ENGINEERING | AND | SCIENCE

APRIL/1957

The next hundred years . . . page 19

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

General Motors wants Good Men

THIS IS ABOUT the time of year when engineering seniors sit down to some serious thinking about their futures.

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ENGINEERING AND SCIENCE

IN THIS ISSUE

ON THE COVER, reading from left to right, are James Bonner, professor of biology; Harrison Brown, professor of geochemistry; and John Weir, associate professor of psychology at Caltech. They are joint authors of a new book, *The Next Hundred Years*, to be published in June by The Viking Press.

The book had its origin in a series of conferences set up last year by Robert V. Bartz, then executive director of Caltech's Industrial Associates. For almost a year, Professors Brown, Bonner, and Weir had conferences with representatives of 33 companies and corporations affiliated with the Institute's Industrial Associates program, to present their forecast of future prospects in mineral, energy, food, and manpower resources. Their forthcoming book is one of the results of these highly successful conferences.

The article on page 19 is the first of a three-part extract from the book which we will be running in our April, May and June issues.

JAMES C. DAVIES' stimulating article, "New Cars and New Politics," on page 29, has been adapted from a talk given at the 1957 Alumni Seminar.

PICTURE CREDITS

Cover	Martha Holmes, Time Magazine
pps. 24-27	David Groce '58
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	David Groce '58

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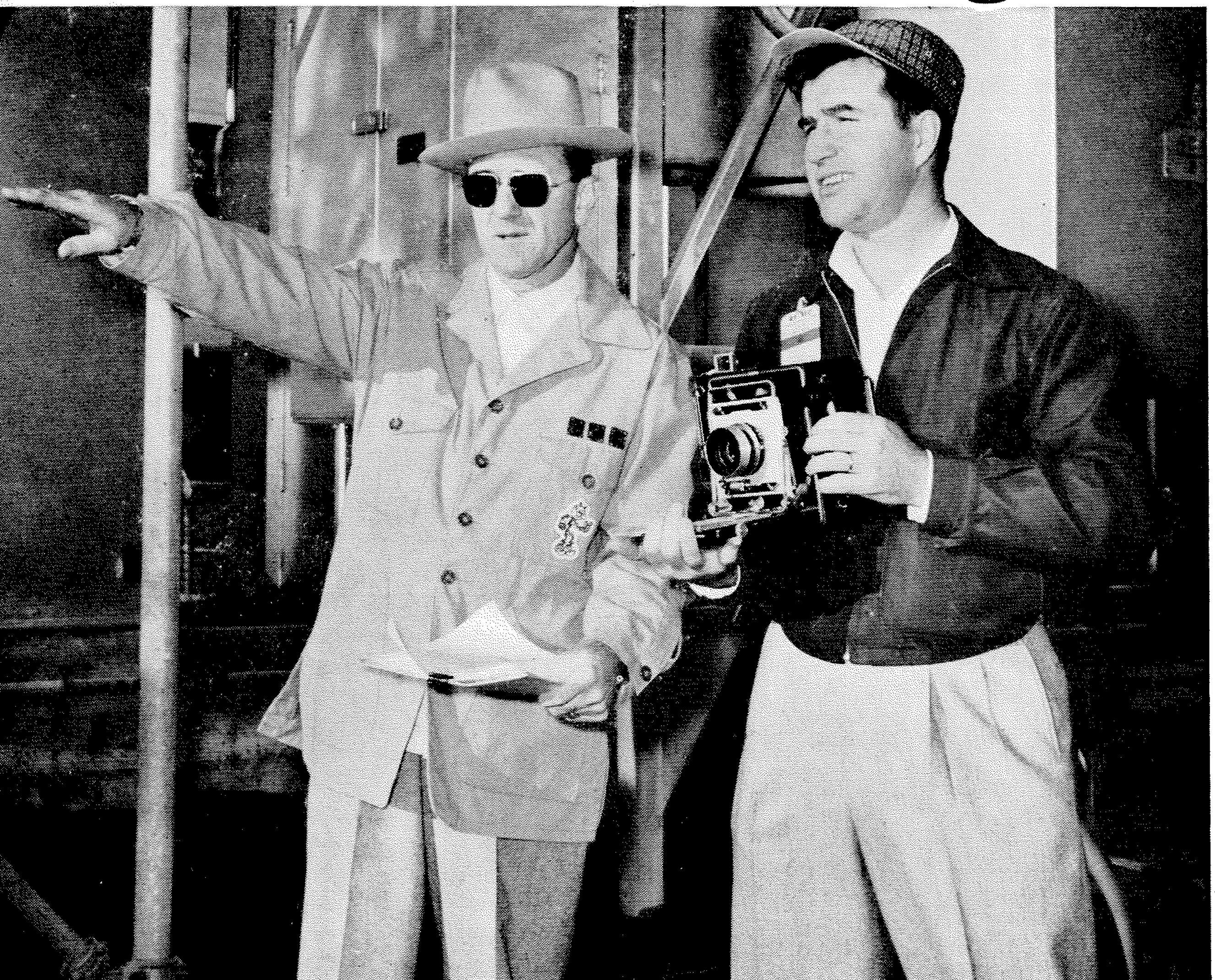
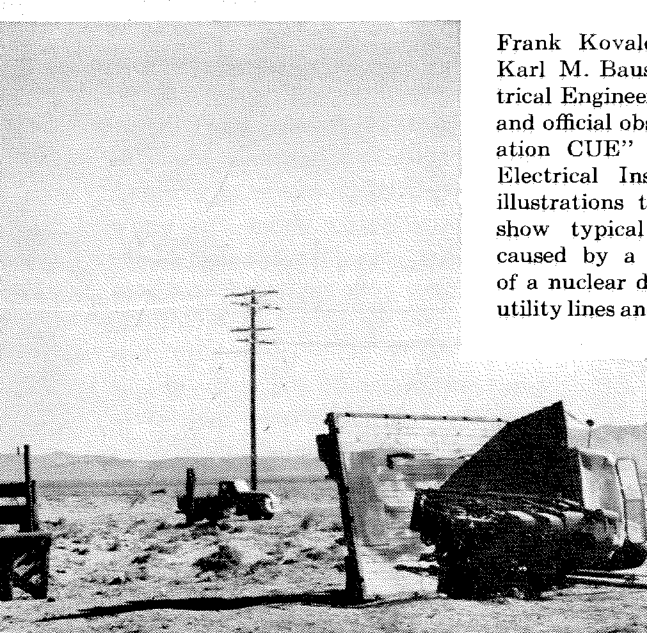
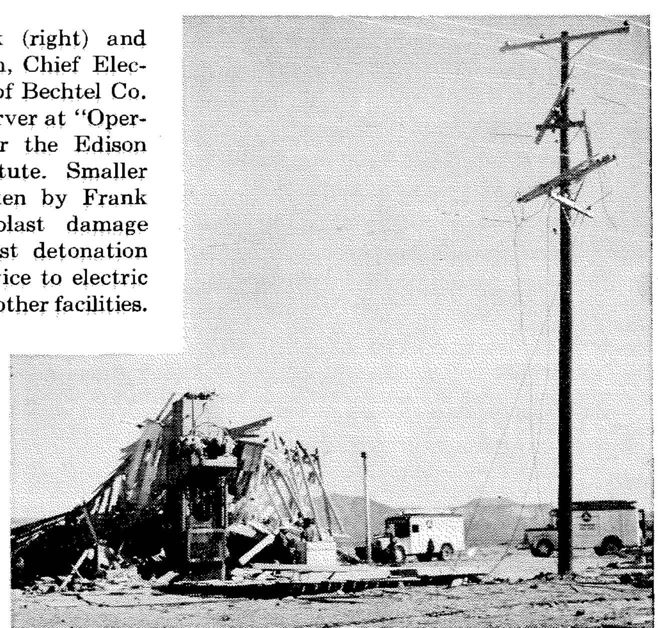
..an editor on the go





Frank Kovalcik (right) and Karl M. Bausch, Chief Electrical Engineer of Bechtel Co. and official observer at "Operation CUE" for the Edison Electrical Institute. Smaller illustrations taken by Frank show typical blast damage caused by a test detonation of a nuclear device to electric utility lines and other facilities.



BOOKS

THE EVOLUTION OF HUMAN NATURE

by C. Judson Herrick
University of Texas Press $7.50

Reviewed by R. W. Sperry
Professor of Psychobiology

THIS LARGE volume is divided into two parts, the first dealing with the biological and the second with more specific neurological factors in psychobiology. The whole is a somewhat heterogeneous discussion of diverse issues, findings, and theories relating to the nervous system, behavior, and experience, and to their evolution.

The author, who is professor emeritus of neurology at the University of Chicago, has devoted some 60 years to intensive study of the microstructure of vertebrate brains and has published well over 100 outstanding papers and monographs on his original researches, plus seven books—including his *Introduction to Neurology,* which ran to five editions, and his *Brain of the Tiger Salamander,* an unquestioned classic in the field of comparative neurology. He is probably the world's most eminent living authority on the apparatus of mind and behavior.

In this latest volume of 34 chapters in 508 pages, Herrick, who is now in his late 80's, surveys some of the more important deductions regarding the biological bases of human nature and behavior which he has drawn in the course of his long, productive career. From the beginning, Herrick's investigations of the brain have been motivated by a deep interest in the nature of mind, and his scientific publications have been intermixed, since the turn of the century, with associated articles in philosophy. Accordingly, the present book, with its epilogue on "The Unknown God," is not another elderly scientist's late fling at philosophy, but represents the matured outcome of an active life-long concern with

CONTINUED ON PAGE 10

"Take my advice...

"Before I left school I just didn't know where to look for a job in engineering that offered the greatest opportunity. First of all I wanted to make sure of getting into an industry that wasn't overcrowded... where I wouldn't be lost.

"Also, I wanted to hook up with a firm that had pioneered in its field, yet was young enough to go places and take me along with it. And, I wanted to be certain that salary would be right and there'd be a good chance of lasting security for my family.

"After looking around, I decided to get into the aircraft industry because of the bright future it offered. That's particularly true now with the development of supersonic aircraft and missiles. To my way of thinking there's no greater opportunity in engineering—anywhere!

"So take my advice...your best bet is in the aircraft industry where you can build a real career for yourself and have something worth-while to show for it the rest of your life."

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Northrop ingenuity is continually applied on new and revolutionary programs. Significant advances are being made in the important field of boundary layer control. Northrop is also world pioneer in the development of the first operational inertial and celestial guidance systems. Other vital projects include Northrop's new supersonic jet trainer plane, the T-38, and the Snark SM-62, first intercontinental guided missile for the Strategic Air Command of the U.S.A.F.

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psychophysical and correlated problems, approached from the vantage point of an intimate and perhaps unequaled working knowledge of brain organization.

The title is not strictly indicative of the content, but perhaps serves as well as any for binding together the collected theories of the author, which touch upon topics that range widely from emergent evolution, morals, and creativity, through psychomechanics and the indeterminacy principle, on down to details of cerebral structure.

Any critical reader is bound to find plenty with which to argue, especially in the first half of the book, where Herrick frequently risks judgment in fields rather remote from his specialty. In any case—right, wrong, or incomplete—Herrick's concept of the human mind and its relation to brain mechanism deserves serious consideration by anyone concerned with this paramount enigma, whether it be from the standpoint of science, religion, or philosophy.

A SCIENTIFIC SAMPLER

Raymond Stevens,
Howard F. Hamacher,
Alan A. Smith

D. Van Nostrand Company, Inc. $6

For something like 30 years the industrial research firm of Arthur D. Little, Inc., has been turning out a bright, readable, and informative monthly bulletin, which it sends out to clients and other interested parties.

The *Industrial Bulletin* is chiefly devoted to new scientific developments, but is just as likely to contain articles on anything from pumps to molasses.

This collection of almost 200 articles from the *Bulletin* provides a grab bag of miscellaneous scientific information for the edification of businessmen, laymen, scientists and engineers—and shows why the *Bulletin* has been such a well-read publication for all these years.

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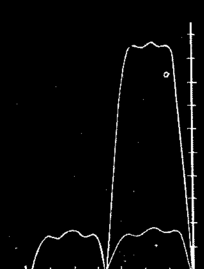

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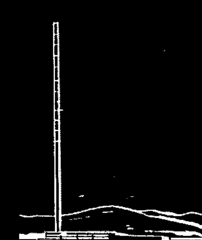
Collins supplies a complete new AM station from mike to antenna or modernizes existing facilities. Besides the superior line of transmitters, Collins supplies the broadcaster's needs with such advanced additions as TV-STL microwave relay system, the lightest 4-channel remote amplifier on the market, phasing equipment and audio consoles. Collins field service organization has built an enviable reputation in assisting the broadcaster in installation or in times of emergency.



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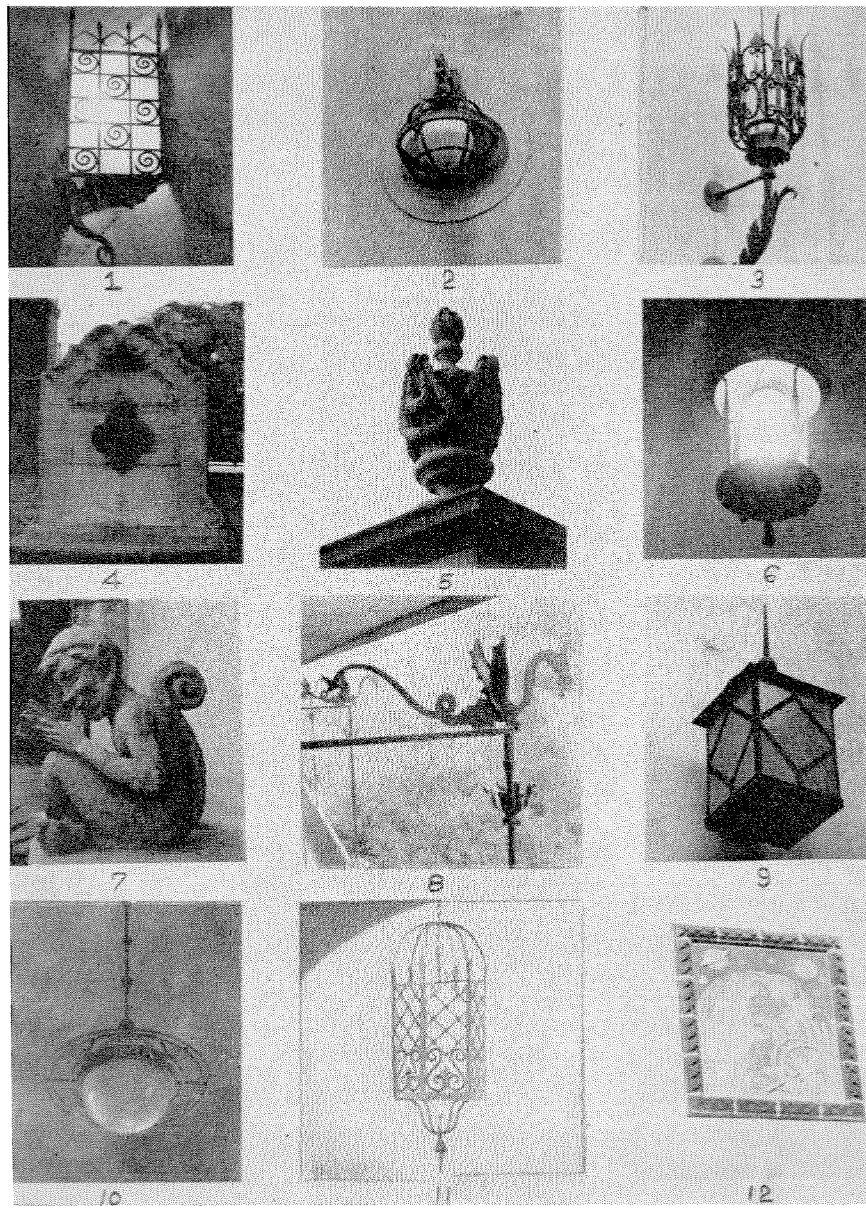
LETTERS



Where is it?

If you had any luck in identifying George Beadle's pictures of the Caltech campus which ran in the February, 1957, issue of E&S, you may want to try your hand at these puzzlers taken by Ed Bryan '54. Ed, who is now working at the Bell Labs in Whippany, New Jersey, made up this quiz while he was an undergraduate here. To date, he's never found anyone who could score higher than 3.

Answers

1. South wall of Throop Hall opposite Kellogg entrance.
2. Synchrotron archway, California Street.
3. Throop Alley entrance to Kellogg.
4. Between East Bridge and the High Voltage Lab.
5. On a pillar at the southeast corner of East Bridge, and at the southwest corner of High Volts.
6. The hall in West Bridge.
7. West balcony of Dabney House.
8. West balcony of Fleming House.
9. West entrance of Dabney House.
10. In the Mudd and Kerckhoff cupolas at the west end of the campus.
11. Above the statue of Apollo in Throop Hall.
12. Dabney House courtyard.

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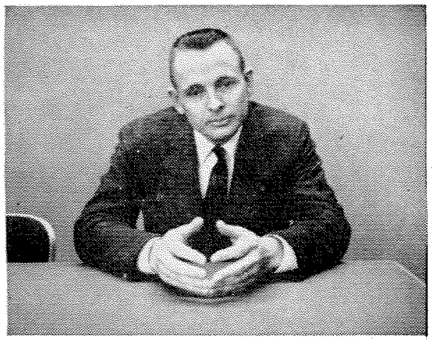
What a MATHEMATICIAN *can do at* IBM



Mathematics is an ancient but ever-advancing science that contains many forms. It shouldn't surprise you then that it took some time before John Jackson discovered the one brand of mathematics that seemed custom-tailored to his ability and temperament. John is an Applied Science Representative, working out of the IBM office at 122 East 42nd Street, N. Y. C.

