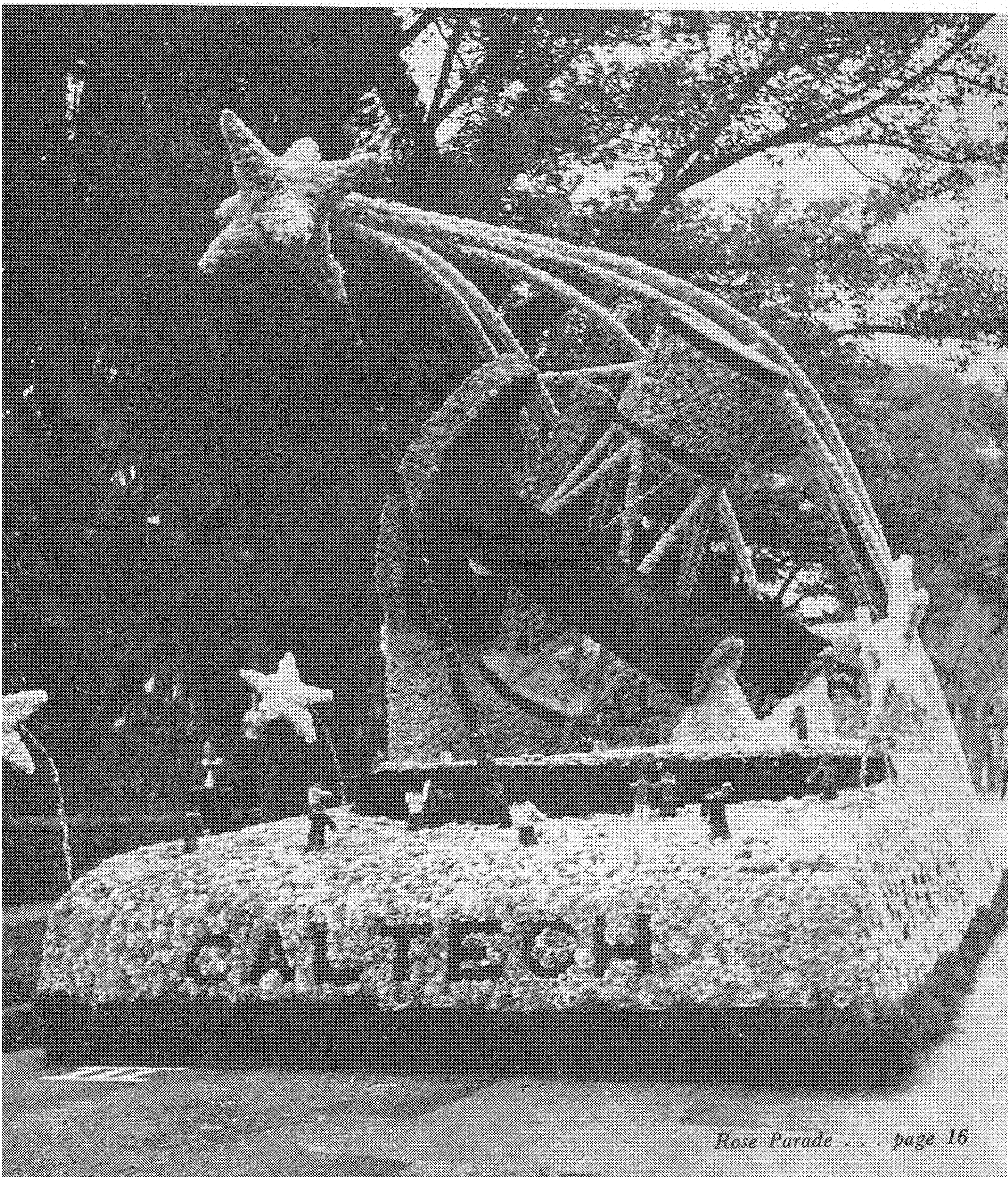
ENGINEERING AND SCIENCE

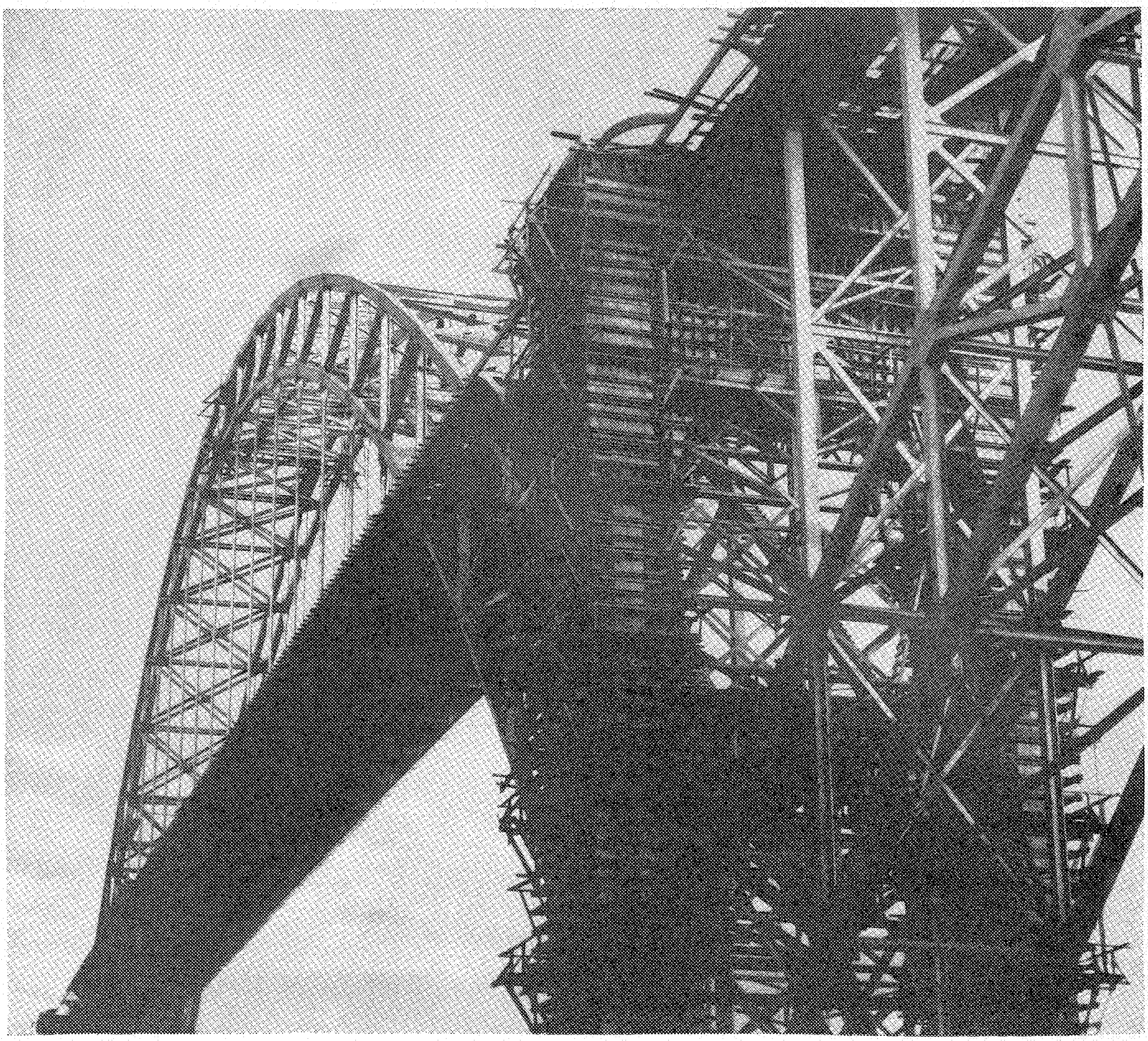
January, 1950



Rose Parade . . . page 16

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

Cross a bridge and make a wish



NEXT time you cut ten or twenty or fifty miles off a weekend trip home by taking the short way over a bridge—give a thought to the days when the bridge wasn't there, when people *had* to take the long way around.

Right then would be a good time to make your wish . . . a wish that you will soon be able to put your engineering knowledge to work in helping to plan and build the things that make America great.

The steel industry offers hundreds of possibilities in this direction. From the mining of raw ore to the fabrication of the finished product, steel-making is directed by technically-trained men. Specialists in every phase of engineering play a vital role in the many and varied steps in making steel. Thousands of other engineers supervise the transformation of finished steel into structures like this mighty bridge.

United States Steel recognizes the need for carefully-trained specialists and pays particular attention in its educational program to the development of college graduates and other technically-trained men. This program has as fundamental objectives providing employees a sound foundation for advancement and assuring them opportunity for maximum personal development.

The training program in United States Steel has become the "bridge" to successful careers for hundreds of capable young men.

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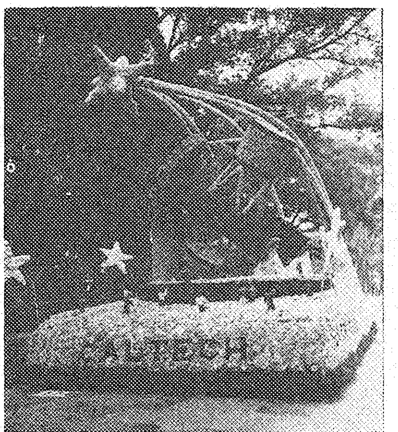
UNITED STATES STEEL



ENGINEERING AND SCIENCE MONTHLY

VOL. XIII CONTENTS FOR JANUARY NO. 4

In this issue

On the cover this month is Caltech's entry in the 1950 Rose Parade. It's the first time the Institute has been represented in the Tournament of Roses in the 61 years of the festival's existence. The Caltech float, a colorful representation of the Palomar telescope, was a student-sponsored project — not only a highly successful one, but a back-breaking one besides. The story of the building of the float is on page 16.

