—economic, political and otherwise. Was married in '51 in Tucson while home on leave and my wife and I travel extensively —have put on over 200,000 miles within the territory—via bullock cart, bus, car, train, plane and foot."

1938

Clay T. Smith, MS '40, PhD '43, writes that "life proceeds as usual in Socorro, New Mexico, where I am pounding knowledge into recalcitrant students. Got a quick look at the new athletic plant during a whirlwind visit to Pasadena recently and I am properly envious. The basketball team had better show terrific improvement now because they surely haven't any more excuses about practice areas and places to play. I'm head of the geology department here at the New Mexico Institute of Mining and Technology."

William R. Sears, PhD, has been named editor of the *Journal of Aeronautical Sciences*, which is published by the Institute of Aeronautical Sciences. Bill has been director of Cornell University's graduate school of aeronautical engineering since it was established in 1946. Before he moved to Ithaca, he was chief of aerodynamics and flight test engineering at Northrop Aircraft in Hawthorne, California. He's an active private pilot and uses his own plane on most of his business trips.

1940

A. M. Zarem, PhD '44, resigned last month as assistant director and manager of the Stanford Research Institute, where he has been since 1948. He has now

opened an office in Los Angeles where he will engage in independent research counseling and advisory services to business and industrial management, specializing in reviewing research policy programs and planning.

1943

Robert M. Sherwin, MS '50, ChE '52, has been appointed assistant plant engineer in the Tacoma plant of the Hooker Electrochemical Company. Bob has two children, Sarah, 2½, and Bob, Jr., 1.

1944

Warren Amster, MS '47, AE '48, who was a research engineer with Consolidated Vultee Aircraft in San Diego, is now a senior associate of the Planning Research Corporation in Los Angeles.

Donald W. Pendery has been made assistant director of the Applied Science Division of the International Business Machines Corp. in New York City. In this new position, Don is responsible for the coordination of Applied Science activities with product planning and engineering. He will also supervise the field operation of IBM's Applied Science Division in the eastern part of the United States. Don has been with IBM since 1949.

Ruben F. Mettler, MS '47, PhD '49, engineering executive for the Ramo-Wooldridge Corporation in Los Angeles, has been chosen as one of the Ten Outstanding Young Men of America for 1955, by the United States Junior Chamber of Commerce, for "his contributions in rocket fire control developments and classified military electronics."

Rube is the fourth Caltech alumnus to receive this distinction. The others: *Dr. Irving P. Krick,* MS '33, PhD '34, president of the American Institute of Aerological Research, in 1940; *Kenneth S. Pitzer,* '35, dean of the college of chemistry at the University of California in Berkeley, in 1949; and *A. M. Zarem,* MS '40, PhD '44, private consultant in research counseling, in 1950.

1947

Herbert Mason Royden III, was married to Barbara Nancy Busby of Westwood Hills on November 26. Herb is a research physicist at Atomics International in Canoga Park.

1948

Charles Susskind, who was with the Microwave Laboratory at Stanford as a research associate, is now assistant professor at the University of California in Berkeley. The Susskinds have two children—Pamela, 3, and Peter, 1.

Julius S. Bendat, MS, is now with the technical staff, Control Systems Division, of the Ramo-Wooldridge Corporation in Los Angeles. He was formerly with Northrop Aircraft. The Bendats have two children—James, 7, and Lucinda, 3.

1949

William N. Harris is an ensign in the U. S. Navy and is currently working in Washington, D.C., in the Naval Reactors Branch of the Bureau of Ships.

Arturo Maimoni, MS, lives in Walnut Creek, Calif., and is working at the University of California's Radiation Lab in Livermore. He's married and has a son, Luis.

1951

Thorne J. Butler writes that he is interning at the University of Iowa Hospital. He's married and has a six-month old daughter.

Paul L. Armstrong joined the staff of the DuPont Electrochemicals Research Laboratory in Niagara Falls, New York, this summer.