First of all, what's it all about? What does a fellow like John Jackson do all day? In his own words, "I keep in touch with the executives of many different companies—advising them on the use of their IBM electronic data processing computers. I personally consult with these customers, and analyze their scientific and technical problems for solution by IBM. Occasionally, I'm asked to write papers, and give talks and demonstrations on electronic computing. All in all, it's pretty fascinating . . . something new pops up every day." In other words, John is a full-fledged computing expert, a consultant . . . and a very important person in this age of automation through electronics.

Calling on a customer

Since the IBM laboratories are always devising easier and faster ways to solve the problems of science, government, and industry, an Applied Science Representative can never say he's learned his job and that's the end of it. At least once every two months, he attends seminars to be updated on the latest developments in engineering and operations research.

Introduces new methods

During the two years that John has spent with IBM in Applied Science, he has shown innumerable customers new and better ways to do things *electronically*. For example: about a year ago, an aircraft manufacturer wanted to experiment with a radically different design for a nuclear reactor. The basic format had been established, but the project still required months of toil with mathematical equations. The aircraft people couldn't afford to wait that long, so they called in IBM. After discussion

Mapping out a computer program

with top executives, John helped to map out a computer program that saved the organization over 100 days of pencil-chewing arithmetic. Later, for this same company, John organized the establishment of computer systems for aircraft performance predictions . . . for data reduction of wind tunnel tests . . . and for wing stress analysis. At the same time, he worked with this company's own employees, training them in the use of IBM equipment. John still drops around to see that everything is running smoothly.

Another service that John performs is the constant reappraisal of each customer's IBM operation. Occasionally, a customer may tie himself in knots over a procedural "stickler." Periodically, in fact, John brings IBM customers together . . . just to talk over what's happening in each other's business—how everybody else handled that old bugaboo . . . details.

New field for Mathematicians

John is exercising his mathematical know-how in a field that was practically unheard of ten years ago. Even now, this kind of work may be news to you. It was to John Jackson a few years back when he was an undergraduate at the University of Colorado. At that time, he was considering actuarial work or mathematical research. But John liked the excitement and diversification of science and industry and he wanted to use his mathematical background. It was not until he was interviewed by IBM that field computing whetted his scientific appetite. A few months later, John launched his own IBM career as an Applied Science trainee.

Promotionwise, John has come a long way since then. He's now an Applied Science Representative in one of the biggest offices in the IBM organization ... mid-town Manhattan.

Discussing a problem with colleagues

With his wife, Katherine, and daughter, Lisa, 20 months, and John, Jr., 6 weeks, he enjoys his suburban Port Washington home. He's happy and he's satisfied. And then, too, John knows a few vital statistics about IBM . . . such as the fact that the Applied Science Division has quadrupled during the past three years, and that in 1956 alone, over 70 promotions were conferred. If ever a future held promise, here is one.

• • •

Equally challenging opportunities exist for experienced engineers and scientists in all of IBM's many divisions across the country. For details, write P. H. Bradley, Room 8704, IBM Corp., 590 Madison Ave., New York 22, N. Y.

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Brown, Bonner, and Weir

THE NEXT HUNDRED YEARS

by HARRISON BROWN, JAMES BONNER AND JOHN WEIR

This article has been extracted from the book, The Next Hundred Years: Man's Natural and Technological Resources, *by Harrison Brown, James Bonner and John Weir, copyright 1957 by The Viking Press, Inc., to be published in June. Dr. Brown is professor of geochemistry at Caltech; Dr. Bonner, professor of biology; Dr. Weir, professor of psychology.*

This extract, the first in a series of three, has been drawn largely from Dr. Brown's evaluation of our mineral and energy resources. Next month, Dr. Bonner reports on agricultural resources. In June, Dr. Weir discusses technical manpower sources.

DURING THE LAST 300 years man has achieved a degree of power over his environment which is unprecedented in the thousands of years of human history which preceded them and in the hundreds of thousands of years of human prehistory. Our rate of material progress and our rate of growth seem to be steadily accelerating, and one cannot help asking, for how long can this acceleration and this growth continue?

What is the future of our industrial civilization likely to be? Can we foresee the major problems that will confront us? Are these problems soluble? What kind of society could our science and our technology help us to create in a world at peace?

In this study we would like to take what we call "the long view" and attempt to make an assessment of the future of our scientific-technological-industrial civilization.

The reader should keep in mind that we are in . . . a period of rapid transition from a culture which has been predominantly agrarian to one which is predominantly industrial . . . Had we made a forecast at almost any time in the past, or perhaps were we writing at practically any time in the future, our chances of being correct would be considerably greater than they are today . . .

The transition from a culture which is primarily agrarian to one which is primarily urban-industrial, has proceeded unevenly in different parts of the world and brought with it no little confusion. The closest parallel in the past course of human existence is the transition from a food-gathering to an agrarian culture which took place some seven thousand years ago. . .

The contrasts which then existed between the wealthy agricultural minority and the poverty-stricken food-gathering majority are paralleled today by the contrasts between the wealthy industrialized minority and the poverty-stricken agricultural majority. Then the techniques of agriculture spread from one region to another, eventually to become world-wide. Today the techniques of industry are spreading from region to region, and it seems likely that, barring a world catastrophe, they too will become world-wide.

The spread of the agricultural revolution reached its eventual limit as the world's arable land became settled. As agriculture requires land, so industry requires huge quantities of raw materials—ores of iron, copper, aluminum, and a variety of other metals; quantities of non-metals such as sulphur, phosphate rock, and water; adequate sources of energy such as coal, petroleum, and water-power. To what degree can we expect the longevity of industrial civilization and the extent to which it spreads to be limited by the availability of these raw materials?

Raw materials

The factors which will determine the future supply of and demand for raw materials are numerous. In attempting to assess them, we can divide the broad question into several component parts. First we must inquire into the increasing per capita demands for raw materials in highly industrialized societies. Within the United States, for example, these have increased steadily during the course of the last century. With each new year more raw materials are required to support an individual within our society than were required the year before. For how long a time can we expect this trend to continue? Is there any foreseeable limit to the per capita requirements for raw materials within a highly industrialized society?

The second factor concerns the rate of spread of industrial civilization. During the course of the last three hundred years we have seen industrialization emerge in Western Europe and jump the Atlantic Ocean to the United States. More recently it has come to dominate Japan and the Soviet Union. Today we hear rumblings of impending industrialization in India, in China, in parts of Africa and in parts of South America. How quickly can we expect this process to take place? How rapidly can we expect the per capita demands for raw material in these at present underdeveloped areas to increase? And as they increase, are there sufficient raw materials in the world to satisfy, in such areas as India and China, demands which approach even remotely those which are now characteristic of the nations of the West?

Third, we must ask how large the population of human beings in the world is likely to become. Knowing the per capita demands for raw materials in the various regions of the world, by how many people must we multiply in order to determine the total drain upon the earth's resources? In order to determine this we must assess the number of people that we can feed.

The fourth factor is concerned with the amounts of raw materials available to man. What is a usable raw material? Certainly during the course of the last few decades we have seen our concepts changed drastically. We have seen that as industrialization spreads throughout the world the demands for raw materials will become enormous, and indeed will dwarf existing demands. As demands increase and as the world's high-grade resources are consumed, it will become necessary for us to process materials of lower grade, making our demand for raw materials increase still further as a result of the fact that more equipment, more energy, and more technology will be required for the processing.

What, if any, are the limits to the grades of ores which can be processed? Is it possible for the trend toward lower-and-lower-grade materials to be continued indefinitely? Or is there some limit of concentration below which processing will become impossible? Since the beginning of the present century the average grade of copper ore in use has dropped to one-sixth the concentration formerly processed—that is, to about 0.8 percent copper. Can we look toward the possibility of processing ores which contain as little as 0.1 percent, or perhaps as little as 0.01 percent copper?

When we examine this problem from the technological point of view, we see that fundamentally there is no lower limit to the grade of an ore which can be processed . . . If at some future time the average concentration of copper in copper ore were to drop to 0.01 percent, and if there were still an acute need for copper, there would be little question but that the metal could be extracted in high yield. To make this possible, two criteria must, however, be fulfilled. First, a satisfactory process must be developed—which means that scientists and engineers must work on the problem in the laboratory and in the pilot plant and conceive, develop, and test various methods for achieving the desired result. Second, energy must be available for the processing—for the mining and transport of vast quantities of ore, for the manufacture of the huge quantities of equipment which must be used in the processing and as a driving force in the process itself.

Potential resources

If we are given adequate supplies of energy, almost any material in the earth's crust can be looked upon as a potential resource . . . The ultimate resources of energy which are available to man are enormous—and indeed are sufficient to power a highly industrialized world for literally millions of years. This means that, given adequate brainpower, there is little doubt that the trend which has led us to process ores of steadily decreasing grade can continue until we reach the point where we are processing the very rocks of which the earth's crust is made.

If the energy consumption of the world were to increase no further, mankind could probably maintain its present level of productivity for an indefinitely long period of time—even after resources of fossil fuels had disappeared—simply by developing all potential water-power resources and by harvesting all the world's forests on a sustained-yield basis. But if rates of energy consumption continue to accelerate, and reach the levels we have seen to be probable, and if these rates are maintained beyond the time when our supplies of petroleum and coal are exhausted, it will be necessary for man to make use of new, less conventional sources of energy.

When we survey the energy sources which are potentially available, we find that forms such as earth heat, winds, and tides can be, at best, of limited usefulness. There are a few localities where such sources are being tapped today, and there are others where they might be tapped economically in the future. But when we assess the total energy output which might eventually be developed economically from such sources it turns out to be very small, compared to eventual world-wide demand.

Indeed, from a long-range point of view it is apparent that we must eventually depend more and more upon solar energy and nuclear energy. We now know that from the technological point of view both of these can be utilized. The question as to which will be most widely used is a question of economics. Which will require the least capital investment per unit of output? Which will have the lowest operating cost? On the basis of what we now know about the technologies of utilizing these two forms of energy it appears that, for the generation of mechanical power and electricity, nuclear energy will probably be less expensive than solar by a considerable margin.

Solar energy

A number of systems have been devised for transforming solar heat into electricity, but the capital costs per units of capacity have in all cases been extremely high. In hot regions the sun's energy might be used essentially to replace fossil fuels for the heating of water in an electrical generation plant. In order to accomplish this, the sun's rays are captured by special flat-plate collectors. Capital costs might run to $20,000 per acre; and the resultant power, depending upon the efficiency of the system, might cost several cents per kilowatt-hour, compared with prevailing costs of generating electricity, of a few mills per kilowatt-hour.

We also know that electricity can be generated by allowing the sun's radiation to fall upon semi-conductors. This phenomenon is now being put to good use in the Bell "solar battery," which can be used to generate electricity for a variety of small-scale uses. The large-scale use of this method would, however, involve prohibitively high capital costs. Other systems for the direct conversion of solar energy into electricity present the same difficulty.

One of the most efficient and least expensive means of producing mechanical and electrical energy from solar energy is to grow trees in the sun, to harvest the wood, and then to burn the wood in the firebox of a boiler. Or one can ferment sugar, which can be obtained in high yield per acre by growing cane or sugar beets, and thus obtain alcohol or a variety of combustible gases and liquids which can be used for generating power. But in view of the pressure on the world's agriculture to produce food and the probability that the food shortage will continue for a considerable time in the future, it is unlikely that much potential agricultural land will be diverted to the production of fuels.

Power from algae

An ingenious system has recently been described for the production of power from algae grown in a closed system containing a high concentration of carbon dioxide. The algae are cultured and then fermented in such a way that methane and hydrogen are produced. These gases are burned in a gas turbine or engine which is used to generate electricity. The carbon dioxide which results from the combustion is returned to the algae culture unit. In this way, under ideal conditions, one would have a closed system which would convert between 1 percent and 3 percent of the incident solar energy into electricity. It has been estimated that a system of this general type could be used to produce electricity at a cost of 2.5 to 5 cents per kilowatt hour, and liquid fuels at a cost of about $150 per ton.

Although it is doubtful that solar energy can compete with nuclear energy for the large-scale generation of power, there are areas where it will probably turn out to be very useful on a smaller scale. We have already mentioned the solar battery. Solar water heaters are coming into widespread use in tropical regions. An inexpensive solar cooker has been devised in the National Physical Laboratory in India; this could, if widely used, bring about the savings of substantial quantities of fuel. At the same laboratory a solar pump has been devised which could be used for pumping water on a small scale in isolated regions where fuels are not available.

It is likely that the most important use for solar energy in the future, however, will be for space heating. We now know that houses can be designed in such a way that requirements for space heating could be met almost entirely by solar energy in populated regions of the world as far north as Boston. The additional capital costs which would be required in house construction do not permit these techniques to be used widely at the present time. But as the prices of conventional fuels increase we will probably approach the time when most buildings will be designed to make maximum use of solar heat.

It is now reasonably certain that electricity can eventually be produced from nuclear energy at costs which are less than 1 cent (10 mills) per killowatt-hour. How much lower than 10 mills the cost can become, and how rapidly, are matters for conjecture. At the International Conference on the Peaceful Uses of Atomic Energy, which was held in Geneva in 1955, estimates as low as 4 mills per kilowatt-hour were given. Forecasts of the eventual nuclear-power-generating costs in the United States range from 4 to somewhat over 6 mills per kilowatt-hour. Sapir and Van Hyning, in their study on the outlook for nuclear power in Japan, have reviewed the evidence and made the reasonable assumption that we might have available 10-mill nuclear power by the mid-1960s, 7-mill power by the mid-1970s, with the cost gradually approaching 5 mills per kilowatt-hour. These estimates can be compared with generating costs of between 6 and 7 mills per killowatt-hour for new coal-fired units in the United States and about 18 mills for similar plants in Japan.

Nuclear electricity

It is likely, then, that nuclear electricity will compete with that generated from coal in the not too distant future. And it seems clear that this competition will take place unevenly throughout the world.

On a per capita basis the United States has the largest coal reserves in the world, with the result that we are not likely to encounter a fuel shortage for many decades. Our coal seams, however, are not uniformly distributed through the nation, and fuel costs increase as one moves away from the available supply. A number of areas which are far removed from coal fields—for example, southern California—are at present able to generate power at reasonable prices from petroleum or natural gas. There are other areas, however, where both coal and petroleum are expensive and where power costs are, as a result, considerably higher than the national average. It is in these areas that nuclear power might be expected to play its first major role in the United States.

If, as seems quite possible, we pass through a peak of domestic petroleum production by about 1970, nuclear power may well become important in those areas, such as the Far West, which lack coal but which at present have ready access to adequate supplies of petroleum or natural gas. After 1970 or 1975 the domestic importance of nuclear power may well increase rather rapidly. If, as seems possible, we pass through the peak of world petroleum production in about 1990, demand for coal will increase sharply and nuclear energy will probably be able to compete economically on a fairly broad front. But the production costs of coal in the United States are so low that it seems likely that it will remain our major fuel for a very long time.

The situation in the greater part of the world differs considerably from that in the United States, largely because of the substantial differences in fuel costs which prevail. In the United States we are able to generate steam electric power at coal costs which average about $6 per ton. In Western Europe, by contrast, the cost ranges from $13 to $20 per ton. Coal averages about $20 per ton in the United Kingdom. Western Europe is paying $20 per ton at the dock for large quantities of American coal. When we take into account the fact that more than 50 percent of the cost of generating electricity can be fuel cost, we can realize that nuclear electricity can probably compete with coal-generated electricity in other parts of the world long before it is competitive on a really broad base in the United States.

When we couple the fuel cost differential with two additional factors, the differences between the situation in the United States and that in other countries becomes even more dramatic. The first consideration is that of foreign exchange. Those regions of the world which must look forward to continued heavy imports of fossil fuels, and which face balance-of-payment difficulties, may well prefer to generate nuclear power, even when it is more expensive than power generated from conventional sources, if by so doing they minimize the drain upon their domestic financial resources.

The second major factor involves the striving on the part of most nations for economic self-sufficiency. Supplies of petroleum are uncertain. A very large fraction of the world's potential oil reserves are in the Middle East, where they are sensitive to the status of international relationships. Many nations will prefer an assured supply of nuclear power at relatively high but decreasing prices to less expensive but uncertain supplies of crude oil at prices which are destined to continue increasing.

The Soviet Union appears to be a rather special case with respect to nuclear-energy needs. Although she has vast coal resources, most of the coal lies in Siberia, while in the European part of the country there is a fuel shortage. Each year, apparently, nearly 15 million tons of coal are shipped from Karaganda and Kazakhstan to European Russia—a distance of some 1500 to 2000 miles. This is one of the reasons the Soviet Government has stressed the importance of the industrialization of Siberia. And it is one of the reasons it has announced the establishment of a program to build five new nuclear-electric plants in Moscow, Leningrad, and the Urals.

Nuclear energy and the United States

It seems clear that nuclear energy can play a major role in many regions of the world—particularly in Europe, South America, Southeast Asia, and Japan—just as soon as reactors are developed capable of producing power at costs of 10 mills per kilowatt-hour, or less. It is ironical that the United States, possessor of what is probably the world's most highly developed nuclear technology, has at the moment the least need for nuclear power, except for specialized military purposes. And the prospects are that, while our need will grow, it will grow considerably more slowly than will the needs of many other nations.