Research in Progress

The Annual Report of the Institute for 1948-49 is being released this month. On page 5 you will find some of the highlights of the report, on research in progress and progress in research in 1948-1949.

Millikan Autobiography

On March 20, Prentice-Hall will publish the long-awaited *Autobiography of Robert A. Millikan*. On page 10 of this issue E & S is privileged to bring you a short extract from the book, covering Dr. Millikan's early years at the Institute.

In our February issue we hope to be able to run another short section from the book.

In March you can get the book for yourself, and—after this advance look—we're sure you'll want to.

PICTURE CREDITS

Cover—Charles A. Davies '53

p. 5—Bill Wright '51

pp. 6-9—Ross Madden-Black Star

pp. 16-17—Charles A. Davies '53

pp. 18, 19—Robert M. Lehman '31

ENGINEERING AND SCIENCE MONTHLY
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LETTERS

Morphological Thought

SIRS: This letter is partly for the purpose of expressing my amusement and delight over Dr. Fritz Zwicky's article, "Free World Agents of Democracy," in the November issue of *Engineering and Science*. It is affording me much pleasure to circulate photostatic copies of this artful composition among the scientists of this Station's Research Department.

The other part of the reason for bothering you with fan mail concerns the morphological method of which Dr. Zwicky is a noted proponent. It has been several years since Dr. Albert Wilson first described this system of analysis and approach and since we contemplated its possibilities. I have had too little opportunity to follow the development and application of the morphological method and since it seems to suit my temperament I would consider it a great favor if you would inform me where I might obtain the literature on the subject for serious study.

G. M. Schroedter
U. S. Naval Ordnance Test Station
Inyokern, Calif.

SIRS: Of life's many small satisfactions, one of the pleasantest for me is to find my unspoken thoughts put down in black and white by someone else, past or present. Especially when it is done as entertainingly as in Dr. Zwicky's article, "Free World Agents of Democracy." It was most enjoyable, besides being astonishingly apropos.

As a matter of fact, we have been dabbling with the general problem of ship stabilization here at Stanford, and I had just begun to cast about for ways and means of bringing what little I knew of group theory and topology to bear on the general problem of classifying, reducing, and evaluating the possible solutions to this problem, when up popped your article.

As Dr. Zwicky's specific comments on the morphological method were brief, I am extremely interested to know if there are more specific, unclassified references available on the subject, and if so where and how they may be obtained.

Joseph H. Chadwick, Jr. '44
Stanford University, Calif.

P.S. As a free world agent (active chiefly in the realm of science), not on Dr. Zwicky's list, I would like to nominate Henri Poincaré engineer-mathematician-universalist.

For the benefit of Mr. Schroedter, Mr. Chadwick, and the other readers who wrote E & S for more information on the morphological method, here are some further references:

F. Zwicky, Morphology and Nomenclature of Jet Engines, *Aeronautical Engineering Review*, June 1947; The Morphological Method of Analysis and Construction, *Courant Anniversary Volume*, Interscience Publishers, 1948; Morphological Astronomy, *Observatory*, Vol. *68*, 845 (1948); Morphology of Aerial Propulsion, *Helvetica* Physica Acta, *21*, 299 (1948).

E & S has a limited number of reprints of these articles on hand if anyone is unable to come by them himself.

Metachemistry

SIRS: That was a fine article of Dr. Zwicky's in your November issue but I certainly could have wished for a fuller explanation of "metachemistry" (page 13). Is this something I should know all about? Is it a new science? Or is it just something like metaphysics?

T. L. Kelly '27
New York City

Metachemistry, as defined by Dr. Zwicky, is "the science of those reactions which involve initial metastable excited states of matter."

Says Dr. Zwicky, in fuller explanation:

In the search for ever higher concentrations of "packaged" energy the idea is proposed to attempt the stabilization *in bulk* and the *exploitation* in *macroscopic quantities* of *metastable high energy states of matter*. It is for instance of vital importance to make available propellants of high energy density in order to operate long distance rockets. Generally speaking both high energy per unit mass and per unit volume are important. The best ordinary chemical propellants pack of the order of 1 to 10 Kilocalories per cubic centimeter or per gram respectively. There exist, however, metastable states of atoms and molecules of long lifetime whose energy lies in the range from 10 to 100 Kilocalories per gram, or even higher.

The excited metastable states of atoms, ions and molecules can in principle be used in two ways for the production of power, or more specifically for the generation of propulsive power.

1. The excited particles may be used wherever they are found naturally, for instance in the upper atmosphere and in interstellar space. This involves the solution of the tricky problem of artificially de-exciting the particles and of transferring the energy gained into propulsive power, for instance to drive a missile.

2. The excited particles may be collected and stabilized in bulk into a metachemical propellant of macroscopic density and energy higher than that which is characteristic for chemical propellants. The most obvious approach to the stabilization of metachemical propellants is through the use of very low temperatures.

In addition to the importance of metachemistry for propulsion, there exist intimate relations between metachemistry and the problem of directly exploiting the radiation from the sun as well as the problem of storing energy for varying periods.

BOOKS

MODERN ARMS AND FREE MEN
by Vannevar Bush

Simon and Schuster, New York, 273 pp. $3.50

Reviewed by Lee A. DuBridge
President, California Institute of Technology

This is a most important book. It is also both a fascinating and thought-provoking one. It is at times jarring, at times reassuring. It is never dull.

The subject matter covers a field which no one but Dr. Bush could treat in so authoritative a manner. As the author states it, "This book is about science and war and democracy and their inter-relations."

Dr. Bush is not attempting in this book to write a history of the Office of Scientific Research and Development, which he headed during World War II. Rather he seeks first to *analyze* the impact of the developments in science and technology on the weapons and techniques of modern war. For this purpose he treats briefly the techniques of World War I and the developments which occurred between the two wars. He then takes up in considerable detail the technical developments which occurred during World War II as they affected the war on land, in the air, and on and under the sea. These chapters are most illuminating for they discuss not the technical details of various new weapons such as proximity fuses, radar, rockets and the rest, but their impact on the nature of war itself and how new techniques will affect future warfare.

He devotes two special chapters to an analysis of guided missiles and atomic bombs and their effect on future warfare. In view of the extravagant claims which have been made for the future potentialities of these weapons, and in view of the equally extravagant attempts to dismiss them as unimportant, Dr. Bush's careful analysis is a contribution of surpassing importance. As might be expected, this analysis reveals that extravagant claims on either side are likely to be false, and that the truth lies along a middle road. The atomic bomb is a weapon of devastating power. But the wiping out of a highly industrialized country by sending dozens or hundreds of atomic-bomb-carrying planes may be a highly expensive business if the defending country is alert and well prepared. Dr. Bush is obviously skeptical of the thesis that the next war can be decided overnight solely by the operation of a huge fleet of atom-bomb-carrying planes. The jet plane and the guided missile offer promise of formidable defenses against fleets of strategic bombers. Though there may be no specific defense against the atomic bomb itself, there are potentially powerful defenses against the planes that must carry them.

But the heart of Dr. Bush's book is not his discussion of the techniques of warfare. Rather it lies in the chapters where he contrasts the ways in which these techniques can be developed and used by a democratic nation as compared with their development and use by a dictatorship. Here he presents a convincing case for the thesis that free men in a democracy are in a far better position to develop and perfect the techniques and instrumentalities of war and to achieve the industrial power needed to win a war than men whose freedom is suppressed under

The Main Line

JANUARY, 1950

Happy New Year!

With Christmas a thing of the past, and New Year's resolutions made and broken in most quarters, about all that remains is that recurring question of what to do with yourself for the rest of the winter.

Happily, we have the answer. Go to New Orleans.

Sea Food, Mama?

The restaurants alone should be lure enough. There's Gulf shrimp which is beyond comparison. Or oysters—on the half shell, Rockefeller, fried, or as you like them. There's pompano. And red snapper. And singularly succulent crab. You name it—they've got it.

The restaurateurs there have a flair for the dramatic. At the drop of a suggestion in come more flaming dishes than you can count—everything from cherries jubilee to a brandy hot-foot for the Maitre d'hotel. Simultaneously, singing waiters serenade you with a chorus of "La Madelon."

(Anti-inflation note: In the heart of the French Quarter is a wonderful, open-all-night market where you can buy three piping hot, freshly sugared doughnuts and a cup of New Orleans' famous coffee, all for a dime.)

Fat Tuesday

But food is only part of the story. Next month is the big month of the year in New Orleans. The "greatest free show on earth" gets under way on February 14 with parades, and there is no let-up through Tuesday, February 21—Mardi Gras day this year.

If you'd like to get in on the festivities, ask your nearest S.P. agent about it. There'll be a special tour train leaving San Francisco and Los Angeles February 15, with rates from $210 to $375 (from Los Angeles), including a private grandstand view of Mardi Gras parades, plus a flock of extra side-trips, parties and entertainment going and coming.

If you don't get in on this one, you might as well give yourself up—for Lent, anyway.

Rising Sunset

In addition to the special train, you can ride the improved *Sunset Limited* to the Crescent City. It will be a few months yet before it will be the new, $15,000,000-dollar streamliner we've been telling you about. But in the meantime it's still the best way to visit the Old South. It's all Diesel-powered, and makes the run in 47 hours eastbound, 46½ hours westbound. Choice of all types of Pullmans and reserved seat reclining chair cars. We don't know for sure, but we think the dining car personnel trained in New Orleans restaurants. Anyway, the food is scrumptious.