Howard F. Mower is an organic chemist at the DuPont Experimental Station in Wilmington, Delaware.

Royal S. Foote, MS, has formed a new company called Resources Development Corporation, with offices in New York and Denver. He was formerly head of the Geophysical Exploration Branch of the AEC's Raw Materials Division.

1952

David L. Hanna reports that "after an Army stint in Korea and six months of civilian pleasure in Europe, I returned to the Anaconda Wire and Cable Company and a job in the engineering department there, as a cable engineer. I now live at Hastings-on-Hudson, New York."

1954

Lee A. Henderson is with the Army until next September as an instructor in the electronic equipment maintenance school in Massachusetts and writes that he and his wife now have a two-month-old daughter, Gail Lee.

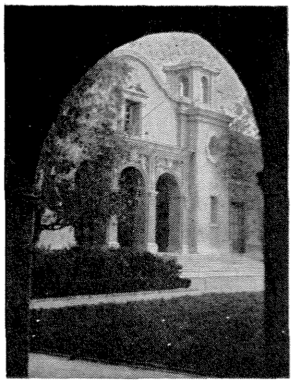
Paul Concus is now a graduate student at Harvard. Though a recent report in E & S had him working in the ground systems department at Hughes Research and Development in Culver City, this was merely a summer vacation job.

Reinaldo V. Gutierrez is stationed at Fort Monmouth, New Jersey, with the Army.

1955

John J. Merrill, a grad student in physics at Caltech, announced the arrival of his second daughter, Linda, on November 23.

Truman O. Woodruff, PhD, has been made a research associate in the metallurgy and ceramics department of the General Electric Research Laboratory in Schenectady.



CALTECH CALENDAR

January, 1956

ALUMNI CALENDAR

February 4	Dinner Dance Oakmont Country Club
April 7	Annual Alumni Seminar Day
June 6	Annual Meeting
June 23	Annual Picnic

CALTECH ATHLETIC SCHEDULE

VARSITY BASKETBALL

January 20—
Caltech at Nazarenes
January 21—
Caltech at Chapmon
January 24—
L.A. State at Coltech
January 28—
Caltech at Whittier
January 31—
LaVerne at Caltech
February 4—
Redlands at Caltech
February 7—
Nazarenes at Caltech
February 10—
Whittier at Caltech

FRIDAY EVENING DEMONSTRATION LECTURES

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

January 20—
Accelerators for Nuclear Physics
—Dr. Robert Langmuir
January 27—
The Search for Hidden Ore
—Dr. Albert E. Engel
February 3—
An American Professor in India
—Dr. Alfred Ingersoll
February 10—
Uranium and Thorium in Southern California
—Dr. D. Foster Hewett

PHOTOGRAPHY AT WORK—No. 18 in a Kodak series

What's their credit rating?

With Photography and Air Mail working together, the Credit Clearing House of Dun & Bradstreet, Inc., speeds vast quantities of information across the country overnight.

A Southern wholesale confectioner had received an order for $10.00 worth of candy bars from the Horsie Hollow Candy Shop. It was a first order, and when the credit manager didn't find the name listed in the Reference Book, he phoned the Dun & Bradstreet office for a report on the venture.

The reporter assigned to the case located the concern on a dirt road, and he took a snapshot of the premises and its busy proprietors which inspired this illustration. He interviewed the owners and wrote a report which was forwarded to the wholesaler.

It informed him that the enterprise was operated as a partnership by two neighbors who were both "eleven years of age and unmarried"—also that "although the owners are men of limited means, they have a high standing in their community." The financial statement indicated assets of $13.25 in merchandise and cash, with a valuation of $35.00 for the building consisting of a remodeled turkey coop.

The partners were reported as experienced with a five-year record of selling lemonade and cookies with their home pantries as the principal sources of supply. There was no indebtedness as their mothers' terms were strictly C.O.D. The wholesaler took a more liberal attitude and shipped on regular terms. The bill was paid in ten days, and the wholesaler opened an account in his ledger for the "Horsie Hollow Candy Shop."