On the basis of the preceding discussion, let us now map out a possible but reasonable pattern of world energy consumption for the next century. Barring a world catastrophe, and assuming that industrialization will spread throughout the world, that population will continue to grow, and that we shall have adequate brainpower to solve our prodigious technical problems as they arise, total energy consumption will continue to rise rapidly following the law of compound interest. During the next ten to twenty years consumption of petroleum will probably increase more rapidly than will the consumption of coal, but at about 1975 the rate of increase is likely to slacken, so that the total rate of consumption will pass through a broad peak late in this century.

As the petroleum supplies diminish, increasing emphasis will be placed upon the production of liquid fuels from shales, tar sands, and coal hydrogenation. After about 1975 it seems likely that the gap between coal and petroleum as primary sources of energy will widen rather rapidly.

After about 1980 nuclear energy should represent a significant proportion of world power production, primarily as a replacement for fossil fuels in electrical power production. Its use should spread rather rapidly. By the end of the century nuclear energy may account for about one-third of our total energy consumption. During this period demand for coal will continue to increase, largely because of the continually increasing demand for liquid fuels and for a variety of complex chemicals. By the middle of the next century it seems likely that most of our energy needs will be satisfied by nuclear energy, with coal reserved almost entirely for the production of liquid fuels and chemicals.

Uranium and thorium supplies

We must now ask how long we can expect the earth's supplies of uranium and thorium to power an industrial world. These elements, like coal and petroleum, are fossil fuels; they were made when the elements were formed, and they are not being made at the present time. The quantities of uranium and thorium which are available to us are, then, finite. Nevertheless, the energy available to man in the form of uranium and thorium is enormously greater than the energy contained in our reserves of coal and petroleum. This is because uranium and thorium are found in low but significant quantities in the common rocks of the earth's crust.

An average piece of granite contains only about 4 parts per million of uranium and about 12 parts per million of thorium. These are indeed small quantities, yet the uranium and thorium in 1 ton of average granite contains energy equivalent to about 50 tons of coal. Of course, not all this energy is available, as the process of extracting the elements from the rock necessitates a substantial energy expenditure. Energy is consumed in quarrying, crushing, and grinding the rock, in transporting the rock to the chemical plant, in making the chemicals which are used in processing, and in the manufacture of the processing equipment. Clearly, if the energy required to extract the uranium and thorium were as great as the energy content of the extracted material, there would be no profit.

It has been found, however, that about one-third of the uranium and thorium is localized within the rock in such a way that it can be extracted with very little expenditure of energy. Thus, from 1 ton of ordinary granite, energy which is equivalent to about 15 tons of coal can be economically extracted. This means that from the long-range point of view man need not be confined to high-grade uranium and thorium ores for his energy. He will be able, if need be, to extract his energy needs from the very rocks of the earth's crust. And, as we saw earlier, the same rocks can supply the variety of metals which are necessary for the perpetuation of a highly industrialized civilization.

Power from thermonuclear reactions

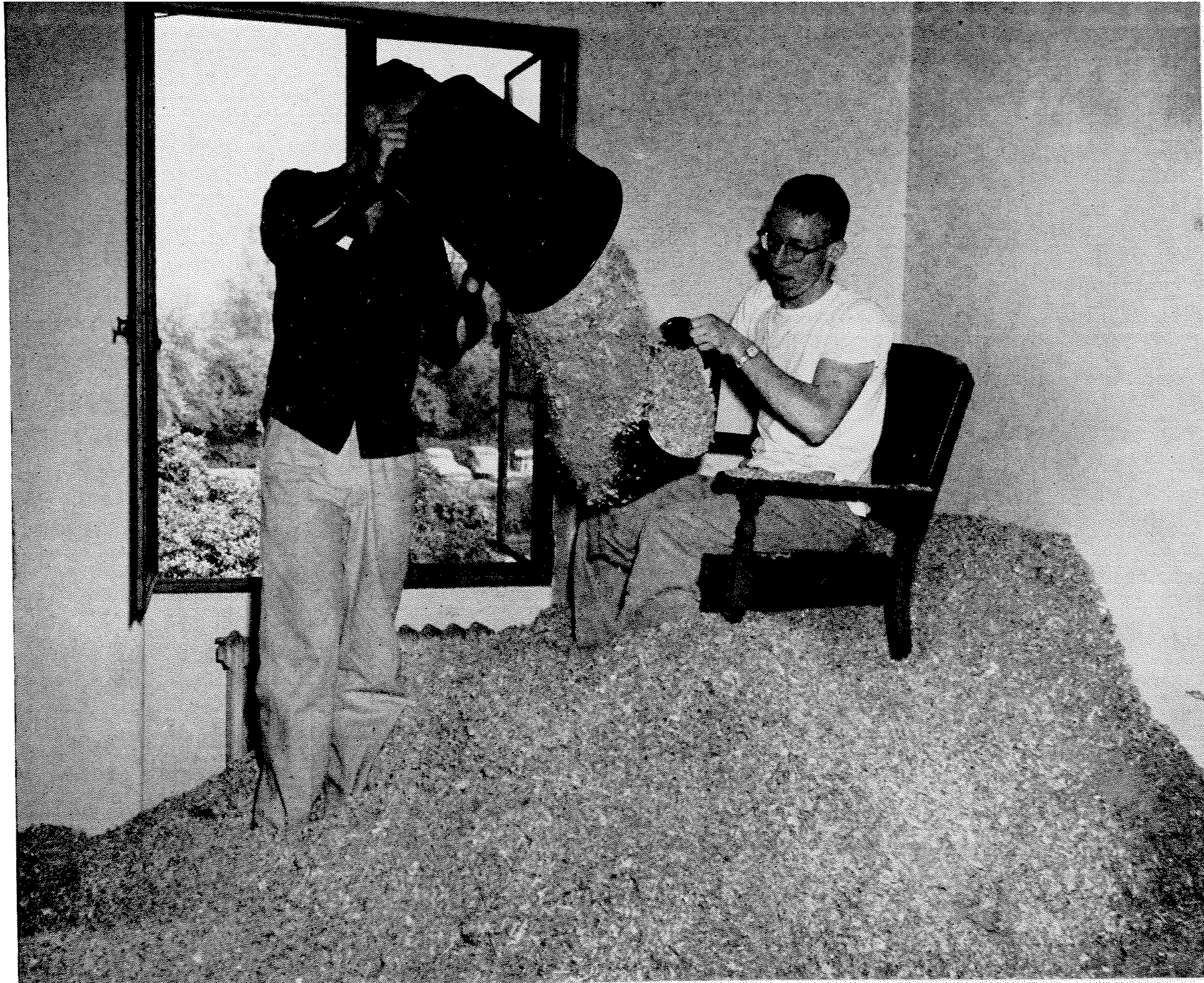
There is, in the long run, the possibility of producing power from thermonuclear reactions—from fusion of hydrogen as distinct from fission of uranium. No one as yet sees very clearly just how this is to be done, but it is nevertheless a very real possibility. If the technical problems are solved, the waters of the seas will be available to man as an almost infinite source of energy. This new energy may well be more expensive than that obtained from uranium fission. Nevertheless it may well be available for tapping when it is needed, at some distant time.

It is interesting to speculate about the pattern of energy consumption in a highly industrialized world, a world in the distant future when all fossil fuels have been consumed. Let us assume that human beings learn to regulate their numbers and that the population of the world is eventually stabilized at about 7 billion persons. Let us assume further that energy requirements amount to the equivalent of 10 tons of coal per person. This would be larger than the present per capita consumption of energy in the United States. But it should be emphasized that the per capita flow of goods would be considerably less than at present, for the reason that all goods would be more expensive, in terms of energy needed to produce them, than they are today. The total energy requirements for this society would amount to the equivalent of 70 billion tons of coal annually. We can assume that by then solar energy is being used, wherever possible, for space heating. We can assume further that all potential hydroelectric sources have been developed and that the world's forests are developed and harvested on a self-sustaining basis. Under these circumstances about 65 percent of the total energy needs would be satisfied by nuclear energy.

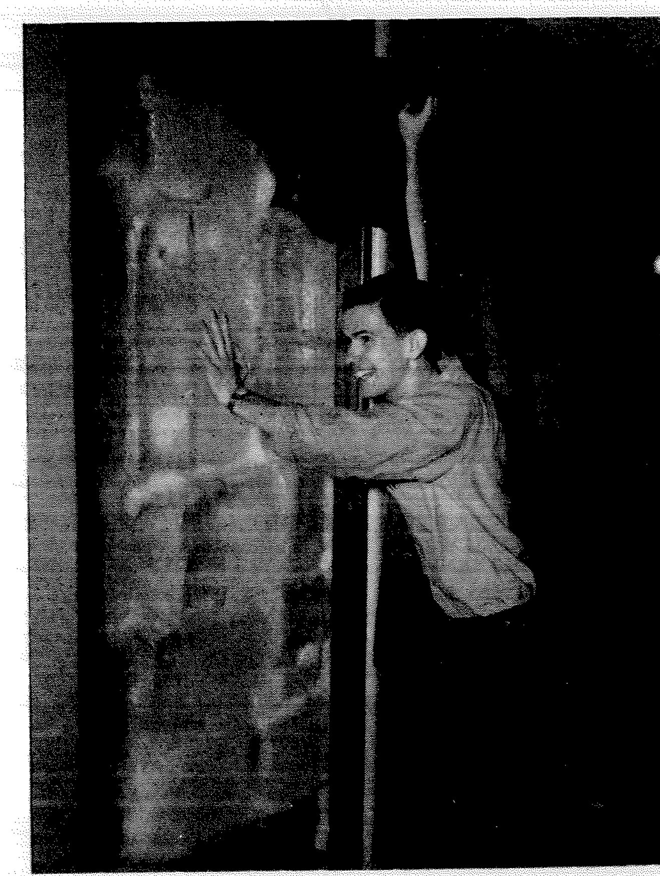
In conclusion, it seems clear that man has available potential supplies of energy which are sufficient to satisfy his needs for a very long time. However, these sources have yet to be transformed from potential supplies into actual ones. Before they can be used they must be developed. Whether or not man will be able to develop them in time is a very real question, the answer to which will be determined, in the long run, by many factors of a political, economic, and social nature.

THE SILLY SEASON

The silly season was under way this year by the end of second term, when the sign above appeared on the campus at exam-time. In full flower by March, the season was thoroughly blasted in early April, when Senior Ditch Day arrived, ahead of its time. While the seniors enjoyed their traditional day at the beach, lower classmen wreaked the traditional havoc on seniors' rooms. The presence of Life Magazine photographers on the campus this year did nothing to calm the fun-loving students. Mute (fortunately) evidence of their awful energy and ingenuity may be found on the following pages.

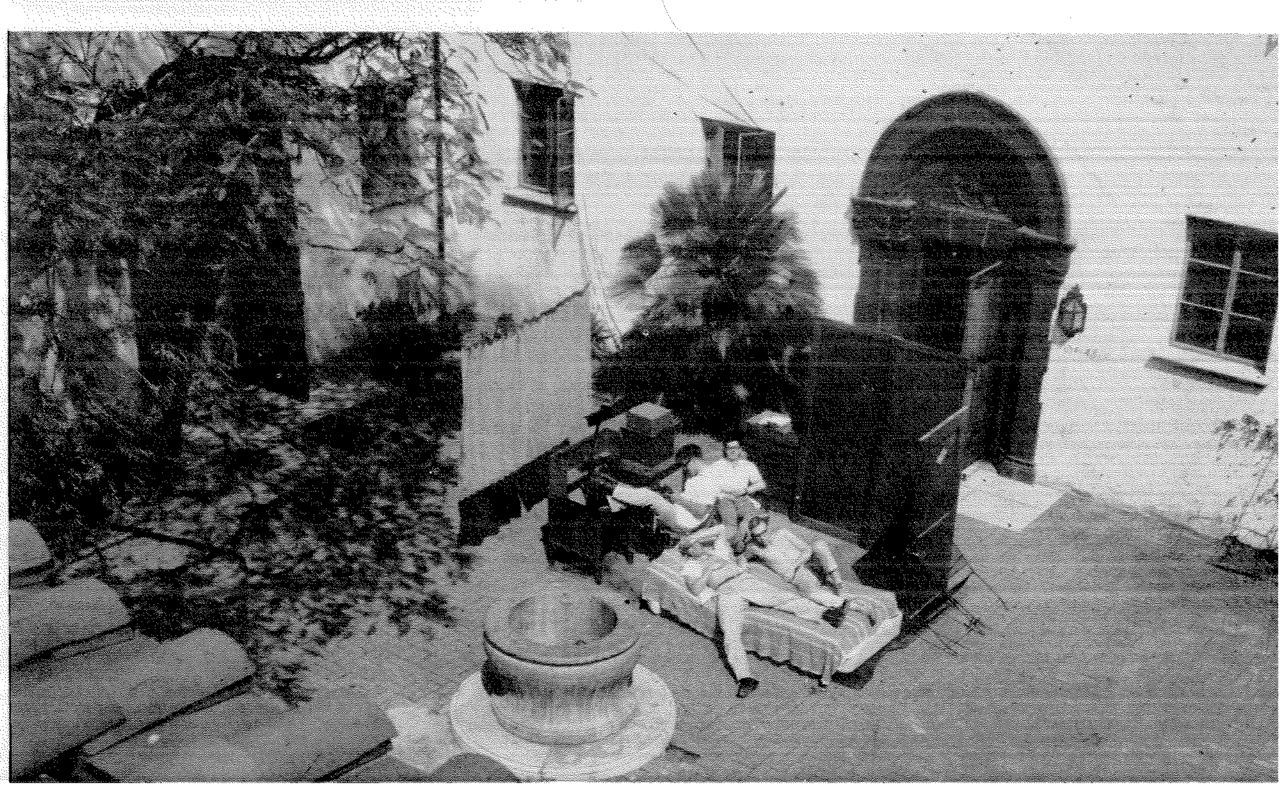


These industrious undergraduates are stuffing a senior's room with sawdust.

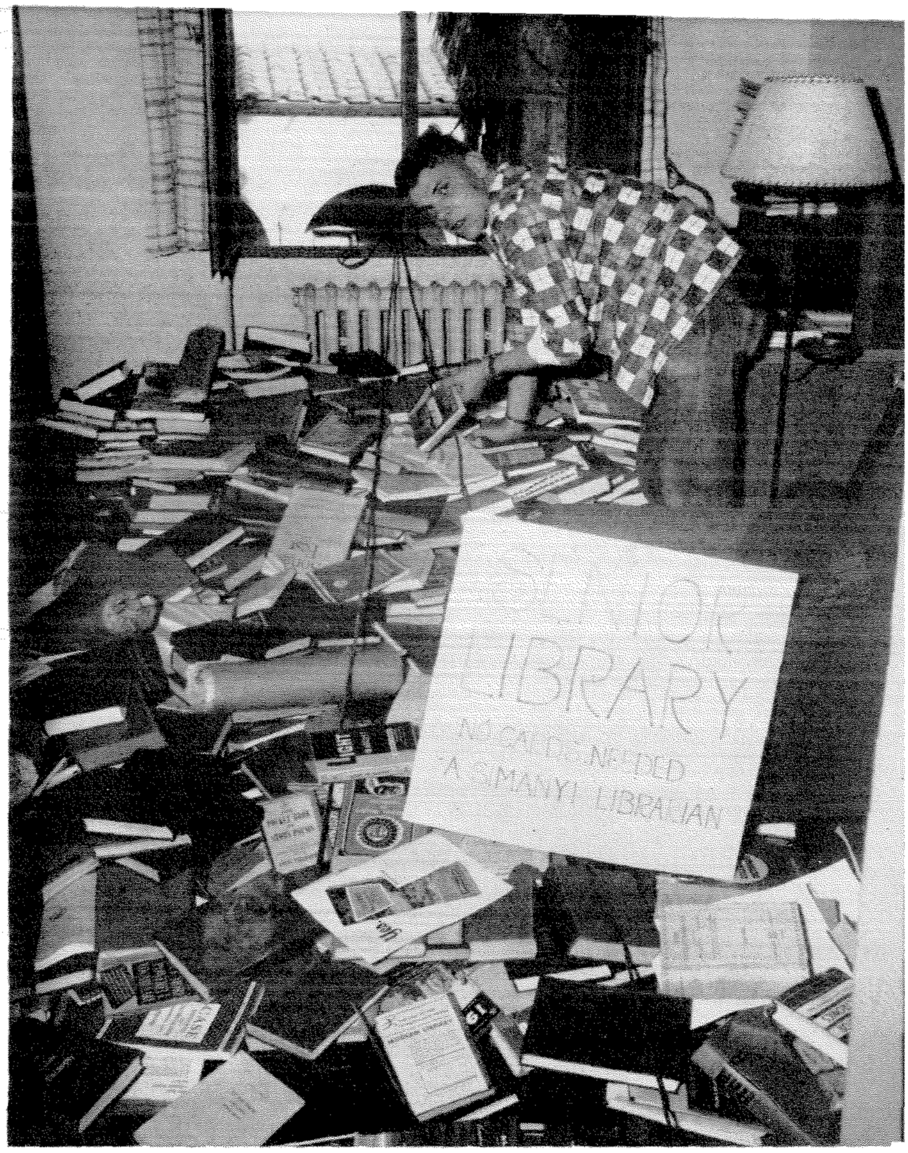


Some hapless senior had to breach this solid wall of ice after he returned from a carefree day at the beach.