Short Haul

If Louisiana seems a little distant to you, Palm Springs or Southern Arizona offer a fine alternative. You can shuck the winter doldrums in eighty-plus-degree sunshine. Fast schedules on the *Sunset* and *Golden State* with convenient Los Angeles connections, put you almost within commuting distance anywhere in the west.

Erratum Revisited

Last October we put our foot in it by announcing that the ski lift at Squaw Valley in the High Sierra was the "world's longest." We soon found out, though, that you don't get to be champ just by claiming the title. Anguished cries of "Foul!" from Oregon and Colorado sent us scurrying for our bifocals and another look at the record. What we should have said was "largest," not "longest"—or maybe skipped the superlatives altogether and simply said that it's a mighty fine spot for winter sports. Anyway, to each of you who has a longer ski lift, herewith our humble apologies.

(In passing, however, we might lay claim to the world's longest, most luxurious, least expensive ski lift at that. We have a slick new San Francisco-Reno parlor car service on the *Overland*. It serves Truckee and the High Sierra ski country and it's tailor-made for winter sports fans. Only $7.50 one way, $13.50 roundtrip, plus tax. That's less than 3¢ a mile on the roundtrip.)

a dictatorship. Dr. Bush recognizes, however, that the strength of a democracy will remain great only if due attention is given to preserving it. His clear and decisive suggestions as to how the strength of democracy can best be preserved are in refreshing contrast to much of the partisan political bickerings to which we are being exposed during these difficult days.

It would be an injustice to Dr. Bush to attempt to summarize his arguments or even his major thesis in such a brief review, but the reviewer can say with assurance that the thoughtful reader will find pleasure and stimulation in following through Dr. Bush's arguments and analyses for himself.

It should be emphasized in conclusion that this is not a book written primarily for scientists or about scientists. Scientists will, no doubt, read it with unusual pleasure, but it is a book for every American citizen who is interested in the future welfare and security of his country.

HEREDITY EAST AND WEST: LYSENKO AND WORLD SCIENCE

by Julian Huxley

Henry Schuman, N.Y., 246 pp., $3

Reviewed by Norman H. Horowitz
Associate Professor of Biology

It frequently happens that the findings of science come into conflict with accepted views. Indeed, this is an inevitable consequence of scientific inquiry, since it is the function of science to correct and deepen our understanding of things. Unfortunately, it is always painful and difficult to abandon the convictions of a lifetime, perhaps even to deny the evidence of one's senses, in favor of new and strange ideas. It may even be difficult to tolerate such ideas in others. Nevertheless, this is what we are required to do if we are to enjoy the benefits which science alone can bring. The free expression of ideas is essential for science, and wherever society adopts an authoritarian attitude, that is to say, wherever it in effect demands unanimity of opinion, the pursuit of science becomes impossible.

The genetics controversy in the USSR is the most recent episode in the long conflict with authoritarianism which has marked the rise of science. It so happens that the findings of genetics have come into opposition to certain tenets of the

CONTINUED ON PAGE 22

L. A. DuBridge

RESEARCH AT THE INSTITUTE

Research highlights from the Annual Report of the Institute, 1948-49

IN HIS ANNUAL REPORT for the year 1948-1949, which is being released this month, President DuBridge remarks that "this year has been one of normal steady progress without either spectacular new developments or difficult crises."

Nevertheless, the reports from the chairmen of the various divisions, on research conducted during the year, make some of this normal steady progress seem pretty spectacular after all.

Though it is obviously impossible to make even a cursory listing of all the research projects which were underway at the Institute last year, it is at least pertinent to note a few of the more impressive accomplishments of each division during the year.

Here, then, in the following pages, are some of the highlights from the reports of the divisions on research in progress—and progress in research—at the Institute in 1948-1949.

BIOLOGY

Smog Investigations

A DIVISION OF BIOLOGY might seem to be the least promising of all places in which to learn about industrial air pollutants. But the biologist has been forced to develop methods by which minute amounts of various chemical substances can be studied. Vitamins, hormones and other biologically active substances often produce significant changes in living things in amounts as low as one millionth of an ounce per individual per day. The result has been the development of laboratories of microanalysis in which routine analyses are made with incredibly small quantities of material.

The Institute has in its Biology Division such a laboratory—under the supervision of Professor A. J. Haagen-Smit. It was therefore not really remarkable at all that the Los Angeles County Air Pollution Control District should turn to him for assistance in determining just what are the dangerous and annoying eye-irritants in local smog. In an amazingly short time Professor Haagen-Smit tracked down the offending substances and identified them as organic peroxides—carbon-containing compounds related to the familiar hydrogen peroxide of the corner drug store. These are known products of the burning of hydrocarbons. While the biology laboratories are not designed to do such purely public service work, the Division is proud to contribute to public welfare when its facilities are necessary because of uniqueness and when the problem is in obvious and urgent need of solution.

Chemically Induced Gene Mutations

In 1865 the Austrian monk Gregor Mendel postulated the existence of units of inheritance that we now know as genes. After lying dormant for 35 years his theory was revived and developed with great vigor in both

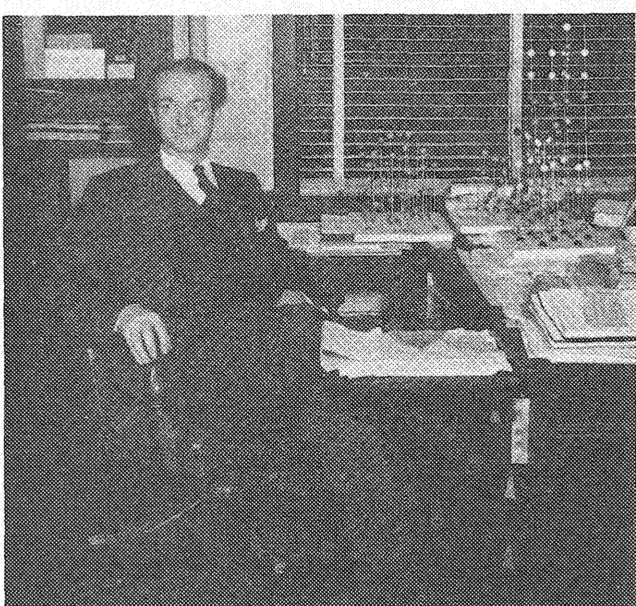
Europe and America. After the rediscovery, it was soon learned that genes are mutable, that is, that they suddenly become permanently modified so as to modify the character of the individuals of a plant or animal species that inherit the changed gene from its parents. But for many years—until 1926 in fact—it was thought that gene mutations were just accidents, beyond the control of man.

In 1926, Professor Herman J. Muller, then of the University of Texas and a former student of Thomas Hunt Morgan, made the important discovery that X-rays could increase the frequency of gene mutations a hundred fold or more. At once a new field of investigation was opened. How do X-rays produce this effect? What other high energy radiation will act similarly? Can mutations be produced by chemical treatments? Advances at first seemed rapid and spectacular. The so-called "direct hit" hypothesis of radiation-induced gene mutations was proposed and appeared to be supported by many experimental facts. It postulates that as a result of absorption of energy in a gene a direct chemical modification is produced.

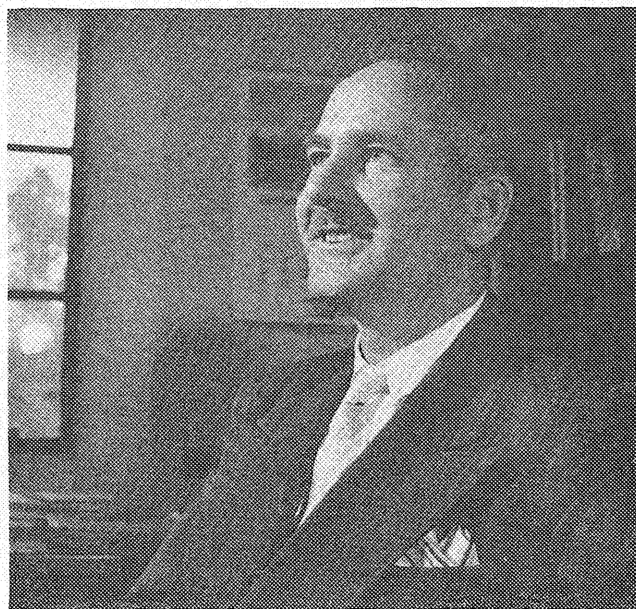
Within the past few years the growing doubts as to the correctness of the direct hit theory were strengthened when Stone, Wyss and Haas of the University of Texas found that certain types of mutations are induced in bacteria if a culture medium in which they are grown is irradiated with ultraviolet *prior to adding the bacteria to the medium*. For several reasons peroxide formation was suspected as a factor in this mutation production.

At this point in the story two graduate students at the Institute entered. They were Frank H. Dickey and George Cleland, both at the time candidates for the Ph.D. degree with majors in organic chemistry and minors in genetics. During the war Mr. Dickey worked with organic peroxides and became an authority on them. On theoretical grounds he believed that induced mutations in general—those produced by direct irradiations of the organism, those resulting from irradiated medium, as well as those resulting from mustard gases—could be the result of organic peroxides as mutagenic intermediaries.