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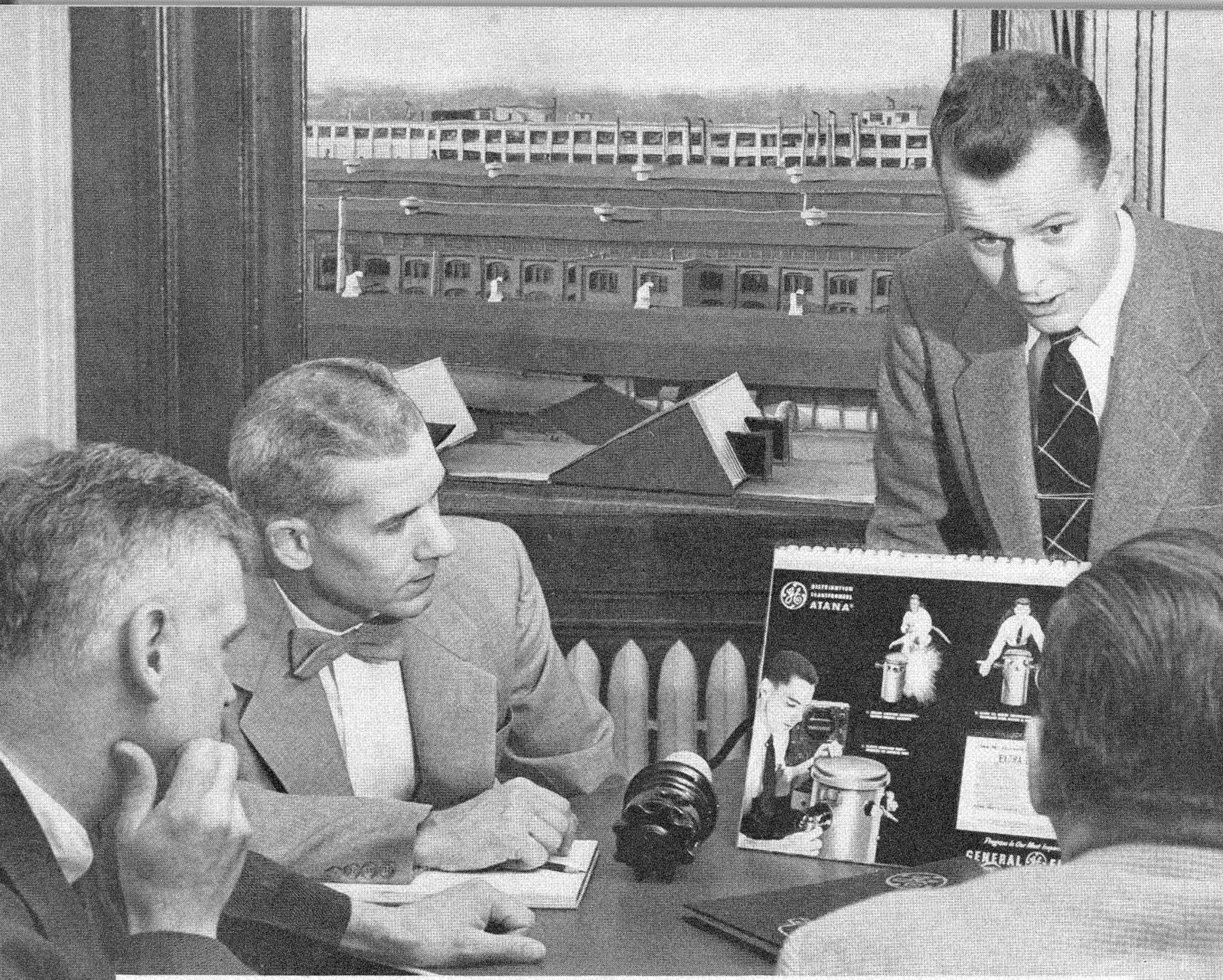

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