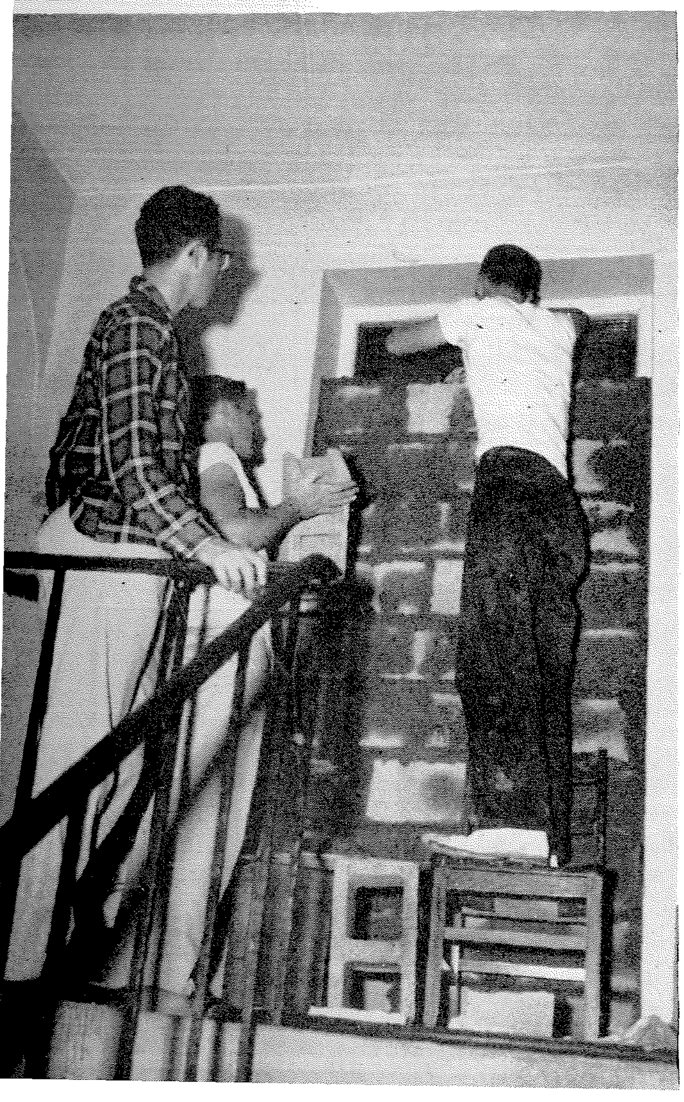
Many returning seniors found their rooms relocated. Some were nicely set up in the student house courtyards (below)—while some were in more precarious locations (left).



Culturally-inclined residents of Dabney House established a communal senior library in Attila Simanyi's room.



Cement blocks wall up one senior doorway (below), while a skeleton, awaiting a returning senior, passes the time at cards with a lower classman (right, below).



THE MONTH AT CALTECH

Gifts and Grants

CALTECH'S BOARD OF TRUSTEES reports that the Institute received a total of $1,050,000 in gifts and grants during the three months ending March 31, 1957. In all there were 91 donors, including corporations, foundations, individuals and government agencies. Of the total amount, $116,000 was for endowment, $494,000 for plant and building purposes, and $440,000 for current operations.

The major gift added to the principal of the endowment fund was $95,600 from the Marguerite Stokvis estate. Major additions to the plant and building funds were $386,250 from the Winnett Trust Foundation for radio astronomy and student facilities, $85,000 from the United States Public Health Service for chemical biology facilities, and $21,600 from Mrs. Archibald B. Young for the new student health center.

Of the gifts for current operations, $132,675 came to the Institute as "unrestricted money," to be used at the discretion of the administration and trustees. The largest bloc of such funds ($103,000) was given by Caltech's Industrial Associates.

JPL Contract

CALTECH and the Army signed a new $21,000,000 contract last month for the Institute to continue operation of the Jet Propulsion Laboratory during 1957. This was the largest annual contract ever awarded by the Army for work at JPL. It calls for engineering research and development in the fields of guided missiles, free rockets, wind tunnel operations, and materials research.

The new contract brings to $115,000,000 the total sum of Army Ordnance contracts awarded to Caltech for guided missile research. An additional $6,000,000 award is expected later this year.

JPL was the first government-sponsored research group in the United States devoted to rocket work. It originated the first successful jet-assisted take-off units in this country; designed and tested the first two-stage rocket, the Bumper Wac; and developed the first long-range supersonic guided missile, the Corporal.

JPL is now in need of more space, incidentally, and the Army is currently trying to acquire 125 acres of foothill property immediately back and to the west of the present laboratory site.

New Executive Director

CHESTER M. MCCLOSKEY, who has been chief scientist of the Office of Naval Research in Pasadena since 1955, is the new executive director of Caltech's Industrial Associates. He succeeds Robert V. Bartz, who has taken position with the Institute for Defense Analyses i Washington, D. C.

Dr. McCloskey comes to his new position with broa experience in both industry and science. While with th Office of Naval Research, he worked closely with ac ministrative and research people in aircraft, oil, chem ical and engineering firms. A chemist by training, he ha done extensive research on carbohydrates, vinyl poly merization and propellants. He served as chief chemist of Alexander Kerr & Company in 1946 and 1947 and was a chemist on the staff of the O.N.R. in Pasadena from 1948 through 1954.

Dr. McCloskey was graduated from Whittier College in 1940. He received his MS in organic chemistry at the State University of Iowa in 1942 and his PhD there in 1944. He did postdoctorate research in chemistry at Caltech in 1945, and since 1953 has been a research fellow on the Caltech staff. He will now serve as a senior research fellow in addition to his duties as executive director of the Industrial Associates.

NEW CARS AND NEW POLITICS

An examination of the mood and aspirations of the American people in facing up to — and evading — the political problems of our time

by JAMES C. DAVIES

PUBLIC OPINION—the sentiments and views of ordinary citizens on politics—has always been a significant factor in making public policy, even in old monarchies and modern dictatorships. But with the increase in political participation among all segments of society, the range of free action of public officials in a democracy has become somewhat narrower than in the days before universal suffrage, mass-circulation newspapers, radio and television.

In the past few years public opinion has created certain new limits. I'd like to discuss these limits in the light of public problems which, by and large, have been created by forces beyond the control of people and politicians in this country. In discussing this, I am concerned not with what Americans think about Eden, Nasser, or Nehru, but rather with the mood and aspirations of our people in facing up to and evading the political problems of our time. For it is the mood or basic attitude—the deep-seated tendency to react in particular ways to external events—which has so much to do with the kind of officials we elect and the kind of policy they can carry out.

Let me begin an appraisal of American opinion with a comment on some Caltech opinion I have been gathering among undergraduates since the fall of 1953. I ask each person at the beginning of a course to fill out a questionnaire which contains a series of personal questions, including one as to what he wants of life in terms of occupation, income, and other things. The most characteristic response expresses the desire to have a congenial and secure job, a good income, and a well-adjusted married life, with a house more or less full of kids.

The accent is on serenity, lack of trouble, and lack of outward direction. Even in another question, asking what the person is most worried or concerned about, the response is rarely related to distant horizons; it reveals concern about the draft or being individually atomized, rather than concern about national defense, war, or peace. The goals, the worries, the concerns tend to be private and personal.

My explanation for this privatization of worries and aspirations among the undergraduates I have known necessarily relates to American society in general. For no university is an island unto itself: it is at most peninsular in its relation to the larger community; it is washed by the same currents, basks in the same sunshine, and lives through the same stormy weather as the mainland.

In saying, then, that Caltech undergraduates are in a mood for private concerns, I am saying that this is the mood of the general public, whose mood is so closely related to the character of public policy. One aspect of the mood is good will—in the abstract towards mankind; in the semi-abstract towards strangers one sees on the streets and highways, and in TV audiences; and lastly in close relationships with one's associates at work and play.

It is the temper of people to be pleasant to each other in a way that indicates an acceptance among the general public of the value of good human relations. The man who repairs the car, the drugstore clerk, the official who handles income tax problems, all are somewhat educated to the notion of being inoffensive and gay, presenting to the customer or applicant a visage that is bright and free of troubled preoccupation, repressed anger, or frustration. And the customer himself is unusually pleasant. We all expect others, and ourselves, to present in public the mildly ecstatic happiness of life in the movies or on the TV quiz show.

Coupled with this is the sense that one must, in all things, be moderate and non-controversial. The content of current motion pictures is an extreme example. Anything that might conceivably offend any group is hard to find: Catholics, Protestants, Jews, businessmen, members of the armed forces—everyone but the clearly identifiable villains, such as individual bank

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Dr. James C. Davies, associate professor of political science at Caltech, specializes in the study of political behavior and public opinion.

robbers, sports promoters, paranoid race-baiters, psychotic Naval officers, and mad scientists—must be presented as having nothing but whimsical faults. The implication is that there can be nothing to attack in any categorical way, that there is nothing wrong with society or any social group. It is not groups of people who are at fault, but only the inexplicably deviant individual. And when the reasons for an individual's deviation are analyzed, they are apt to revolve around the oversimple notion that, either because of inheritance, or a conveniently traumatic childhood, even the villain is not really responsible for his own socially inappropriate behavior.

In public affairs, the manifestation of this temper of our times is again moderation and avoidance of anything that might rock the boat as it sails serenely over the choppy seas of prosperity and peace. On the domestic scene, the intense and sustained controversy over economic and social policy during the New Deal period has been replaced by no more than serious concern over interest rates, expansion of social security, and equitable income for farmers. The McCarthy controversy, as the apogee of the postwar skyrocketing of frustration over the inability to wipe communism from the face of the earth, probably did not end with much increased understanding of the real and external threat of Soviet imperialism and the utopian appeal of Marxist doctrine to unindustralized Asia and Africa. It ended more in the belief that we must be increasingly on our guard to avoid encouraging controversial trouble-makers who are violently pro- or anti-communist. Again, as is true of the movie makers, we avoid either individual or collective self-criticism and self-appraisal.

Private excitements

Being unable to really do without the excitement of variety and change, we look away from politics toward our personal lives for these things. And here we are furnished with many delightful new means of diverting ourselves. For 1957 we have the daring new "inner" automobile with its sculptured look. You can get there faster, more comfortably, and perhaps even more safely than ever before. What's more, if you get a new car, your discriminating taste will mark you off among strangers and neighbors as being a leader, a distinct and tolerably different person—distinct because you have a new and different car, reflecting your belief in moderate progress; tolerably different because your discrimination reflects acceptance of the basic belief that progress in America is measured in terms of improved and more abundant products of the technologically most advanced nation on earth.

At this point you very likely have made an inference either that there is something inherently pernicious about this current American mood, or at least that *I* regard these tendencies as pernicious. Nothing could be further from the truth, and nothing closer to the half-truth.

If our movies and our own actions reflect a disbelief in the merit of promoting controversy between Protestant and Catholic, military officer and enlisted man, or between scientist and non-scientist, I must say I share this disbelief. If the smile of the TV master of ceremonies is sometimes not heartfelt, and the happy tax clerk is internally seething at the cupidity and stupidity of a querulous taxpayer, I would scarcely advocate that the emcee snarl and the tax clerk bite. If the often handsome and always more powerful 1957 cars are harder to fit into the garage, this does not imply that we should get back to the true merits of the Model T, when men were men and could apply a strong right arm to the hand crank. Nor would I advocate in politics that we return to the bitterness engendered by the almost irreconcilable inter-group conflict during the New Deal, or to the suspicion, hatred and hysteria engendered by McCarthyism. Unless a person likes conflict, immoderation, and difference for their own sakes, he must acknowledge that these times are in most ways happier than any we have had since 1929—a full quarter-century ago.

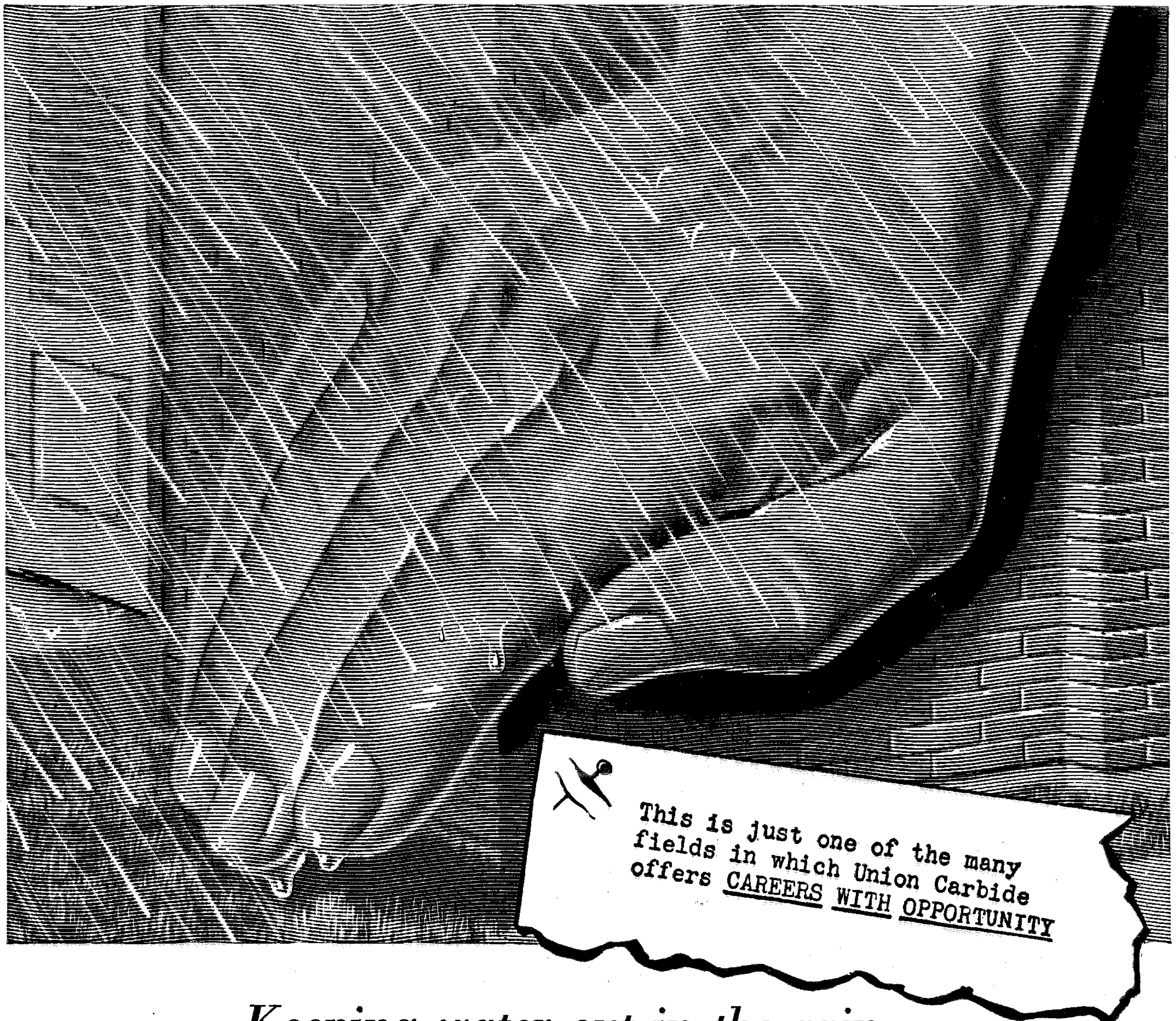
Relaxed societies

In fact, the mood of moderation and turning away from public to private concerns can be largely explained by the intense and inescapable involvement in a wide range of long-needed domestic reforms, and in a devastating war which could have been avoided by our country only at the risk of losing all sense of public morality—and perhaps of losing the material benefits of our advanced economy as well. Human beings, collectively or individually, cannot stand unrelieved periods of great tension and effort. Broad national societies must relax just as individuals have to.

The difficulty is that, while we have been enjoying an ever higher standard of living—with longer, lower new cars that have that sculptured, supersonic look—other societies have been confronting us with new politics which we, as Americans, have had far less part in creating than we did with the growth of Nazism in Germany.

If our carefree isolationism of the 1920's was in part responsible for the tragic set of events that ended in the chaos of war, it is not so easy to demonstrate that our recently more mature and responsible participation in international affairs is responsible for the growth of nationalism and the demand for the benefits of industry and technology which have become so strong in the Orient. It was not America that exploited Egypt, northern or southern Africa, India, the East Indies, or China. We have been relatively humane in our brief imperialistic period, and can point with true pride to our course of action in giving independence to the Philippines and Puerto Rico.

Relatively free as we are from moral responsibility for the exploitation of underdeveloped societies in the Near and Far East, the inescapable fact is that the



Keeping water out in the rain

MASONRY WALLS made of brick, stone, or concrete have long stood the test of time. But today, they can be made even better with a coating of silicone water repellents. These amazing materials prevent damaging rainwater from entering the countless tiny pores or openings in masonry structures.

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Orient, in all its parts, is at last no longer a Gulliver, tied down while asleep by Lilliputian armies and civil servants and entrepreneurs from the West. The metaphor is more apt than one might think, from the majestic and powerful standpoint of Western civilization. The world's population is now over 2.6 billion, out of which almost two-thirds (1.7 billion) live in either Asia or Africa.

Poor neighbors

At present, the peoples of Asia and Africa are like the poor and prolific neighbors down the street who thus far have done little more than demand of other neighbors of ours that they stop picking fruit off Asian or African trees, stop freely digging wells in the back-yard, and stop acting as though they had a perpetual right to collect fees from every traveler who takes a short-cut across the lot. But many of these poor and prolific neighbors have proud family histories which, they are now reminded, contain glorious chapters of ancient and established culture—including military and imperialistic greatness that made even the Western world tremble in terror before the brave armies of Genghis Khan.