As graduate students, Dickey and Cleland carried out a series of experimental tests of the Dickey peroxide theory. The results were so promising that it was obviously highly desirable to push the work vigorously. Mr. Dickey (now Doctor Dickey) was awarded a Noyes Fellowship by the Division of Chemistry with the understanding that a part of his time would be devoted to studies on the mechanisms by which chemical mutagens produce their effects on genes. Technical assistance and laboratory facilities for this work are currently being supplied in Kerckhoff Laboratories by the Biology Division.



Linus Pauling, Chairman of the Division of Chemistry and Chemical Engineering



George W. Beadle, Chairman of the Biology Division

Dickey's peroxide theory of gene-mutation may well prove to be an outstanding example of progress in understanding living systems through collaboration of chemistry and biology. It is certainly an example of how the attack on an important biological problem can be assisted by collaboration such as is encouraged by the joint Chemistry-Biology research program at the Institute.

Virus Research

Viruses are important to man because they produce many serious diseases in him and in the plants and animals on which he depends directly or indirectly. But the fact that many viruses produce diseases of direct significance in man's existence is not the only reason for learning about them. They represent the simplest systems known to possess the properties of self-multiplication and mutations, two fundamentally significant characteristics of all things that live. Like genes, the units of self-multiplication and mutation of higher plants and animals, viruses are composed of giant nucleoprotein molecules.

At the Institute two viruses are being studied, tobacco mosaic virus, which is the first virus to be isolated in pure crystalline form (by Wendell Stanley in 1937); and a virus that attacks and kills the colon-bacillus. The latter is known as a bacteriophage or bacterial virus.

Several phenomena of significance in bacterial virology are currently being investigated at the Institute and elsewhere. One of these is the production of recombination types when two related viruses infect a single bacterial cell. This has been extensively studied by Doctor A. D. Hershey who spent the first half of 1948 at the Institute. It is found that permanent recombination types are found in definite proportions, indicating that the bacterial virus contains units like the genes of higher plants and animals and that there is some recombination mechanism, possibly involving a primitive form of sexual reproduction. A similar conclusion is reached by Dr. S. E. Luria of Indiana University who finds that viruses inactivated with ultraviolet radiation may be reactivated if two or more viruses, each inactive if adsorbed singly by a bacterium, simultaneously infect a single bacterial cell.

Dr. Albert Kelner of the Long Island Biological Association Laboratory at Cold Spring Harbor, Long Island, New York, discovered during the past year that certain bacterial spores inactivated with ultraviolet radiation can be reactivated with visible light. This remarkable finding was very soon extended to bacterial viruses by Doctor Renato Dulbecco of Indiana University, and to Neurospora asexual spores by Mr. Albert Siegel, a graduate student at the Institute. Doctor Dulbecco will continue his studies of photoreactivation of bacterial viruses during the academic year 1949-50 in the laboratories of Professor Delbrück. Such studies may well provide entirely new clues as to how living systems are constructed and how they operate.

CHEMISTRY

SPECIAL MENTION may be made of two discoveries, the discovery of a method of manufacture of specific adsorbents, and the discovery that a certain disease is a disease of a molecule, the hemoglobin molecule, rather than a cellular disease.

Frank H. Dickey, DuPont Fellow in Chemistry, who received his Ph.D. degree in June 1949, made an important contribution to the general technique of chromatographic analysis when he discovered a way of preparing specific adsorbents to order. The technique of chromatographic analysis, in which Professor László Zechmeister is a leading authority, is very useful for the separation of substances from complex mixtures. It is especially useful in the investigation of natural products.

In applying this technique a substance such as silica gel is packed into a glass tube and a solution of the mixture to be separated is poured over the column of adsorbent and then developed by the passage of additional solvent through the column. The different substances in the mixture are absorbed with different strengths to the silica gel, and accordingly move down the column at different rates.

A difficulty in applying this technique is that it is not always possible to find an adsorbent that has the power of holding the substance in which one is interested more strongly than other substances. Dr. Dickey found that by preparing silica gel in the presence of a particular substance, and then afterward removing the substance by treatment with a solvent, the silica gel made in this way has a special power of attracting that particular substance, and can accordingly be used to separate that substance from others. He found that it was possible to increase the power of adsorption of silica gel made in this special way for a particular substance by as much as 20-fold by the application of this technique. It is likely that this discovery will lead to many important advances.

During the past three years Dr. Harvey Itano, at present U. S. Public Health Service Fellow in Chemistry and formerly American Chemical Society Fellow, has been studying the disease sickle-cell anemia, in collaboration with Professor Linus Pauling. This disease is responsible for about 10,000 deaths each year, and no satisfactory therapeutic treatment is at present available.

During the past year Dr. Itano and Dr. S. J. Singer (U. S. Public Health Service Fellow) discovered that the hemoglobin contained in the red cells of patients with this disease is different from ordinary human hemoglobin, in respect to its chemical composition and its electrical charge. It seems to be this difference in the nature of the hemoglobin molecule (which is determined by genetic factors) that is responsible for the symptoms of the disease. This is the first time that any adult human hemoglobin different from the normal hemoglobin has been found. The investigation of sickle-cell anemia hemoglobin is being continued, in the hope that information may be obtained which can be used in developing a therapeutic treatment of the disease.

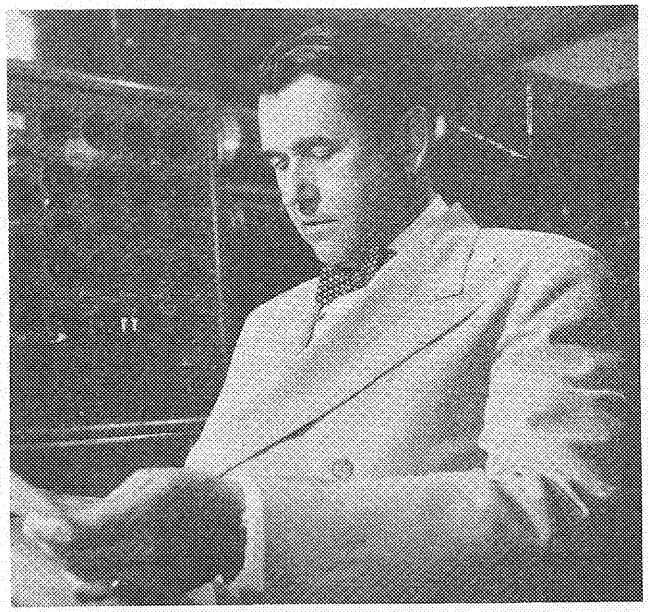
ENGINEERING

Civil Engineering

IN RESEARCH, the principal increase in effort has been the study of the response of building structures to earthquakes. This work has been implemented by a contract with the Office of Naval Research for a systematic analysis of seismograms obtained on a nationwide basis by the U. S. Coast & Geodetic Survey. The response of arbitrary building structures to these earthquakes is to be analyzed with the Institute's Analog Computer. This work is the first large-scale systematic study of this type.

Mechanical Engineering

RESEARCH IN rapid loading of materials is continuing under sponsorship of the Office of Naval Research. The initial project for study of the axial flow compressor, which has been under way for two years, as an ONR contract, has led to a final report, and the work is to be continued under contract extension through 1950.



Frederick C. Lindvall, Chairman of the Division of Civil and Mechanical Engineering and Aeronautics

Hydrodynamics

IN THE HYDRODYNAMICS LABORATORY fundamental work in cavitation has been of primary interest in the water tunnel and in particular in studies of rotating channels. This latter work is producing results of fundamental significance to designers of centrifugal turbines and pumps.

The studies at the Azusa laboratory on the Guam Harbor model have been completed, and this program has been extended to include fundamental studies of arbitrary shapes and inlets to establish design criteria for harbor works.

The Soil Conservation Laboratory, which has been inactive during the past year, will provide facilities for work on a new contract with the Office of Naval Research on the general subject of fluid transport of particulate matter.

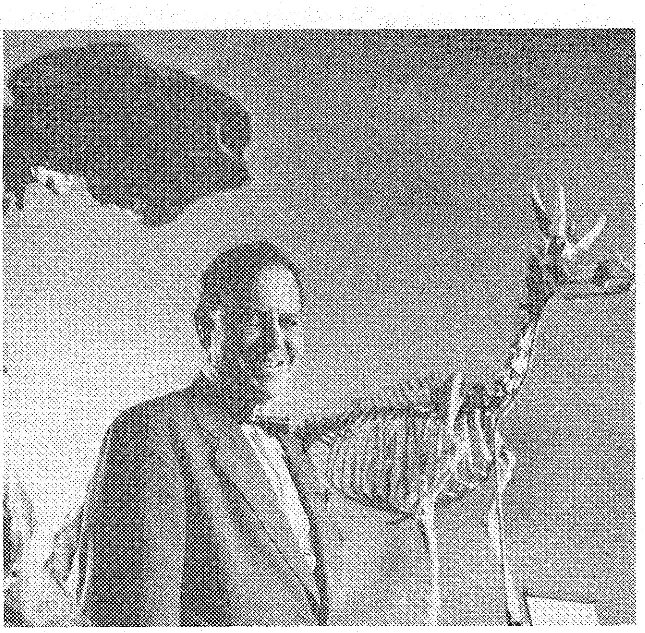
Applied Mechanics

UNDER AN ARMY ENGINEER CORPS contract fundamental studies have been in progress on soil compaction by vibration. Methods have been developed for measurement of static and dynamic physical properties of aeolotropic granular media. Concurrent theoretical work on such aeolotropic media has materially advanced the analytical approach to the soil compaction problem and is about to be correlated with the experimental data.

Aeronautics

Experimental Fluid Mechanics—Researches in turbulence and transonic flow have been energetically pursued, and work in supersonic aerodynamics has also been actively pushed with significant results. The 10-foot wind tunnel has been utilized to an increased extent for low speed, aerodynamic investigations.