They are also constantly reminded of the more recent history of their exploitation by the West. The Chinese recall that in 1842, at the end of the Opium War, they had to give Hong Kong to Britain, pay an indemnity for opium the Chinese had destroyed, and later to legalize the importation of opium so that Chinese could lapse into further doped slumber, to the profit of supposedly Christian and unmistakably Western traders. Chinese also recall the Boxer Rebellion which left their country even more prostrate before Western exploitation at the turn of the century, and humbled them with periodic reminders in the form of indemnity payments, programmed for a third of a billion dollars, to pay for Western property destroyed, not in the West but in China.

Indians are reminded that England started to colonize their subcontinent about the same time that America was being settled, at the beginning of the 17th century, and that India completely lost its independence just when America was gaining its own, at the end of the 18th.

Those Asiatic and African nations that have thrown off the imperial yoke see themselves in a position much like that of the United States of 175 years ago. The comparison for them is both more idealistic and realistic than we might imagine. During the 1948 Indonesian revolution, which ended in its independence from the Netherlands, a streetcar in Djakarta carried the inscription, "All people are created equal." And in his 1956 visit to the United States, President Soekarno made a pilgrimage to Monticello to see the home of Thomas Jefferson, the author of the inscription on the Djakarta streetcar.

My main concern here is not the current mood and opinions of people in Asia and Africa but those of people in America. Mention of the renaissance in the Near and Far East is relevant though, because only at great risk can we escape active involvement in events occurring outside Western civilization. The irony of Marxist dogma describing the increased exploitation of the working masses by capitalists is that it has taken firmest hold in countries that have experienced mostly non-industrial exploitation. What this reflects is that Africa and the Orient are looking abroad for help in extracting themselves from the poverty and inertia of ancient feudalism and modern colonialism. They are looking with enthusiasm toward the dogmatically simple and seemingly humane Soviet and Chinese proposals, and Soviet and Chinese Communist leaders are eyeing the uncommitted Orient and Africa with even greater enthusiasm.

Party leaders

So we are confronted with a vast, almost world-wide two-party system in which we are leaders of the party which refuses to lead. The two-party competition is not the black-and-white one of communism against anti-communism; it involves the difference between a system which believes in making changes with the active political consent and participation of the people, and one which makes changes without such consent.

It should be apparent that I see the major problem of new politics as being the relation between us and the underdeveloped nations with their dark-skinned peoples. The reason I regard this as more portentous than the problem of atomic warfare is that I do not believe that the leaders of any country will venture upon an atomic war which can end only in destruction of both combatants. Even Hitler, who seems to have been a psychopath by any standards, did not initiate the use of lethal gas, which he recognized as being so mutually deadly a prospect. I cannot see either the Russians or ourselves getting so desperate as to resort to nuclear weapons to decide a conflict which they and we know would produce victory or survival for no one. Wars of considerable intensity may very well occur, but at present it seems most unlikely that they will be wars fought in large theaters, and involving an utter commitment of the full armed potential of any great nation.

If this appraisal makes sense, it means then that the conflict will be more political than military. It means a struggle over the means by which the underdeveloped nations will achieve the industrialization, the decent standard of living, and the self-respect which

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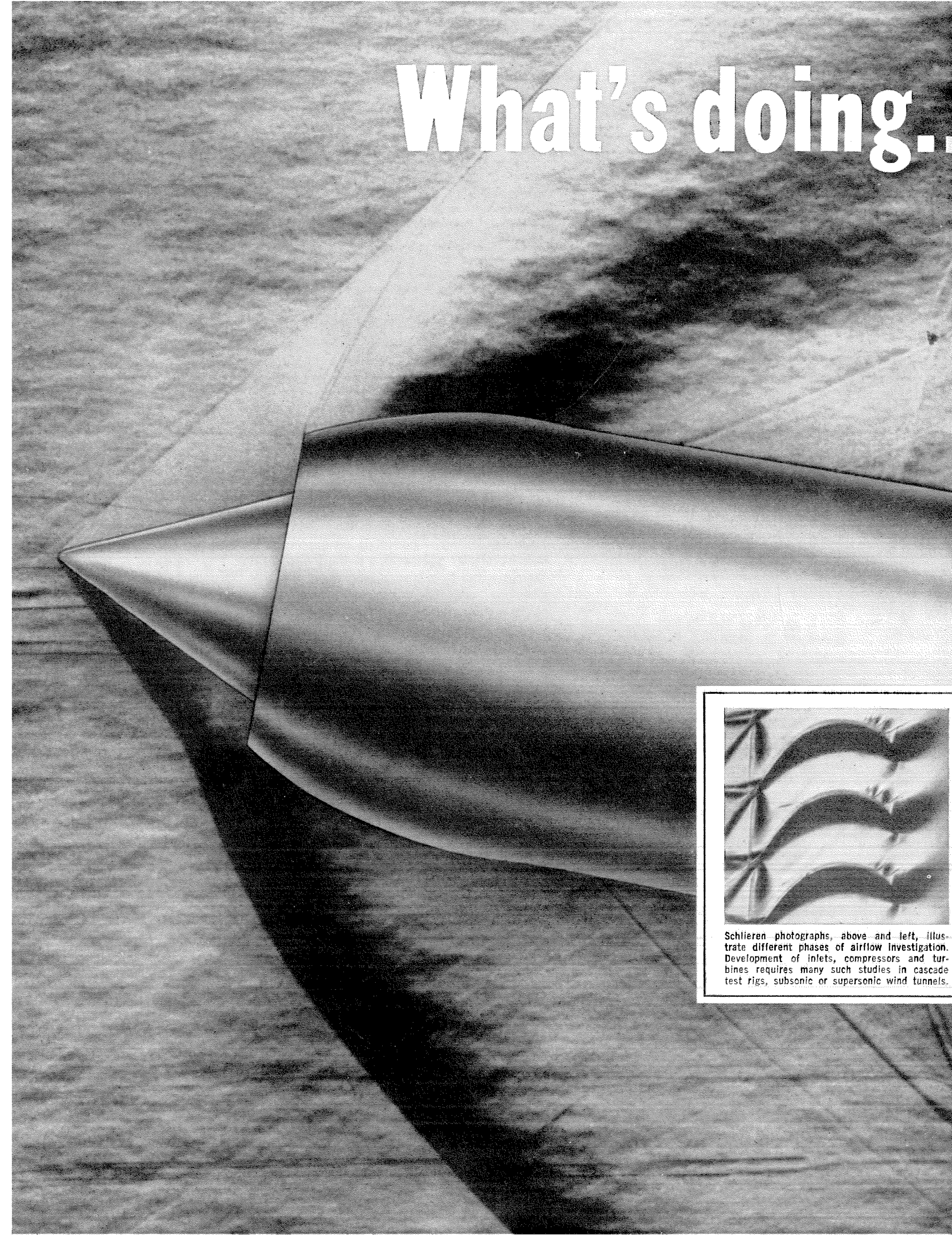
What's doing...



Schlieren photographs, above and left, illustrate different phases of airflow investigation. Development of inlets, compressors and turbines requires many such studies in cascade test rigs, subsonic or supersonic wind tunnels.

they are determined to get by whatever means.

If the goal is reached by governments which become increasingly democratic—responsible and responsive to the basic policy choices of the ordinary citizen—the prospects for international peace, friendship, and stability are very great. This is so, it seems to me, because no general public in any nation has given prior approval to the launching of a large aggressive war by its leaders in government.

If, on the other hand, the goal is reached by irresponsible, undemocratic governments, the prospects of peace, friendship, and stability are remote. This does not mean that the ensuing wars would be atomic, but that they nonetheless could involve substantial commitment of armed forces by all participants in Korea-like theaters.

Even in the absence of widespread war, the prospect is not bright if we remain aloof in the two-party political struggle. We have become increasingly dependent on overseas sources for the maintenance of the industrial productivity and high living standard which are too exclusively the mark of American accomplishment. If the underdeveloped countries achieve economic well-being, can we really expect them *not* to establish quotas and outright embargoes on raw materials which will become as necessary to their economic goals as they are to our own? This does not seem likely, when the needs of two-thirds of the world's population become really competitive with our own, and when these peoples a generation hence have no reason to be grateful for aid that was circumscribed by the conditions of the cold war. And mutual defense pacts with nations too poor to afford armies are not an international trade commodity that encourages economic give and take.

The fact is that our own domestic welfare—including the new inner automobiles with that sculptured, supersonic look—is inescapably tied up with our relations with Asia and Africa over the next generation. I think it is true, as Lincoln would have said, that the world cannot long remain half-slave, half-free. I think it is also true that the world cannot long remain half-impoverished, half-prosperous.

And all of this brings us back to the mood of the American public—of which you and I are members—and what this portends for the future. In international affairs we appear to be as preoccupied with gadgetry as we are at home. Just as we see the good life being implemented by better detergents and better cars, so

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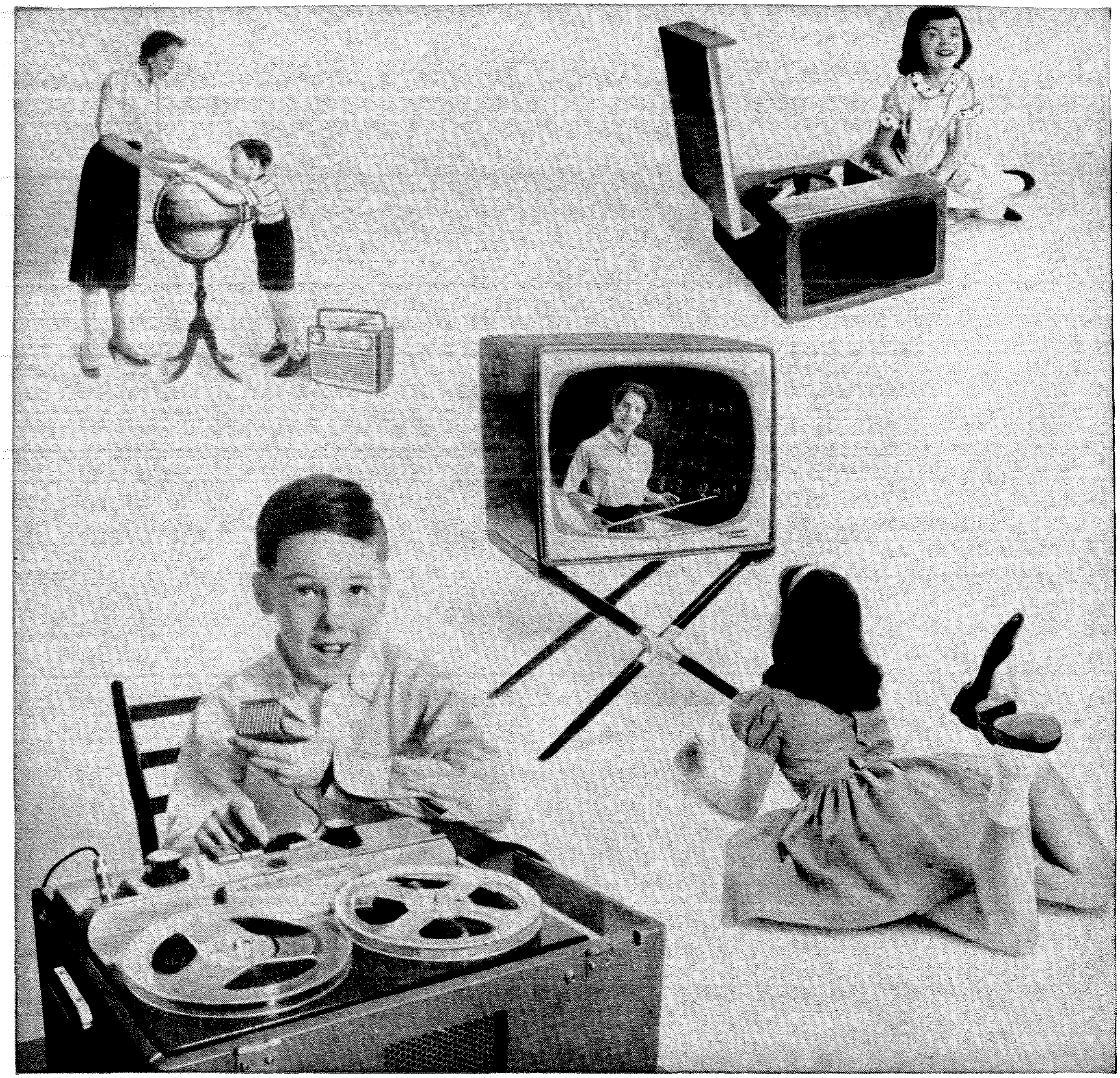

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Through its leadership in electronics, RCA contributes a great deal to the success of this new and broader kind of education. In fact, helping our oncoming generation to see, to hear... to understand... is one of the most important jobs we do. TMK(S)®

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

RCA

RADIO CORPORATION OF AMERICA
Electronics for Living

we judge our foreign policy to be sound if we maintain technical superiority to the Soviet Union in the means of waging total war instantaneously, and from a safe distance, by means of guided missiles. Better gadgetry is indeed a necessary pre-condition of both the good life at home and peace among nations, but better gadgetry *is* neither the good life nor the sufficient condition of a good foreign policy.

To supplement our trust in total weapons, we assure ourselves by comfortable-sounding slogans. If one says or hears: "We shall always adhere to the principles of the UN," or "We have no territorial ambitions," or "We shall never abandon our allies," or "America is the friend of the oppressed everywhere," or "Pray for peace" (which appears on postage stamp cancellations), he is prone to think foreign affairs are under adequate human and divine guidance—and forgets the disturbing slogan: "By their deeds ye shall know them."

The public mood of moderation in all things, and a generalized good will toward all men, shows dangerous signs of having become a vacuous complacency that is incapable of the dynamism and involvement necessary to insure that the world can become, or even remain, a place of peace and good will. We seem, in our escape from public to private concerns, to have lost a clear understanding that ignoring the former endangers the latter. It is the ancient irony of having to dirty one's hands to get the dishes clean. We cannot enjoy a decent, private, non-political pursuit of happiness without involving ourselves in politics.

The truth of this is apparent, I suppose, to everyone who has had his personal life interfered with by a period of military service. It is harder to understand, but no less true, that concern with public affairs—particularly our relations with "dark" Asia or "darkest" Africa—is inexorably linked to our standard of living, our values of individual freedom and dignity, and to all that is wrapped in the parcel labelled the good life.

Comparisons inevitably come to mind of our present times with the insouciance of the isolationist 1920's. The comparison is limited by the clear fact that we are in general now committed to a position of responsibility in international affairs. The group in Congress that is like the LaFollettes and Borahs of the 1920's is now restricted not to being against international involvement, but to opposing more than minimal involvement in the UN, NATO, and foreign aid. But the fact that the 1950's are different from, and much more mature and responsible than the 1920's, does not mean that

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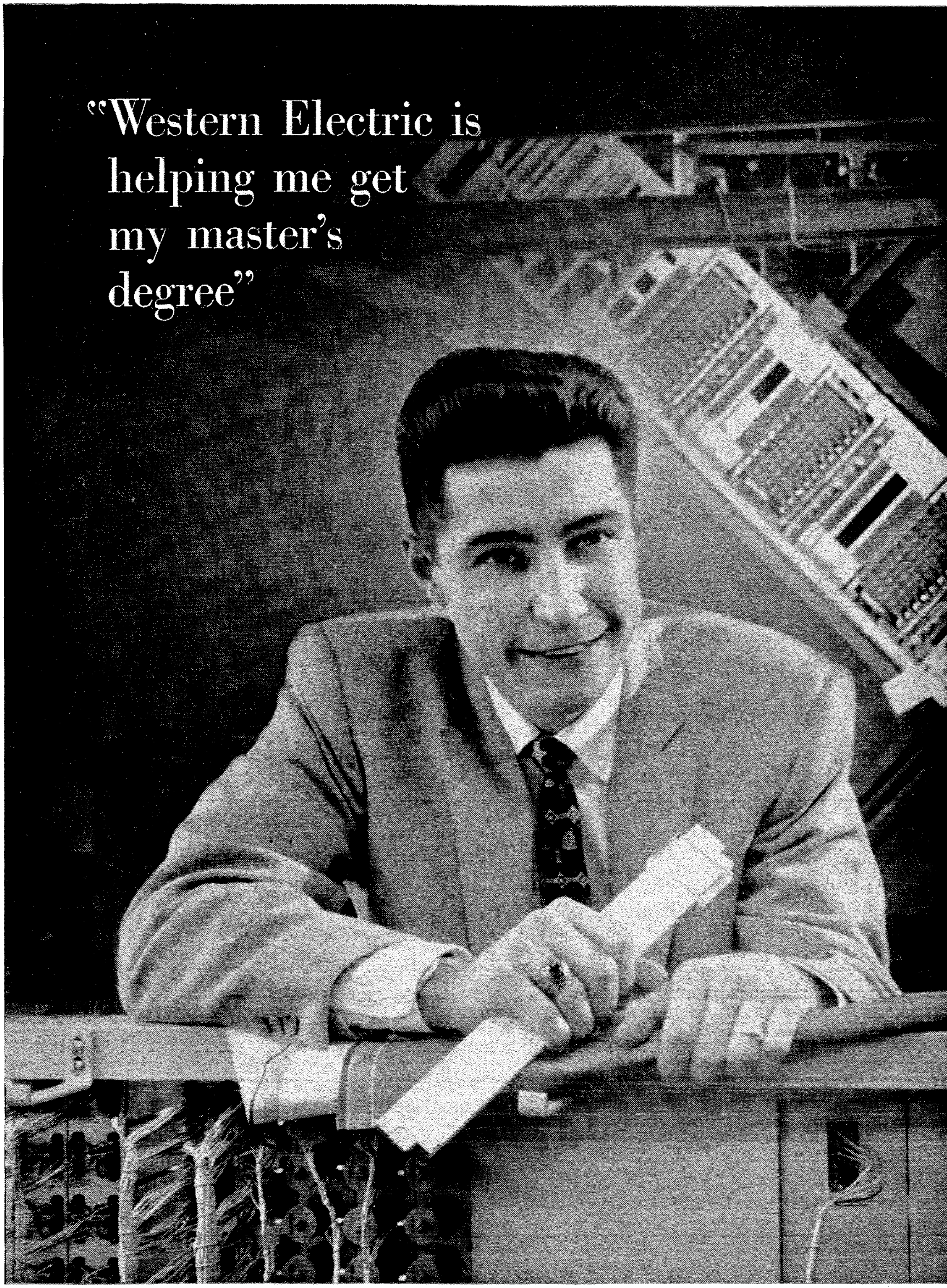


JOHN MORAN, who joined Western Electric's engineering staff at the Kearny Works recently, is now studying for his M.S.M.E. under the new Tuition Refund Plan. Western Electric expects to refund the tuition for John's graduate study at the Newark College of Engineering this year.

Western Electric's new TUITION REFUND PLAN can help you continue your studies while launching an exciting career

Under the new plan, Western Electric will refund tuition costs for after-hours study at graduate or undergraduate level, up to a maximum of $250 for each school year.

Say, for example, that you decide on a career at Western Electric in one of many rewarding phases of telephony—electronics, development engineering, design, manufacturing production, plant engineering, or some other. You may be eligible for financial assistance to help defray the cost of graduate or other study from the very first day. Choose engineering, science or any course that is appropriate to your job or that adds to your ability to accept greater responsibility, and the Company will refund to you up to $250 a year for tuition. (You'll note from the map on this page that Western Electric's work locations are well situated in terms of major population areas. That means that many of the nation's best schools are close by.)

Plus values, like the new Tuition Refund Plan, give Western Electric engineers many opportunities that others never have. There's specialized training both in the classroom and on the job... a formal program of advanced engineering study that includes full-time, off-job courses of up to 10 weeks' duration... a retirement and benefit program that's one of the best known and most liberal in industry... low-cost life insurance that would appeal to any man with his eye on the future. And of paramount importance is the chance to work alongside top men in the field of communications.

There's a good deal more for which there isn't space here. Why not write us or contact your placement office to schedule an interview when Bell System representatives visit your campus.

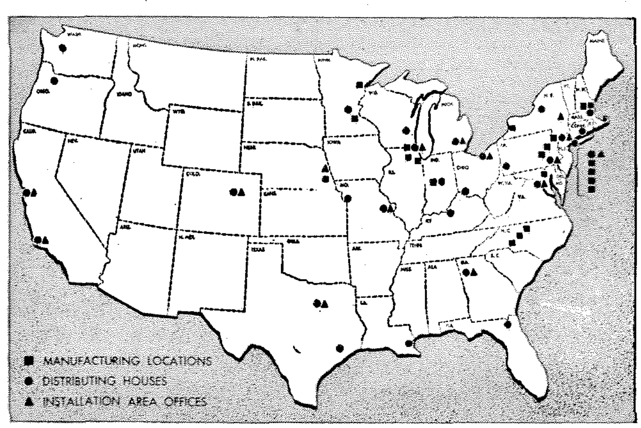
As one of us, you'd help engineer the manufacture, distribution or installation of the equipment needed for the nation-wide communications network of 49 million Bell telephones.

Here—where transistors were first developed for production; where repeaters for the new transatlantic telephone cable were tailor-made—there's a constant need for new products and new processes. Two-thirds of the equipment we make today for the Bell telephone companies is of types developed since World War II.

Besides telephone work, Western Electric—over the years—has been responsible for a continuous flow of defense jobs for the government such as the Nike guided missile system and the DEW Line.

There's plenty of room for advancement... whatever your field of specialization. So—whether you'd be helping with our telephone job, or working on a major defense project like guided missile systems—with Western Electric you can expect to grow!

For our College Tuition Refund Plan booklet and additional information about Western Electric write: College Relations, Room 1030, Western Electric Company, 195 Broadway, New York 7, N. Y.



Western Electric has major manufacturing plants located at Chicago, Ill., Kearny, N. J., Baltimore, Md., Indianapolis, Ind., Allentown, Pa., Winston-Salem, N. C., Buffalo, N. Y., North Andover, Mass. Distribution Centers in 30 cities. Installation headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corporation, Chicago 14, Illinois.

Western Electric

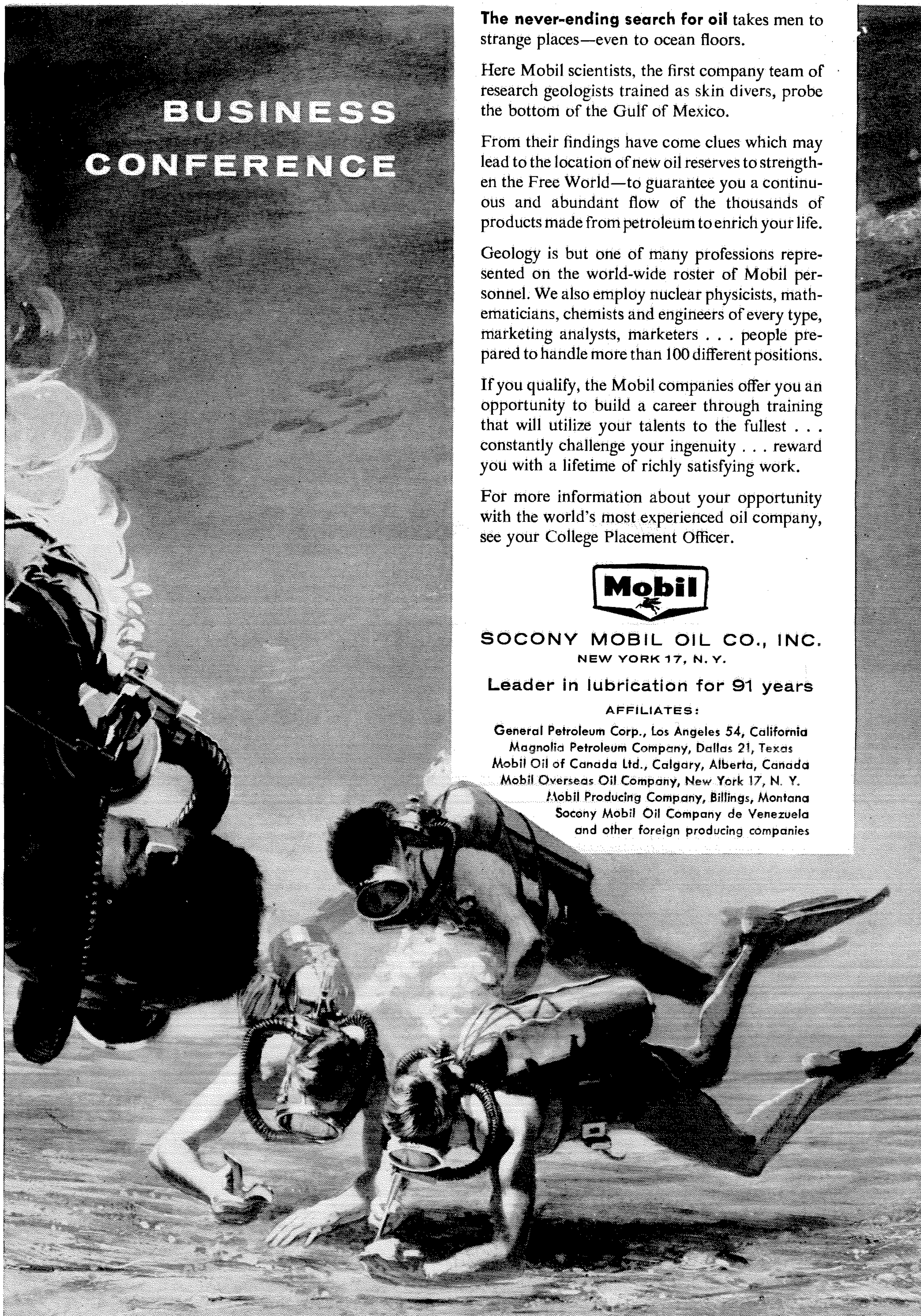
MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM we are mature or responsible enough to meet the unprecedented problems we now face. Then the major problems focussed around Western, Central, and Eastern Europe. Now our major problems have moved in giant strides eastward and southward around the world.

Over 1,000 years ago in China, the Middle Kingdom and the T'ang Dynasty were regarded, with much reason, by intelligent Chinese as being the center of world civilization. As one recent writer put it:

> "They were already old and tired and disillusioned, weary with the weariness of those who had experienced all, mellowed with the sadness of those who knew the vanity of all things earthly, those for whom all questions have been answered, who have found their state of poise in the scheme of things and know there can be no other, who still have longings but no aspirations."

The vitality, or at least self-admiration, of Chinese civilization was not quite played out. Some 800 years later King George III of England sent a trade mission to China, more in search of tea than sympathy. The mission returned to England with a sympathetic message from the Emperor. He complimented George III for his "humble desire to partake of the benefits of our civilization," and ended with: "It behooves you, O King, to display even greater devotion and loyalty in the future, so that by perpetual submission to our Throne you may secure peace and prosperity. Tremblingly obey and show no negligence." How different from the Emperor's message to England is our current attitude toward the Near and Far East?

I am ill-disposed to assume that death, as it must to all men, must come to Western and American civilization. The undiminished vitality of the Roman Catholic Church, which has but a few centuries to go in its second thousand years, suggests that those institutions and values in Western culture that we prize so highly need not be submerged in a sea of squalid Orwellian despotism imposed by either our own government or by rulers of the dynamic Far East. But in a society where government is responsible to the general public, the responsibility for thinking anew and planning anew is ours, and we are escaping from that responsibility into the poor and brittle shelter of our prosperous private lives. And in doing so, we have established limits to our foreign policy which are dangerously narrow for the slowly mounting crises coming our way from various lands of the rising sun.



The never-ending search for oil takes men to strange places—even to ocean floors.

Here Mobil scientists, the first company team of research geologists trained as skin divers, probe the bottom of the Gulf of Mexico.

From their findings have come clues which may lead to the location of new oil reserves to strengthen the Free World—to guarantee you a continuous and abundant flow of the thousands of products made from petroleum to enrich your life.

Geology is but one of many professions represented on the world-wide roster of Mobil personnel. We also employ nuclear physicists, mathematicians, chemists and engineers of every type, marketing analysts, marketers . . . people prepared to handle more than 100 different positions.

If you qualify, the Mobil companies offer you an opportunity to build a career through training that will utilize your talents to the fullest . . . constantly challenge your ingenuity . . . reward you with a lifetime of richly satisfying work.

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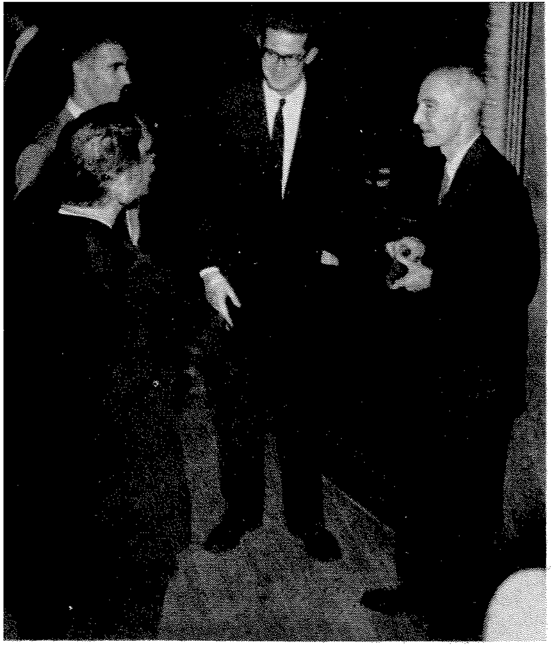

Y President Baird Brandow,
Student Body President Dick Kirk,
and Dr. Oppenheimer—
after his formal talk to undergraduates.

PATHS TO MANHOOD

Some notes on Caltech's Leaders of America

DR. OPPENHEIMER was sitting in a large overstuffed chair in the Tolman study when a student asked him if he thought a classical education was of more value than an engineering or scientific one. He relighted his pipe with a match from his seemingly endless supply before he answered, "There are many types of men, and many paths to manhood."

After Dr. Oppenheimer's visit had ended, I thought back over this answer—and the men we had met through the YMCA's Leaders of America program: Dr. Oppenheimer, Ralph Bunche, William O. Douglas, and Paul Hoffman. Each is eminently successful in his work, each was friendly and eager to cooperate during his visit to Caltech, yet each was completely different from the others. Indeed, the value and appeal of the Leaders program seems to be in discovering each man's personality. A man's ideas can be found in his works, but the program enables us to learn about the man in the best way possible—by meeting him.

When we met Paul Hoffman, the first guest of the program, he seemed shorter than he looks in pictures—and much friendlier than he appears in his Bachrach portrait. For 12 hours a day, for four days, he met with students in small groups, spoke before large groups, talked, answered questions, asked questions, joked, and laughed. In spite of this strenuous pace, his warmth increased as his visit progressed.

We met Justice Douglas and his wife as they hurried through dinner at the Athenaeum before rushing to Dabney Hall for the Justice's first public appearance. His weather-beaten baby face came as something of a surprise, but his relaxed friendly manner seemed altogether natural. He appeared to enjoy talking with students about his broad background and his varied experiences. He was as interested in learning from students as he was in educating them.

Dr. Bunche had the understanding and relaxed poise that comes from many years of working with people. Perhaps more than any of our other guests, he welcomed disagreement. He thrived on ironing out differences of opinion, and as the discussion became more heated he seemed calmer. He had a ready sense of humor that he often used to bring his audience closer. In moments of repose, away from groups of people, he became more serious and, at times, seemed to be deeply tired.

My roommate and I got up at 4:45 in the morning to meet Dr. Oppenheimer at International Airport, and his

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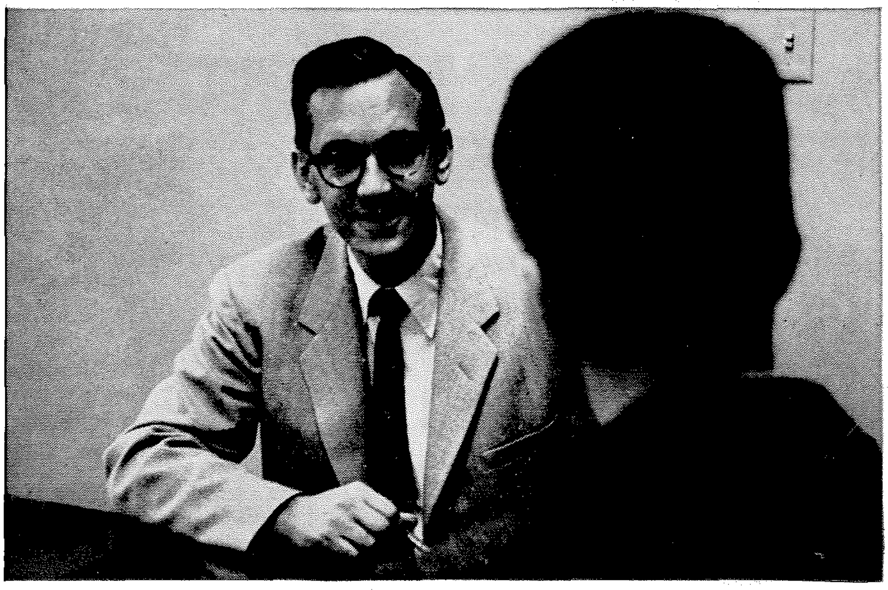
CAREERS WITH BECHTEL



PORTER THOMPSON, *Assistant Chief Engineer, Refinery Division*

MECHANICAL ENGINEERING

One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.

QUESTION: *Mr. Thompson, some engineering graduates seem to believe their first jobs might include little more than filing papers. Would that be true at Bechtel?*

THOMPSON: It would not. When the young man joins the Refinery Division, if he is a structural engineer he starts immediately to do structural design work, under proper supervision. An electrical engineer would join our electrical group, working on electrical systems for refineries, doing some design work, taking off materials and working on instrumentation.

QUESTION: *What about mechanical engineers?*

THOMPSON: Mechanical and chemical engineers may either go right into the process department, where they would do calculations, or into the project group where they would do routine designing and write specifications for pumps, exchangers, vessels, piping, instrumentation, insulation, etc.

QUESTION: *There's certainly no sign of "paper shuffling," is there?*

THOMPSON: No. The training period is interesting right from the start. After a few months, we like to send the young engineer out into the field so he can see the end result of what he has been doing.

QUESTION: *What has been your experience as to the length of time required to train a man?*

THOMPSON: That will vary according to the man, so it's impossible to generalize. The young man will have some responsibility right from the start, but it may well be a matter of several years before he can actually take full responsibility for running a job.

QUESTION: *Assuming he handles his first assignments satisfactorily, what would be his first major step upward?*

THOMPSON: After from 6 to 9 months his first responsible assignment might be on a project in connection with handling pumps. On his next project assignment he might have the responsibility for handling pumps and exchangers. He would likely be assigned some other responsibility on each succeeding project. In that way he would get a good grasp of all types of work and eventually be capable of taking overall charge of a project.