Theoretical Fluid Mechanics—The fundamental investigation of the mathematical foundations of viscous compressible flow (sponsored by the Office of Naval Research) continues as one of the most significant of the department's activities.



Chester Stock, Chairman of the Division of the Geological Sciences

Elasticity, Mechanics of Solids, and Structures—A program of fundamental research on the analysis problems of thin, swept aircraft wings, sponsored by the Air Force, is being continued. An experimental investigation of a promising new type of metal sandwich construction was carried out under contract with the Bureau of Aeronautics. And research programs were continued on the fatigue properties of aircraft materials, loads in aircraft landing gears, and on the plasticity of aluminum alloys.

JET PROPULSION LABORATORY

THE SHIFT IN EMPHASIS from applied research and development work to basic engineering research continued steadily through the year. An example of an outstanding practical application toward which the Jet Propulsion Laboratory has contributed is the Bumper-WAC, a two-stage vehicle which attained 250 miles altitude when fired at White Sands Proving Grounds, New Mexico. The research program for 1948-1949 has covered:

Propellants—The physical properties and performance of both solid and liquid propellants, as well as the kinetics of their combustion, have been studied. For example, liquid hydrogen and liquid oxygen have been operated in a regeneratively cooled rocket for the first time.

Materials—The study of porous metals for "sweat cooling" has been continued to the point where large-scale fabrication for specific applications can be undertaken. And the investigation of refractory oxides suitable for rocket liners has been extended to some of the nitrates, for which suitable methods of pressing and sintering are being sought. A new program of considerable promise is the study of titanium and its compounds as structural materials.

Combustion — Several large-scale phenomenological studies of combustion in burners have been completed during the year. These studies have led to an understanding of the practical, empirical limitations that the combustion process imposes on flameholders, injectors and ramjets.

Heat Transfer — Progress has been made in understanding the process of cooling by a *boiling* fluid at high heat flux densities. Bubble growth and collapse have been photographed with a very high-speed camera using a Kerr cell shutter.

Fluid Dynamics — In the field of hydraulics, studies have been made of the pressure losses in helical coils and of the phenomena of jet atomization into low-pressure chambers.

GEOLOGY

DURING THE YEAR C. F. Richter began a study of the seismograms of the Desert Hot Springs earthquake (near Palm Springs) of December 4, 1948. Shortly after the earthquake instruments were installed at Desert Hot Springs to obtain records from two points situated close to the epicenters, which, in addition to records from eight permanent stations, promise to supply important data on the location of the aftershocks, as well as on the change in position of epicenter and depth of these shocks with time.

The work on rock creep by Dr. Hugo Benioff, which began as an attempt to determine the origin of aftershocks, has been expanded considerably during the year. With regard to aftershocks, his results appear to show that these are, in fact, produced by elastic afterworking of the fault rocks.

Application of the creep method to sequences of earthquakes has yielded some unexpected results. With the aid of the Tonga-Kermadec sequences in the South Pacific Ocean, for example, it was possible to discover the existence in this region of a great fault some 2,500 km. in length by about 900 km. in transverse dimension. A similar study of the South American sequences has indicated the existence of an even larger fault off the coast of South America, which extends some 4,500 km. in length. These two great faults are very much larger than any hitherto known.

Professor C. Hewitt Dix has continued his study of the gravity field of the earth. In connection with this investigation, two projects may be specifically mentioned: (1) The observation of relative gravity taken with a LaCoste and Romberg gravity meter at approximately 300 U. S. Coast & Geodetic Survey bench marks, and (2) A study of the yielding of the earth to tidal forces by observing gravity every half hour for three days in Room 0012, Mudd Laboratory, California Institute, just before full moon and for two and a half days at Mt. Wilson just after full moon. The measured yielding was found to be significantly different at the two locations.

Professor John P. Buwalda is compiling information on the origin of San Gorgonio Pass, one of the great gateways to southern California. Its origin has never been satisfactorily explained.

Professor Ian Campbell has initiated, in cooperation with Mr. L. A. Wright of the California State Division of Mines, a program of research on the kyanite deposit near Ogilby, California. Kyanite is a relatively rare mineral, and the deposit at Ogilby is one of the largest known occurrences in the western United States. The mineral is of fairly simple composition, yet, unlike the majority of simple silicates, all attempts to synthesize it have thus far failed.

PHYSICS

■ *Cosmic Rays and Fundamental Particles* — It has been known for several years that cosmic ray mesons of the type found at sea level undergo spontaneous decay with a mean life of slightly over two-millionths of a second and that an electron is emitted in the decay process. In the past year Professors C. D. Anderson, R. B. Leighton and their students have measured the energy of 75 of these decay electrons. The results show that the decay electrons are not emitted with a unique energy as was previously supposed, but instead that there is a broad distribution in energy from very small values to an upper limit of 55 million electron volts. From these results it can be concluded that the meson decays with the simultaneous production of an electron and *two* neutrinos. The upper limit of the energy spectrum leads to a value of 217 plus or minus 4 electron masses for the mass of the meson.

A small number of cosmic-ray mesons occur with exceedingly large energies. Preliminary results obtained by Professor Anderson's group extend the measurements of the energies of these particles to 40 billion electron-volts as compared with the previous upper limit of 20 billion electron-volts.

Professor Anderson is also embarking upon a program for the detailed study of the high energy nucleon-nucleon collisions that occur in the cosmic rays. Such collisions in which the incident nucleon has several billions of electron-volt energy are extremely complicated and result apparently in the simultaneous production of protons, neutrons, heavy and light mesons, positive and negative electrons, and photons.

Robert F. Bacher, Chairman of the Division of Physics, Astronomy and Mathematics

Nuclear Physics — Research in the Kellogg Radiation Laboratory under the directions of Professors C. C. Lauritsen, W. A. Fowler, and T. Lauritsen during the past year has progressed along these lines:

The 8 x 13-foot electrostatic generator has been employed continuously on various problems in nuclear spectroscopy. A precision determination to one part in 200,000 of the mass of the neutron was made during the year, and numerous new energy levels in light nuclei were found. Gamma radiation from the capture of protons by deuterons has also been discovered.

The most difficult and significant accomplishment in the past year by Professor J. W. M. DuMond, Dr. D. A. Lind and their co-workers has been the extension of the scale of the 2-meter curved-crystal gamma-ray spectrometer to include the gamma-ray range well above 1,000,000 electron-volts. Their work on the Co^{60} lines establishes an all-time record for the shortest wave lengths ever directly measured. In addition, the precision calibration of the 2-meter curved-crystal gamma-ray spectrometer with X-ray wave lengths has been effected for the first time.

Electrical Engineering

■ LAST YEAR'S REPORT indicated that the then newly constructed McCann analog computer and the Analysis Laboratory of which it is the nucleus comprised the outstanding advance of the year in the engineering facilities of the Institute. During the year 1948-49 the laboratory has surpassed even the highly optimistic predictions made for it. The demand for its use by industry having difficult problems to be solved has occupied practically all of the available time for such work. Contracts with government agencies such as ONR, the Coast & Geodetic Survey, Bureau of Ordnance, Naval Ordnance Test Station, as well as for industrial service indicate that during the coming year the laboratory will be taxed to capacity, and thus the cost of operation will be assured. Some of the problems already set up include studies of the effect of earthquakes on buildings, guided airborne missiles performance, and underwater missile research.

When Millikan Came to Caltech

An extract from the forthcoming "Autobiography of Robert A. Millikan" *

After serving as vice-chairman of the National Research Council in Washington during World War I, Robert A. Millikan returned to his post as Professor of Physics at the University of Chicago in the last days of 1919 with some very definite ideas as to the needs of the United States in the field of the physical sciences. The most definite of these was the necessity for establishing research institutes in physics and chemistry in at least half a dozen universities well distributed over the country. Though he naturally expected the University of Chicago to be the location of one of these institutes, he failed to get immediate support there for the idea of an augmented staff and facilities for the physics and chemistry departments.

EARLY in 1921 the health of Dr. Scherer, President of C. I. T., broke down, and my Pasadena friends, George Hale, Arthur Noyes, Henry Robinson, Dr. Norman Bridge, and C. I. T. Trustees Arthur Fleming, Harry Chandler, George Patton, and Henry O'Melveny, who in the winters of '20 and '21 had been content to have me spend the fourth quarter of my Chicago year in Pasadena, laid siege to me to persuade me to change my allegiance and accept full-time appointment at Caltech, as Dr. Noyes had recently done. I told them that my first loyalty was to the University of Chicago, that I had been entirely content there, and that I proposed to remain there if the conditions for carrying out my program in physics were made satisfactory.