QUESTION: *Suppose he is in the structural phase; would there be any difference in his "basic training"?*

THOMPSON: No. He would still have to serve his apprenticeship, moving gradually into more and more complex design work as he gains, a little at a time, the knowledge and experience which qualify him to handle the overall job.

Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering —Mechanical...Electrical...Structural ...Chemical...Hydraulic.

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flight arrived about 6:15, in a drizzly, foglike rain. He stepped off the plane wearing his proverbial tweed suit, battered pork-pie hat, and blue shirt.

He got into the back seat and as we pulled away from the airport, he asked—in typical back-seat style—why we were headed out to sea. At that hour of the morning, we really *didn't* know which way was home, but my roommate pulled out the map and said we were on course—sort of. So, with the help of the map, Dr. Oppenheimer in the back seat, and the Los Angeles freeways, we eventually arrived at the Tolman house in Pasadena, where he would stay during his visit.

When we took his bags into the house he offered to cook breakfast, but he had been on the plane all night, and we were sure he was tired in spite of his good nature, so we thanked him and said no.

He had lunch in Fleming House that day; and it was here that we first saw him react to questioning. When one of the 40 or more students around him asked a question, he smiled a little and fumbled with his pipe before he answered. Sometimes he would answer before a student could finish asking a question, but for the most part he would hesitate, unsure in his own mind that he could give a satisfactory answer, and then reply slowly and deliberately. Often he would stop, draw a nervous finger across his lips, relight his pipe, and stare at the floor—thinking back over what he had said, still looking for the right words, the right sentences to express his ideas.

He was surrounded by students throughout the week, and remained friendly, cooperative, and humble. On Saturday night, an open house at Tolmans' was supposed to provide an opportunity for people to come and talk in small groups, like at any party. But almost immediately

Open house

Press conference

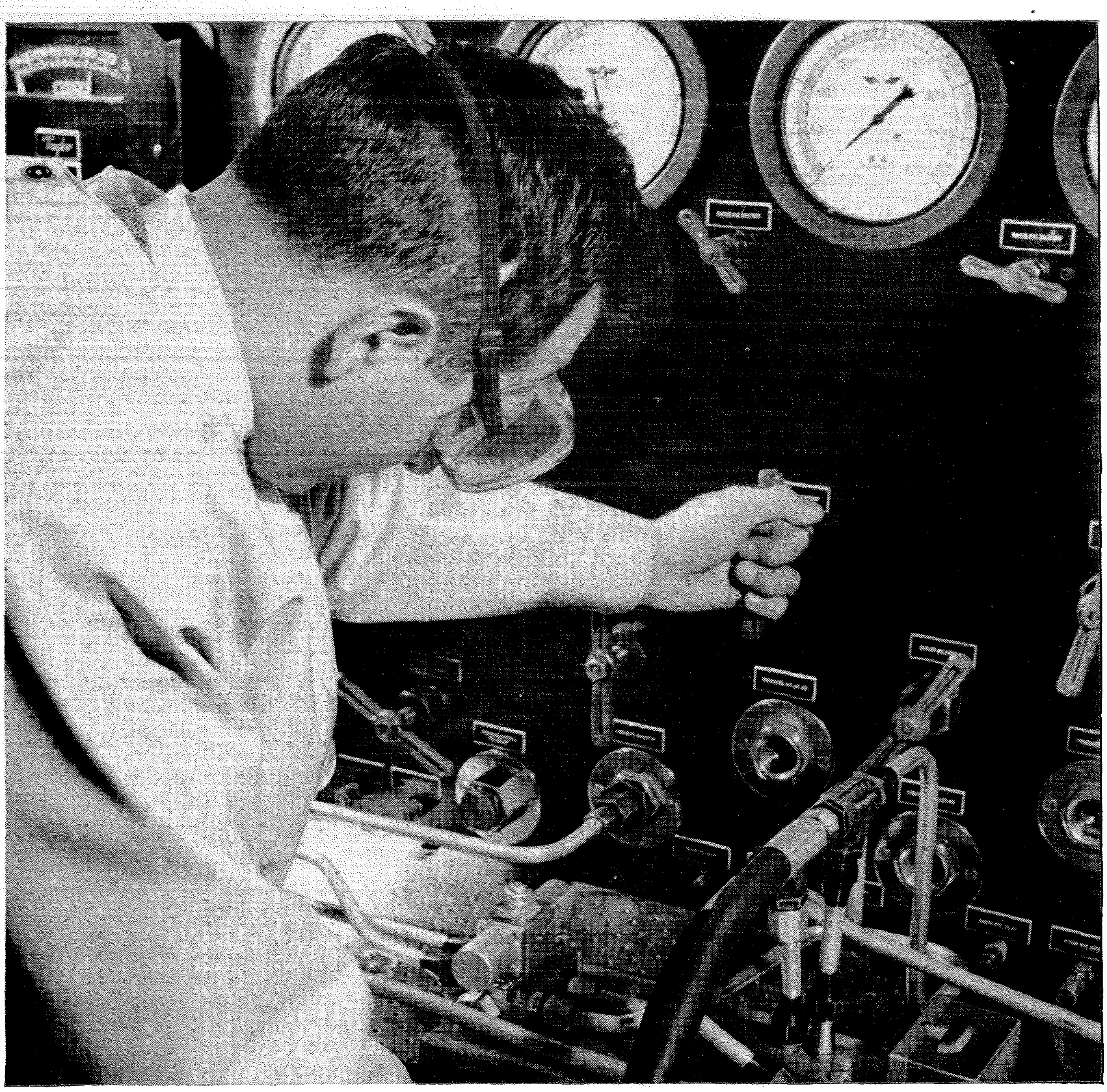
Dr. Oppenheimer was submerged in people, and, as he moved, the crowd moved.

Dr. Oppenheimer abhors formal speeches, but he consented to give one talk to graduates so that he could sum up his impressions of his visit. As he gave the address, he seemed uncomfortable and uncertain that he was expressing himself adequately. Even after the audience gave him a standing ovation he was not sure that he had said what he hoped to say.

During his stay, Dr. Oppenheimer seemed more at ease in small groups, where he could communicate on a personal basis, than in large groups, where he was the center of attention. He was uncomfortable when confronted with difficult questions, because he did not know the answers—yet he seems to live, in part, for these as yet unanswered questions.

By now, I find that I recall more how Dr. Oppenheimer acted than what he said while he was here. I remember him coming from the plane, concerned that we had come so far so early—walking with him to the Tolman house after his speech, and his warmth and hospitality as he invited us in—and finally, as he entered the Biltmore, his apologetically telling a newsboy that he didn't need a paper. Even more than our other guests, he has the humility that comes with experience and the understanding that comes from a personal sensitivity.

—*Richard M. Kirk '58*



PERSONALS

1921

Wynne B. Mullin retired from the Firestone Tire & Rubber Company this month after 30 years of service. When he first started with the company in 1927, he was construction engineer for their West African plantation in Liberia. For the past 15 years, he's been in charge of Firestone's purchasing and real estate department in Los Angeles. Wynne writes that he and his wife, Charl, expect to divide their time between their summer cottage on Shuswap Lake in British Columbia, Canada—and their home in La Habra Heights, California. He also plans to do some consulting work for Firestone and some real estate development for himself. Wynne's daughter, Alyse, is married and lives in Washington, D.C.

1927

Arthur D. Warner, PhD, is now western representative of the Weapons Systems Evaluation Group, an operations research group serving the Assistant Secretary of Defense and the Joint Chiefs of Staff. The technical staff of WSEG is provided by the Institute of Defense Analyses, which is sponsored by Caltech, MIT, Stanford, Case Institute of Technology, and Tulane University. Art's job is to report the results of research and development programs. He writes that about one-third of the Defense Department research and development program is in the West, mostly in California.

1928

Richard D. Westphal writes that he's a sales engineer with the General Electric Company in Los Angeles, specializing in industrial applications of X-ray. The Westphals have three daughters—Alice and Virginia, who are now married, and Jean, a senior at San Marino High School.

Tomizo Suzuki writes from Tokyo, Japan, that he's been a special consultant and civil engineer for the Japan Construction Field Office of the Armed Forces Far East since January, 1954. Before that, he was a technical advisor in the technical information office of the Okinawa Engineer District, on Okinawa. Tomizo writes that, although salaries are only a fraction of those in the United States and taxes and living expenses are very high, the Japanese are living a relatively easier life than they did some years ago.

"Japan may be a very hard country for foreigners to understand," writes Tomizo, "because, although she may be classed as a highly industrialized nation, many things seem to be contradictory because the new exists apparently in harmony with the old, side by side. Thus we see many girls who are dressed elegantly like the Parisians or New Yorkers — but most of them may live in Japanese-style homes and eat Japanese meals three times a day—and who continue to observe age-old Japanese customs. After all, it may be safe for us to say that 'Japan is still in the state of making' in the world of uncertainties."

The Suzukis have three children—two attending universities in Tokyo, and the other still in grade school.

1929

Clyde E. Shields is now in Massena, New York, working on the St. Lawrence River Power Project, with Uhl, Hall and Rich, Engineers, Power Authority for the State of New York.

Thomas Clements, MS, PhD '32, chairman of the geology department at the University of Southern California, and a curator of the Los Angeles County Museum, recently completed a 10,000-mile jeep trip through remote sections of Mexico. For five months he and his wife searched for jade mines which have eluded explorers for centuries. Although they didn't discover the actual mines, Tom and his wife brought back samples of high-quality jade found in the Taxco region which lead them to believe that mines exist nearby. The trip was financed by the museum and the university.

1930

Capt. Deane E. Carberry, MS '31, writes from the Naval Station at Great Lakes, Illinois, that, although he's only been there a little over two years, he's had such titles as District Civil Engineer, District Public Works Officer, and Officer in Charge of Construction—all in the Ninth Naval District of the U.S. Navy. Deane has also built his own home in Lake Bluff and now has two teenagers in his family helping to keep him busy.

R. Stanley Lord writes that, as District Engineer of the Water Resources Division of the U.S. Geological Survey, he's responsible for all surface water branch activities in California and supervises 90 employees located in three major offices—San Francisco, Sacramento, and Los Angeles. Stan has been with the water re-

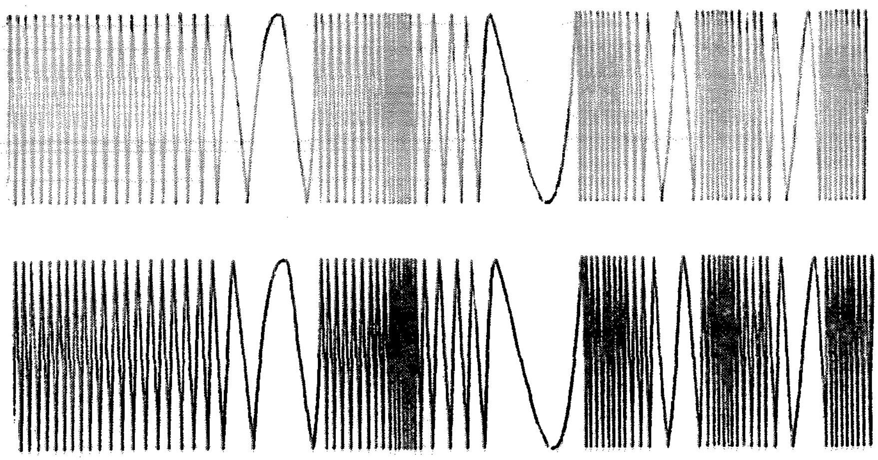
CONTINUED ON PAGE 58

FYI
FOR YOUR INFORMATION

Allied Chemical

DIVISIONS: Barrett, General Chemical, National Aniline, Nitrogen, Semet-Solvay, Solvay Process, International

- *ball-point inks*
- *odor control*
- *biological grade chemicals*



Ball-point inks

If you drew a continuous, unbroken line with a ball-point pen until its ink supply was exhausted, the line would be two to three miles long. Enough to write 50,000 to 70,000 words, compared with the 2,500 to 4,000 words you get from the same amount of fountain pen ink.

Because you would be exhausted long before your ink supply, a mechanical scriber—which produces those mysterious zig-zag lines above—is used to test hundreds of ball-point ink formulations.

The amazing number of words coming from a ball-point pen has enabled ball-points to roll past both fountain pens and mechanical pencils to become the most commonly used writing instruments today.

This would not be so if the ball-point pen remained unchanged, still staining, skipping, smearing, drying up. A better mechanical tool was needed to start with.

Once accomplished, the ink became the most important element, and synthetic organic chemists turned to the key element—the colorant—which is half of the entire ink formulation.

Early ball-point inks were made with the same dyes used for years in fluid inks. But ball-points have different ink requirements: good flow properties, lubricity, solubility, storage stability and—most important—an exceptionally high concentration of dye. Tinctorial value must be twenty times that of a fluid ink.

From research has come a special line of NATIONAL dyes, tailor-made for ball-point inks. Research on both pen and ink has enabled the ball-point to supplant in 15 years the pointed pen, in use for 13 centuries.

Odor control

Odor control presents an ingenious twist on the old question of whether there is any sound when a tree falls in a deserted forest.

We have always had odor-causing sites. But today, with industry expanding and our suburban communities moving further into the country, these odors become a serious problem. Some sources of this problem are sewage plants, land-fill garbage, drainage ditches, storm sewers and market area streets.

SOLVAY OZENE (emulsifiable orthodichlorobenzene) is becoming widely used in industrial odor control situations, for dripping into sewage or spraying on garbage and other odor sources.

OZENE works on odors these ways: its own odor serves as a masking agent; it slows down the production of bacteria which cause sulfide odors; it prevents the growth of fungi which speed the decomposition of waste materials.

A dark-colored liquid, OZENE mixes readily with water and can be substantially diluted for economical use.

Biological grade chemicals

Preparing balanced salt solutions for the growth of cultures is typical of the stringent needs of biochemists for extremely high-purity chemicals, products which have been purified even beyond the universally recognized American Chemical Society quality standards for analytical reagents.

Three such "reagent plus" compounds have been added to BAKER & ADAMSON's line of 1,000 laboratory reagents. These initial chemicals—sodium bicarbonate, sodium chloride and potassium chloride—show very minute trace impurities, materially lower than in similar chemicals produced to A. C. S. specifications.

They are the first in a proposed line of biological grade chemicals made especially for such important scientific applications.

Creative Research

These examples of product development work are illustrative of some of Allied Chemical's research activities and opportunities. Allied divisions offer rewarding careers in many different areas of chemical research and development.

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B. S. Mech. Eng., U. of Vermont, 1949.
Began as Cadet Engineer, Boston Gas Co., 1950. Became Staff Engineer in Distribution Development Section, 1952; Staff Engineer in charge of Development, 1955; Distribution planning Engineer, 1956. Worked closely with company's natural gas conversion programs. Now advisor to Distribution Department charged with developing processes, machines, specifications. Assists management in preparing cost estimates, job analyses, other projects.

W. C. DAHLMAN
B. S. Gas Eng., Texas A. & I., 1938.
Began as Engineer trainee with Lone Star Gas Company after graduation from Texas A. & I. with first four-year Gas Engineering degree offered by institution. Joined Houston Natural Gas Company in 1942. Became District Engineer in Texas City and then District Manager in Beeville and El Campo. Dahlman is currently Chief Engineer with full engineering responsibility throughout the twenty counties in the company's Texas Gulf Coast System.

The Gas industry—the sixth largest in the nation—has a total investment of over $15 billion. Last year the industry set a new all-time record in number of customers, volume of Gas sold, and dollar revenue. In fact, Gas contributed 25% of the total energy needs of the nation as compared with 11.3% in 1940. The Gas industry is a major force in the growth development and economic health of this country.

There are many opportunities for you in the Gas industry. The industry needs engineers, and does not over-hire. You won't be regimented. There's always room for advancement. With utility companies and with manufacturers of Gas equipment, there's a future for you as an engineer. Call your nearest Gas Utility. They'll be glad to talk with you about your opportunity in the Gas industry. *American Gas Association.*

Personals . . . CONTINUED

sources division since he graduated from Caltech. The Lords have two sons: Myron, a first-year medical student at the University of Pennsylvania's Medical School: and Roy, who is a senior at Castlemont High School in Oakland.

1932

James C. Mouzon, PhD, is now professor of electrical engineering at the University of Michigan, and also a research physicist at the Engineering Research Institute in Ann Arbor. He had been working, since 1934, for the Johns Hopkins University Operations Research.

1935

Cdr. Jack W. Schwartz, MS '36, has been public works officer of the Naval Station at Key West, Florida, since September, 1954. "I was married in November, 1954," Jack writes, "and now I have a 15-year-old daughter and a son, Jack Jr., who is 1." Jack has been with the Navy Civil Engineer Corps since 1940, and has been on continuous active duty.

Kenneth Pitzer, dean of the college of chemistry at the University of California at Berkeley, is on the board of trustees at the new Harvey Mudd College in Claremont, California. The school is a member of the Associated Colleges at Claremont, and will open next September with its first class of 60 engineering students.

1936

Lt. Cdr. David M. Whipp, assistant chief of the geophysics division of the Coast and Geodetic Survey in Washington, D.C., writes that the division is deeply involved in preparations for the International Geophysical Year, and the celebration of the 150th birthday of the USGS. Dave's oldest daughter, Patricia Louise, is now at the University of Maryland, taking a mathematics major with the hope of someday becoming a college professor. His youngest daughter is in grade school in Washington.

Hugh F. Colvin, president of Consolidated Electrodynamics Corporation in Pasadena, has been elected to membership in the Young Presidents' Organization, a national group of outstanding young executives. He was one of eight men from southern California elected to the group. To be eligible, an executive must have become president of his company before reaching his 40th birthday, and—among other requirements—the minimum gross sales of his firm must exceed $1,000,000 annually.

1940

Robert O. Cox is still president of the Lauderdale Marina, Inc. in Florida. (Since he's the major stockholder, he can't be

CONTINUED ON PAGE 62

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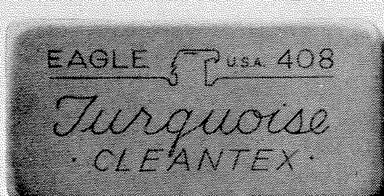

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EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA fired, he writes.) Bob's studying college catalogues for two boys who are entering next year. "I note in the paper," he says, "that there is finally a Caltech student near here (in Hillsboro Mile). All South Florida engineers seem to be Civils—but Yankee engineering organizations have also been flocking here to obtain such benefits as sunshine, taxes, operating costs, etc. so the picture is changing rapidly. There's a vanguard of 25,000 students arriving here in Fort Lauderdale for Easter — which makes Balboa look like a tea party."

1941

Cdr. Eugene A. Lakos is now assistant publics works officer at the New York Naval Shipyard in Brooklyn. He was married on March 3 to Marcille Harris, a clinical psychologist.

1942

Murray L. Lesser is now staff advisor to the manager of IBM's San Jose research laboratory.

Alan E. Bell, MD, an ophthalmologist, writes that he has lived in Pensacola for the past eight years—since his graduation in 1945 from the Johns Hopkins School of Medicine and a tour of naval duty in Key West. The Bells have four children—Laurie, Sandra, Eddy and Peter.

1943

Melvin L. Merritt, PhD '50, manager of the weapons effects department of the Sandia Corporation in Albuquerque, New Mexico, has been named scientific advisor to the supervisor of Operation Plumbbob at the Nevada Test Site. The operation involves a series of low-yield nuclear tests, which will get under way in the late spring.

1944

Richard E. Kuhns, civil engineer for the County of Los Angeles, was recently appointed regional county engineer for the Antelope Valley Region. He lives in Lancaster.

1946

Webster C. Roberts, MS, is now director of research for the Harris-Seybold Company, a printing equipment firm in Cleveland, Ohio. He will direct further expansion of the company's research activities, which include a chemistry and physics laboratory, a printing process laboratory, and an experimental machine shop. Webster was formerly with the Clevite Corporation's research center in Cleveland.

1948

David S. Stoller, MS, is now with the computer systems division of the Ramo Wooldridge Corporation in Los Angeles. He was formerly a research engineer at the Rand Corporation.

1949

James C. Martin is a senior highway engineer in charge of the freeway design group in the Los Angeles office of the California Division of Highways.

Frank H. Beardsley has been appointed staff engineer for the automatic controls division of the Clary Corporation in San Gabriel. He was formerly chief engineer at the Summers Gyroscope Company in Santa Monica.

1950

Richard D. DeLauer, PhD '53, has just been appointed an assistant group leader in the N division of the University of California's Los Alamos Scientific Laboratory. The N division is concerned with research and development of nuclear rocket propulsion. Dick is married and has one son.

J. K. Poindexter writes that he moved to Hawaii last month to work as service engineer for Lockheed Aircraft Service, which has recently extended its operation to Honolulu. "It is with some regret," Jack writes, "that my wife, Beverly, and son, Kim—who is 1½—and I must leave a recently completed house in Upland. But we're looking forward to a perhaps even more exciting architectural adventure in the Islands."

1951

John F. Kinkel is now associate technical director of North American Instruments, Inc. (a division of Morris-Thermador) in Altadena, California. He writes that he's got two sons—John William, 5, and Paul Franklin, 2.

Erdem L. Ergin, MS, PhD '54, and his wife, (the former Leita Harmon, who managed Caltech's Athenaeum until September, 1954), have returned to the United States from Istanbul. Erdem is an engineer in the data and control system department of Beckman Instruments, Inc. in Fullerton, California. They are living in Corona Del Mar.

1955

John L. Honsaker writes that he "returned last September to the United States after a very pleasant year of study in Gottingen, Germany, under a Fulbright Scholarship. My wife, Leni, whom I met in Gottingen, came with me. We were

CONTINUED ON PAGE 66

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POWER EQUIPMENT


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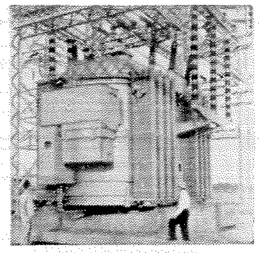
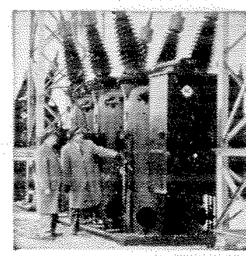
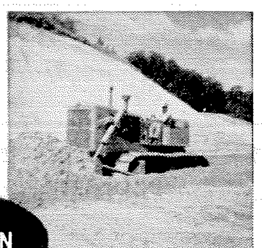
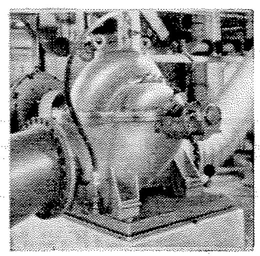
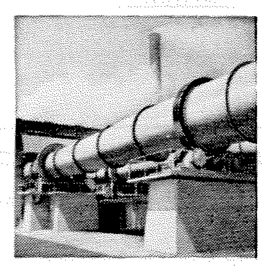

Transformers of all Types


Circuit Breakers

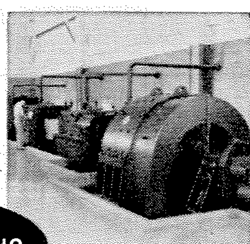
CONSTRUCTION

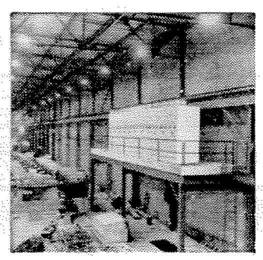

Road Building Equipment

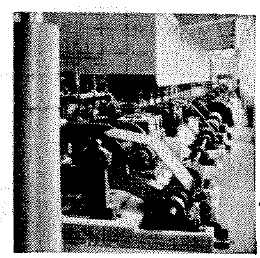

Pumps, Blowers


Cement-Making Equipment

MANUFACTURING


Motors


Control


V-Belt Drives

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Thermodynamics
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Stress Analysis
Hydraulics
Electronics
Process Engineering
Mechanical Design
Structural Design
Metallurgy
Nucleonics
High Voltage Phenomenon
Analog and Digital Computers
Fluid Dynamics
Basic Research

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married in July, and this is her first experience in this country. In October I was called to active duty in the Air Force (from Caltech ROTC) and started as a second lieutenant at the Air Force Base in Albuquerque, New Mexico. Last month my assignment was changed to Los Alamos, where I am now working in the physics division of the Los Alamos Scientific Laboratory. Although I'm still technically an Air Force officer, my duties are essentially those of a civilian physicist.

"I expect to work here for somewhat over two years while I am in the Air Force. After hours I'm working for an MS on a program sponsored by the University of New Mexico. Later, I may be back at Tech to try for a PhD."

Cinna Lomnitz, PhD, reports that he returned to Santiago, Chile, 9 months ago, and is back on the job of strain meter installations for the Caltech-IGY program. He's considering a job in the future at the University of Chile, in charge of geophysical research. Cinna adds that there is a definite need for graduate and postdoctorate geologists and geophysicists to do research work of their own choice during the International Geophysical Year. Anyone who is interested might contact him.

1956

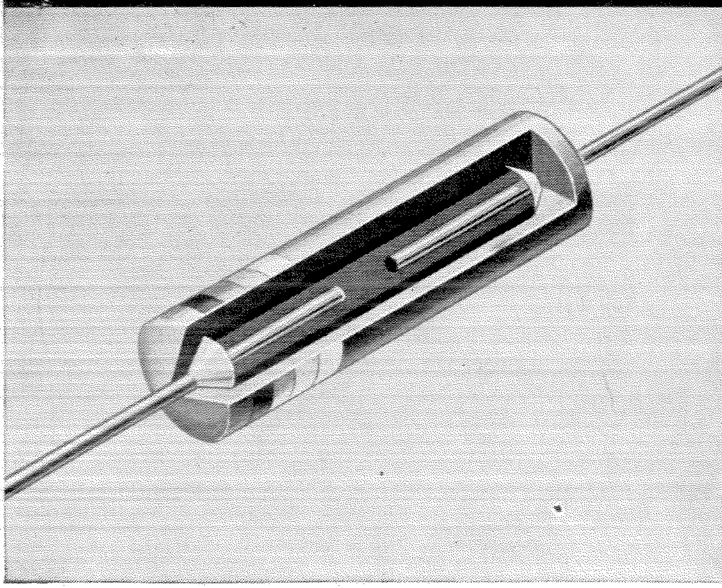
Antonio Kontaratos, MS, writes from Athens, Greece, that he's working in the maintenance department of the Public Power Corporation, stationed at the Aliven Steam-Electric Generation Plant. "Aliven is a 100,000 KVA station consisting of two AEG turboalternators of 50,000 kva each. The maximum capacity of this generating plant is 80,000 kw," says Tony, "and actually, the power capacity of the whole is 200,000 kw."

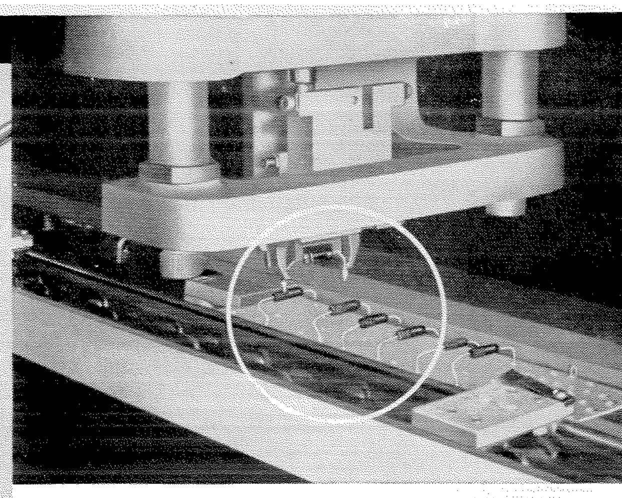
He writes that he receives what is considered a very good salary—$200. This won't last though, because, by about May, Tony will be in the Army for at least two years as a second lieutenant. He hopes to come back to the States after that to get an MS and PhD. In the meantime, he's working on his thesis for a PhD from the Technical University of Athens.

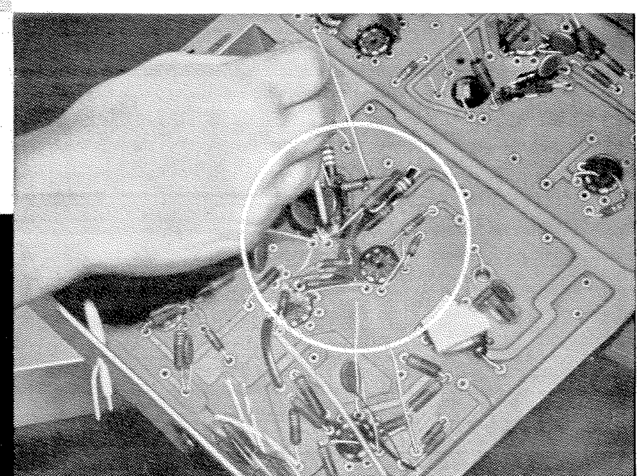
John F. Lovering, PhD, writes from Australia: "Kerry and I returned here in October, 1955, and came to Canberra, where I took up a research fellowship in the department of geophysics of the Australian National University. Kerry has returned to her previous position of petrologist in the geological lab of the Bureau of Mineral Resources (Australia's answer to the U.S. Geological Survey).

"Canberra is a curious city which grew out of the bush some 200 miles south of Sydney to become Australia's capital city when nobody could agree which of the then existing major cities should be made the capital after the states federated in 1901. Scenically it is very attractive but things to do are very limited because of the small population (30,000) and the physical isolation. It is a far cry from Los Angeles or even Pasadena—but at least there is no smog, good skiing to be had close by, and where else could one see an occasional kangaroo hop down the main street?

"We both went to Melbourne for the Olympic Games and I have just returned from a trip to New Zealand, where I attended a conference of the Australian and New Zealand Association for the Advancement of Science. Thanks to the orogenic and climatological settings of this fascinating country, I was able to satisfy two long felt wants—to see a glacier and to climb an active volcano."







CALTECH CALENDAR

ALUMNI EVENTS

June 5 — Annual Meeting
Rodger Young Auditorium

June 29 — Annual Picnic
Disneyland

ATHLETIC SCHEDULE

VARSITY TRACK

April 20
Santa Barbara Relays at Santa Barbara

April 27
Pomona-Claremont at Caltech

May 3
All-Conference Meet at Caltech

May 4
All-Conference Meet at Occidental

VARSITY BASEBALL

April 20
Whittier at Whittier

April 23
Cal Baptist at Caltech

April 24
Whittier at Caltech

April 27
Pomona-Claremont at Pomona-Claremont

VARSITY TENNIS

April 20
Pomona-Claremont at Caltech

April 25
U. of Arizona at Caltech

May 2
L.A. State at Caltech

May 4
Occidental at Occidental

VARSITY SWIMMING

April 23
U. of Arizona & Caltech at UCLA

April 26
USC at USC

May 1
Long Beach State at Caltech

May 3
Whittier at Whittier

FRIDAY EVENING DEMONSTRATION LECTURES

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

April 19
Science of Dry Fly Fishing—
by Dr. William W. Michael

April 26
Geophysical Work in the Mojave Desert
—by Dr. C. Hewitt Dix

May 3
Liquid Air—
by Dr. Earnest C. Watson

May 10
What's Happening to the Automotive Power Plant—
by Dr. Peter Kyropoulos

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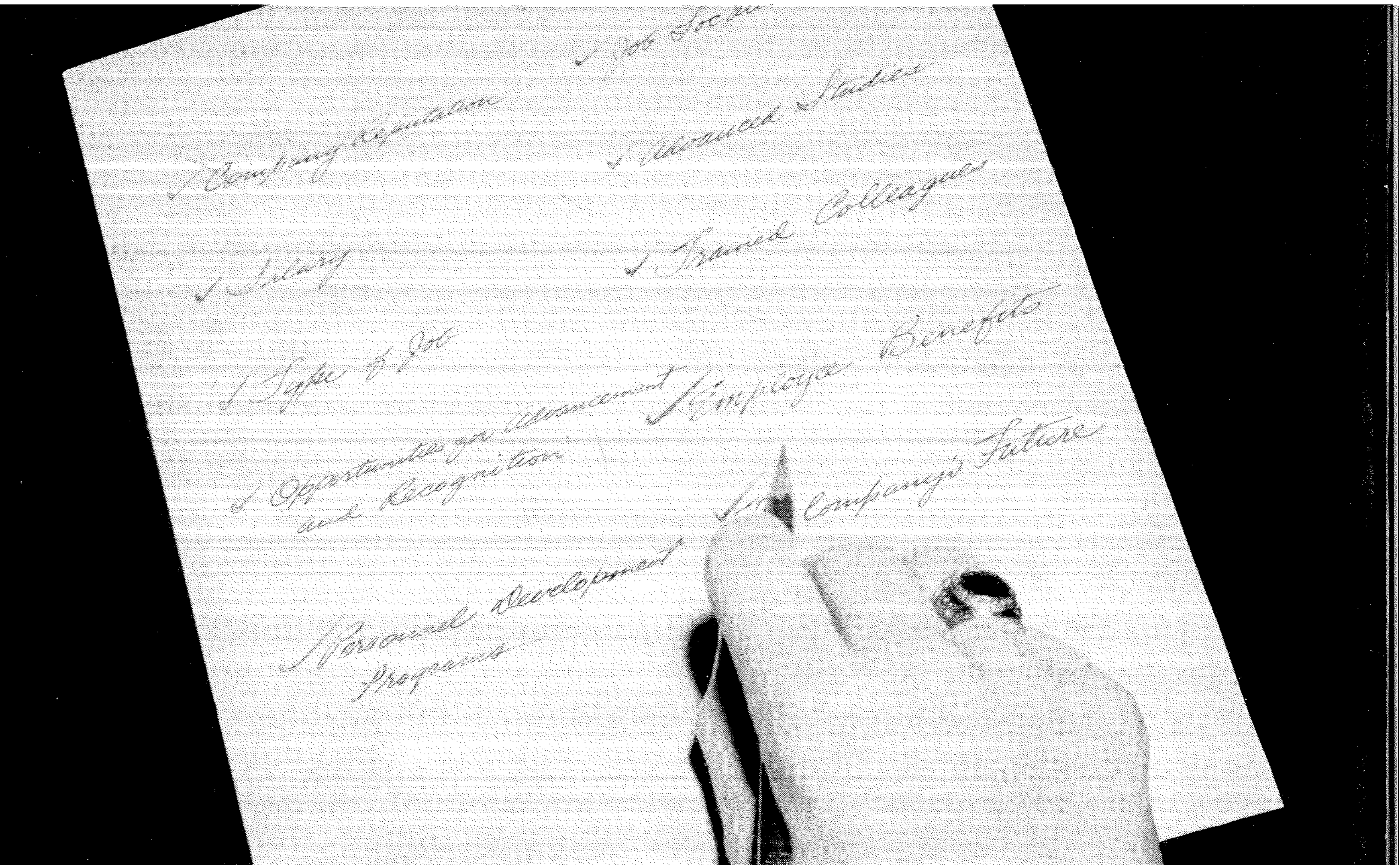

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