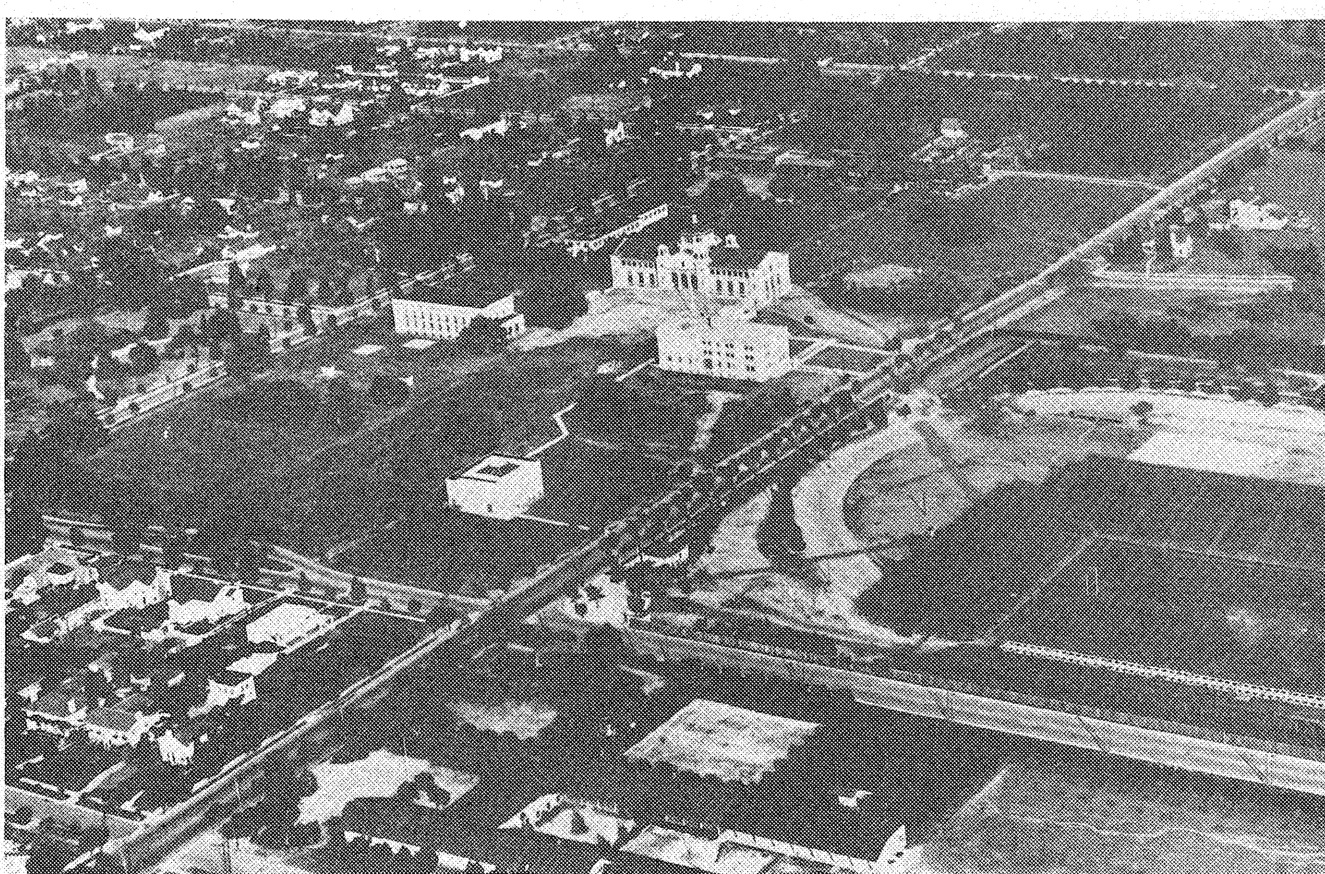
To show me that if I came to Pasadena these conditions would be made satisfactory, Mr. Arthur Fleming, president of the board of trustees, came to me with the proposal that if I would come full-time to Pasadena he would transfer his fortune in trust to the institute. He estimated its value at $4,200,000. He would guarantee me an annual income *for the development of the strongest possible department of physics* of not less than $90,000 per annum, which he anticipated would rise in a year or two to $130,000.

Then Dr. Noyes came on with his Caltech sales talk, as follows: The institute was indeed a very weak institution, with practically no endowment, with but three permanent buildings on the campus: (1) Throop Hall, a good large engineering and administration building costing in 1910 some $170,000; (2) the first wing of the Gates Chemical Laboratory built in 1916 under Dr. Noyes' direction at a cost of $70,000; and (3) Culbertson Assembly Hall, holding 500 persons, built in 1921; but the president of its board, Mr. Fleming, was tremendously interested in the institute's development and each year he made up its deficit from his personal fortune. The institute was ideally located in the most rapidly growing area in the United States, an area that had terrific need for science and its applications but with no possibility of satisfying that need save as the California Institute of Technology could qualify for such a role.

This area had already pioneered in developing the world's first 220,000-volt electrical transmission line. It had here the Mt. Wilson Observatory, already more famous scientifically than anything else in the West. This, with the Huntington Library less than a mile away, and the California Institute of Technology—if the latter could but become outstanding primarily in physics and chemistry, the basis of all engineering and of all biology—would constitute, with suitable cooperative arrangements between the three institutions, a research center in Pasadena of no mean proportions.

But the biggest asset that C. I. T. had, in addition to a remarkable Board of Trustees, was Dr. Noyes himself. His influence in the development of M. I. T. had been exceeded by that of no other individual. He had been at one time the acting president of that institution. While retaining his post in chemistry at M. I. T. for some seven years prior to 1921 he had been spending his winters in Pasadena, and since 1916 directing research in the Gates Chemical Laboratory; but in 1919 he resigned from M. I. T. so as to be able to devote his entire energy to C. I. T. Dr. Noyes felt, and often said as much to me, that the last thirty years of advances in physics were of much more basic significance than were those in his own field, chemistry; that physics itself actually underlay chemistry as well as the whole

* By permission of the publishers of the "Autobiography of Robert A. Millikan," to be published March 20, 1950, at $4.50 by Prentice-Hall, 70 Fifth Ave., New York 11, N.Y.



In 1921 the Institute consisted of four buildings — Throop, Gates, East Bridge and Culbertson.

of biology and of engineering, and he was therefore willing completely to subordinate his own field, chemistry, at C. I. T. to developing strength in physics; that he was wholeheartedly behind Mr. Fleming's proposal to commit a large fraction of the latter's resources to the strengthening of physics, for if physics succeeded the turn of the other departments for expansion would come later, while without strong physics their turn would never come. Such complete self-effacing objectivity is very rare and a very great asset to any individual, and even more so to the institution which he is trying to serve.

But Dr. Hale was my most ardent wooer. He did not quite tell me that he would shoot himself if I did not yield to his suit, but I did actually have some misgivings about his health if I turned him down.

Before making any decision I had another conference with Professor Michelson and another with the administrative authorities at Chicago. Mr. Michelson and I were of one mind, namely, that in a great university like Chicago it is in general next to impossible to get the administration to break step and push one department out in front of the others, no matter how much the general interests might demand such discrimination. Mr. Michelson left me with, "If I were a few years younger I would join you in an ultimatum that it is a substantial increase now in the physics budget, or else! In any case, I will back you to the limit in such a move, since you are not even suggesting an increase in your own salary." The administration did not like ultimatums, perhaps correctly, and so my California venture began in September 1921.

Moreover, the best thing that ever happened to physics in Chicago followed upon my departure. I was fifty-three when I left and my departure not only made it possible but necessary for Chicago to bring in quite a group of younger and abler men who have put Chicago physics very much on the map. I knew this had to happen, and it did happen. My leaving the university, which had given me my chance, was my greatest service to Chicago.

Further, my move made possible the development of a new and active center of scientific and engineering progress which perhaps would not have been created had I remained in Chicago.

Also, I had been extremely sympathetic with President Harper's effort about 1900 to create an engineering department at the University of Chicago. I had no sympathy with the ivory-tower attitude which I found all too prevalent there. The intense interest in fundamental advances is so powerful an urge in everyone that I had no fear whatever of its being smothered in utilitarianism. The continual analysis of *the ultimate* value of our activities to the progress of the race is a wholesome, not an unwholesome, attitude. It is the best possible stimulant to wise choices, the best deterrent to useless research, of which there will always be aplenty. I was happy to become associated with an institution which was likely to be active in following discoveries through to their applications. In a word, I believed heartily in the intimate association of science and its applications because of their mutual stimulus. *At Pasadena science and engineering were merged in sane proportions.* That situation attracted me greatly.

Finally, the only member of the University of Chicago faculty who resented my leaving told me a few years ago that physics in the country had certainly gained greatly from my move.

My first job at C. I. T. was the development of a program in physics. One of the influential conspirators who had set out as early as 1919 to try to detach me from Chicago and attach me to Pasadena was Dr. Norman Bridge, a beloved retired physician who had early come to Pasadena with tuberculosis, made fortunate investments in oil, and was seeking to invest his fortune where it would most effectively serve the public interests. I think it was less than a month after the close of World War I that he telephoned me from New York while I was back in Chicago and invited me to take the Century to New York that Friday afternoon and spend the week-end with himself and Mrs. Bridge at the Plaza Hotel. I packed my traveling bag at once, and the next evening as the three of us chatted together he told me that he was ready to provide the institute with such a laboratory of physics as I might plan if I would take its directorship.

I did not agree at that time to leave Chicago, but I did agree to do such directing as I could by being in Pasadena for the winter quarter of each year, just as Dr. Noyes had been doing with respect to the Gates Chemical Laboratory since the inception of that laboratory in 1916. With that much encouragement Dr. Bridge instructed me to have the New York architect Bertram Goodhue draw the plans for the first unit of such a "Norman Bridge Laboratory of Physics."

Dr. and Mrs. Bridge ultimately put more than a million dollars into the three units of that laboratory and its maintenance. The first unit was completed and ready for occupancy by the fall of 1921, so that when in the late summer of 1921 I had decided to make the transfer from Chicago to the institute I had a fine new laboratory, as well as an adequate budget, with which to attract to the institute graduate students and also the newly established National Research Fellows. They came at once in encouraging numbers.

Recruiting a Staff

In September of the year 1921 I went to Europe in response to an invitation to participate in the so-called Solvay Congress, consisting of twenty-five physicists especially invited by Mr. Solvay to assemble at his expense in Brussels to review the present state of physics. I used this visit to Europe to persuade Dr. H. A. Lorentz to spend the winters of 1921-22 and 1922-23 at the Norman Bridge Laboratory. I also brought back with me from Leiden, as a new member of our physics staff, Dr. P. S. Epstein, an altogether outstanding theoretical physicist; and I further went to Cambridge and arranged to have Charles Darwin join us for the following year. Paul Ehrenfest of Leiden, Arnold Sommerfeld of Munich, and Albert Einstein later came on similar temporary appointments, each for at least two successive winters. In Washington, too, I gathered in Richard Tolman as a permanent staff member straddling physics and chemistry. These men, with Harry Bateman, who was already on the staff, gave as good theoretical leadership as could be found anywhere.

On the experimental side, the National Research Fellows in general brought their own experimental problems with them, and I myself had a bag full of problems that I distributed among the graduate students, just as I had been doing at Chicago. Further, I continued to conduct the graduate seminar in physics. This started the first year (1921-22) with a very inspiring group of twenty-five men, and it grew in the following years to an average attendance of about forty. Further, I had induced the twenty-two-year-old I. S. Bowen, who in 1919 and '20 had been working with me on my personal researches at Chicago, to come with me so as to continue our collaboration at Caltech, both on hot-spark spectroscopy and on cosmic-ray work, in which latter field we made our first balloon flight to an altitude nearly double any thus far attained in Europe. This flight was made in April, 1922, from Kelley Field near San Antonio, Texas, from which point Dr. Victor Neher and I, in the thirties, made some of our best and most illuminating flights.

Small—and Selective

In those early years I did not allow administrative duties to interfere with my primary job of trying to build an outstanding department of physics—the main objective of my going to Caltech. So far as internal administration was concerned, the setup of the institution did not require much of it from me. It was small and highly selective, and we proposed to keep it so. We left the very important problem of mass education to other institutions. The executive council and the trustees were a unit in limiting the number of freshmen admitted each year to 160. Without counting on losses, that would give a total undergraduate body of 640. We did not expect many undergraduate "fatalities" because we had set up a system for the careful screening of applicants, all of whom were required to pass entrance examinations in (1) mathematics, (2) physics, (3) chemistry, and (4) English and history. These examinations were adapted to the level of those finishing the twelfth high school grade.

We admitted no undergraduates whatever by credentials alone, for we wished to avoid the cruelty of admitting men and then dropping them because of unfitness for *succeeding* in the field of our type of training. The failure would then be our fault, not the applicant's. No man was injured, or developed an inferiority complex, if he had to go elsewhere because of failure to pass our entrance tests. It merely meant that his aptitudes did not lie in the direction of our program of studies. He knew, too, that three or four times as many failed as got in, and this try at the examination was his own private business.

Again, we were pioneering in developing an intensive three-year postgraduate program in engineering, with a definite sequence of studies leading to three graduate degrees—the master's degree, M.S.; the professional degree, E.E., C.E., M.E., etc.; and the doctor's or Ph.D. degree, but we wanted all of our staff to have the broadening effect of some undergraduate teaching, although not so much as to swamp them in their efforts to build for themselves outstanding reputations in their professional fields.

The Balance of Power

I shall next give the administrative setup with a presentation of my views about the weakness of power in the field of university administration, beginning with the unsupported assertion that in general the American college or university president has or may assume more power than is good, either for him or his institution. I attribute most of the academic rows about which I have known during the past sixty years to that situation. The following incident shows that I arrived at something like these views as a very young man.

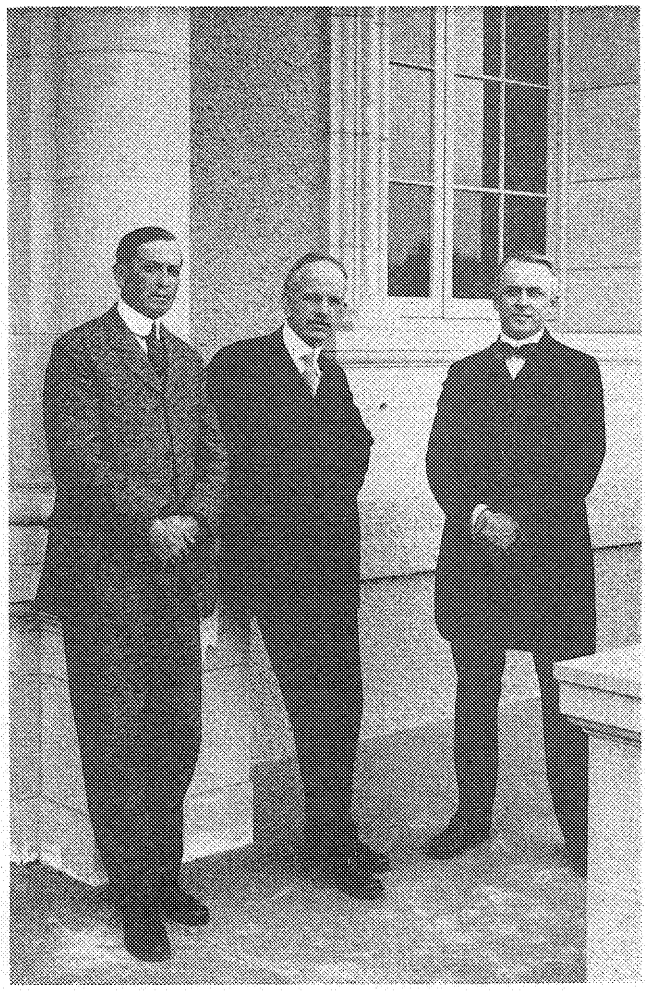
When the University of Chicago was being organized Dr. Harper appointed some dozen or more head professors, paid them the princely salaries (for those days) of $7,000 each, made them essentially czars in their departments, and gave them much power, also, in the

University at large. Some of us younger men led a debate in the faculty as to the wisdom of having head professors at all and got legislation enacted to the effect that no new head professors were to be appointed.

Our argument was that the great University of Chicago of the future, as we envisaged it, would want a number of men of distinction, perhaps many in some single department, and it would be harder to get and hold such men if they had to be subordinated to a one-man departmental head. We therefore urged and secured the abolition of the departmental head after the existing departmental heads were gone. We urged, too, that the highest rank and the highest salaries obtainable in the University of Chicago be associated with its most distinguished and outstanding scholars and teachers, rather than with its deans or other administrative officers, administration being in general subordinated to distinguished intellectual accomplishment.

All full professors in each department were to be charged with electing a man to be responsible for the administrative details of the department. He might be, and perhaps in general would be expected to be, one of the younger men, not one of those of greatest distinction, largest accomplishment, or highest salary. This plan of departmental organization, first started, if I mistake not, at the University of Chicago in the nineties, is now, I think, the most approved type of departmental organization in a large number of our foremost universities, the administrative officer being called "chairman" (in general a rotating officer) rather than departmental head.

However, in my sixty-three years of intimate contact with academic institutions it is not only in departmental organization that I have often felt that there was room for this kind of improvement. Probably the most frequent difficulties which American universities and colleges encounter have their origin in the distribution of power between the president, the faculty, and the board of trustees.



Arthur Noyes, George Hale and Robert Millikan in 1921

Organization of the Institute

What, then, is the origin of the American system in which the president is given so much power and stands to such an extent for the university? I suspect that the system has been transplanted from American business in which, especially because of the newness of the country, aggressiveness and activity being the indispensable qualities for success, there has developed, quite logically, too, a semi-military form of organization with lines of authority and responsibility clearly marked. Let me call it the Pentagon philosophy of organization, and let me recognize the fact that wherever *action* is more important than *wisdom*, as in military operations and to a lesser extent in American business, it represents at any rate a natural, if not a necessary, mode of organization. Also, since the trustees of most of our higher educational institutions are nearly all business men, a president and a hierarchy of deans was the natural basis about which the whole institution became organized and managed.

At the time when I went to the institute with a well formulated scientific program, which it was my purpose to carry out, the Pentagon philosophy obviously represented an impossible mode of organization for me to fit into. The trustees asked me to take the presidency, but I thought that the title itself would act as a deterrent to my scientific program, which I was determined not to abandon.

The written contract that I signed with the trustees when I came to the institute provided that I was not expected to spend my time raising funds; that my first and most pressing job was to build the best department of physics of which I was capable with the aid of a yearly fund of not less than $90,000 if I needed it. The expansion of other departments was to come later.

We then set up a scheme of organization of the institute that was based on the postulate that the field of higher education differed radically from the field of military operations or the field of business in that in it *wisdom* was vastly more important than *action*, and that *wisdom only comes from the joint, independent judgments* of a group of able and informed men. We therefore set up, to take the place of a president, an executive council consisting of four of the most interested and active trustees (an educating device for them) and four members of the faculty, all of large experience in educational matters.

The eight men constituting this council were entirely equal in authority and responsibility. There was no one above any of them save the full board of trustees. These eight met more frequently than the board, discussed beforehand all questions needing the attention of the board (of membership twenty to twenty-five) voted by telephone on obvious, noncontroversial matters, and came to know the institute from A to Z. The four faculty members of the Council sat with the board but had no vote in it. The board elected me chairman of the executive council, but the board got its picture of the institution and its staff equally through the four faculty members of the council rather than as usual through one man, the president, who thus lost power

PERSONNEL OF THE NORMAN BRIDGE LABORATORY—1921

Benioff DeRemer DuMond Goode Lewis Brode Greenlees Pearson
Klein S. Smith Miss Bedell Burt Bowen Friauf Claney Otis Merkel Henny
Whitney Watson Millikan Lorentz Epstein Bateman Gilmore

while the board gained greatly in its knowledge of the institution and the dependability of its own conclusions.

The following eight men served on the executive council without change for more than ten years: from the staff—Arthur A. Noyes, William Bennett Munro, Thomas Hunt Morgan, and myself; from the trustees —Allan C. Balch, Henry M. Robinson, Harvey S. Mudd, and James R. Page. This group thus had all the powers exercised by a president and in addition it had the interim powers of the trustees. Having four active trustees upon it, any clash in judgment between it and the trustees was almost impossible and actually never occurred. Also, embracing four very influential and experienced members of the faculty, it had ideal relations with the staff, which had access to the seat of authority not merely through one man but through four or even eight men. This setup made abuse of power by any individual virtually impossible.

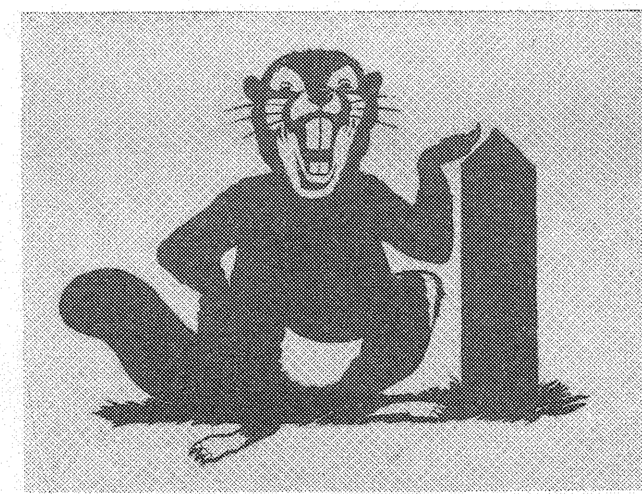
The aforementioned four faculty members of the council, as their names indicate, were all equally competent to represent the institute at home or abroad, for they were all men of broad interests as well as worldwide influence in their respective fields. They all shared the responsibilities of the executive office. After the death of Dr. Noyes and the retirement of Dr. Morgan, Max Mason and Richard C. Tolman, equally well known men, took their seats on the executive council. In general, any subject upon which there was not found pretty general agreement in the executive council at the start, and before prolonged debate, was dropped on the theory that there is practically never need of hasty action in the field of education. If eight competent and experienced men are not in agreement, the subject had better be dropped until conversions have occurred.

In addition to the foregoing device for improving the relations between the staff and the administration, there were set up a rotating faculty chairman and some fifteen standing faculty committees among which a large part of the routine administrative work of the institution was divided. Thus, the administrative work of the institute was spread throughout the whole staff, thereby giving the faculty, to its great advantage, increased opportunity to develop understanding of the institute and some administrative skill, as well as teaching and research ability. This dispersal of administrative responsibilities, instead of their customary concentration in a presidential office, enabled the four faculty members on the executive council to maintain without serious abatement their scholarly activities, as records of the foregoing quartet will show.

Whether such a plan of organization would work in a larger institution some may doubt. Also, there may be other equally good ways of avoiding the bad results, known to everyone, of the undue concentration of power in the presidential office that sometimes has occurred in American universities. The plan was set up to meet an exceptional set of circumstances, and it seems to have worked in the twenty-five years in which I was a part of it. Its essence is in the council of eight selected by the board, half from its own membership and half from the faculty, this council of eight having complete control, subject to the approval of the trustees, of all budgets and all appointments, promotions and salaries. Whether the presiding officer has the title of president or not is unimportant, the charting of some such mean course in university administration between the rule of the czar and that of the academic proletariat is the vital point in the interests of both the ruler and the ruled.

THE BEAVER

Some Notes on Student Life



A funny thing about exams: You worked hard on the subject the night before, panic-stricken about how little you knew, pouring knowledge into yourself from the books like beer into a big mug until you were saturated, brimming. Then you walked carefully to the exam, careful not to jiggle and spill a single fact from the reservoir. In the exam you just let it flow forth through your pencil, like releasing floodgates.

So the Beaver mused coming out of an exam. He felt pleasantly drained of all knowledge. It had always been a matter of conscious habit with him to forget an exam as soon as he had taken it. He had a certain distaste for the undertaker type of student who engaged in post-mortems at lunch, as if the results could be changed by a lot of groaning and gloating. It was like putting body english on a bowling ball.

After each exam, the Beaver felt, you should let your mind go blank (according to its natural tendency), and not worry about the results until after Christmas vacation. After all, worries combined with Christmas celebrations just give a man ulcers.

Accordingly, on seeing his math instructor outside the bookstore, the Beaver intoned "Merry Christmas" instead of "When will the exams be graded?"—and was prepared to make further talk about construction progress on the ME building if the instructor showed signs of tarrying.

Over vacation the Beaver enjoyed the last laugh on exams. While his vacation was bubbling with Christmas spirit in every sense of the term, his friends from State schools lived under the shadow of exams to come in January.

There were other advantages to having exams three times a year instead of twice. It not only cut down the importance of each one; it reduced the amount of material each exam covered. This meant a lot to the Beaver when he considered his cramming habits.

The Sidewalk Kibitzers

■ With great curiosity the Beaver watched the noble concrete structure rising next to the ME building. He joined the ranks of faculty, students, and secretaries in a mute equality of interest and stood beside the green fence, enthralled by the swinging cement pot and the nonchalant workers it almost decapitated on each swing.

It was highly satisfying to the faculty and students who wallowed in construction theory in class and text to have this practical scene, like a laboratory, thrown literally in their collective lap. But the Beaver wondered how the contractor was bearing up under this erudite and endless scrutiny. Didn't it take a bold and hardy man to build under the kibitzing of the entire engineering department?

The construction zone served some useful purpose apart from entertaining students, meandering deans, and secretaries making their hourly coffee-cruises to the Spoon, however; it had completely obliterated a large area of iceplant.

Other Kibitzers

■ There were vague stirrings on campus again about the instructor question. Something seemed to be lacking in teacher-student relations—though it was intangible enough so that no one knew where to aim an accusing finger. As the Beaver saw it and heard it from his friends, not many teachers showed much interest in their students. Small classes were not, in themselves, enough to achieve this; something more was needed. And certainly when students find they can get more from a course by working in their rooms during class time than by going to the class, something *is* needed.

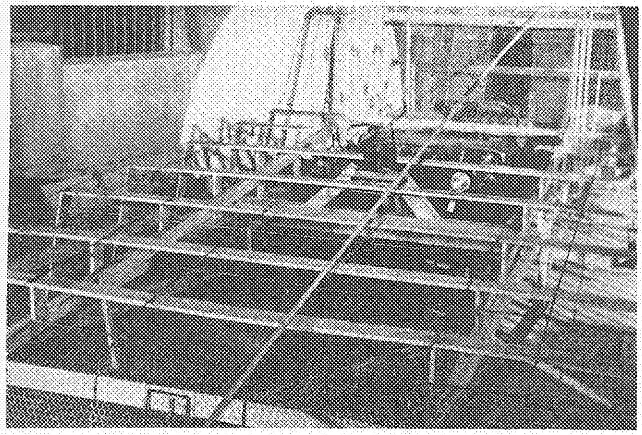
A point of basic significance seemed to be that, although the instructors undeniably understood their material, there was either no attempt or no ability to present it lucidly and dynamically to the students. It would be odd indeed to assume that, if a person knows his field well, he automatically knows how to teach it to groping undergraduate minds, and yet this seemed to be the general assumption. Sometimes, in fact, the opposite was true: An instructor, teaching while engaging in his own research, tended to feel the latter as his center of interest and his teaching only a necessary evil to be dealt with as summarily as possible. The result was an impersonal relationship in which the student ground out problems from the book at night and then watched them hacked over in class the next day. This was certainly not Teaching with a capital T. The Beaver wondered if the faculty wheels could not institute a requirement of teaching ability for its instructors.

The criterion was clear: Did the students feel it worthwhile to attend a class, *i.e.*, was material presented in the class in a more lucid, more integrated, more dynamic way than it could be obtained from a modest perusal of the text? And further, did the students have a personal enough relationship with an instructor to go to him in office hours and get sincere help on individual problems connected with the course?

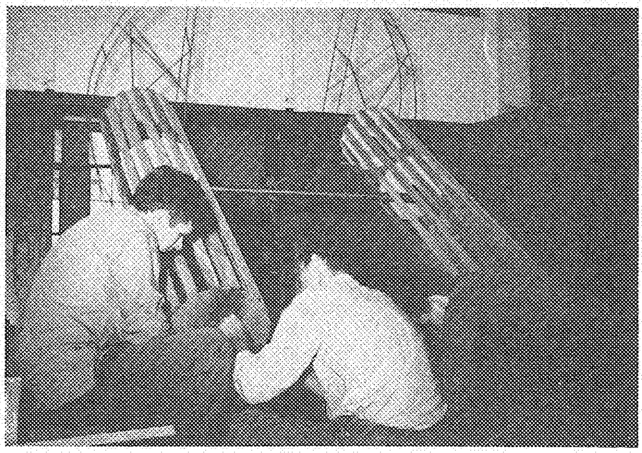
There was a test, of sorts, for these things in the Tau Bate questionnaires—in which the students for two years had rated the teaching of their instructors. The Beaver wondered what had ever happened to those questionnaires, and what results they had ever brought about.

—Jim Hendrickson '50

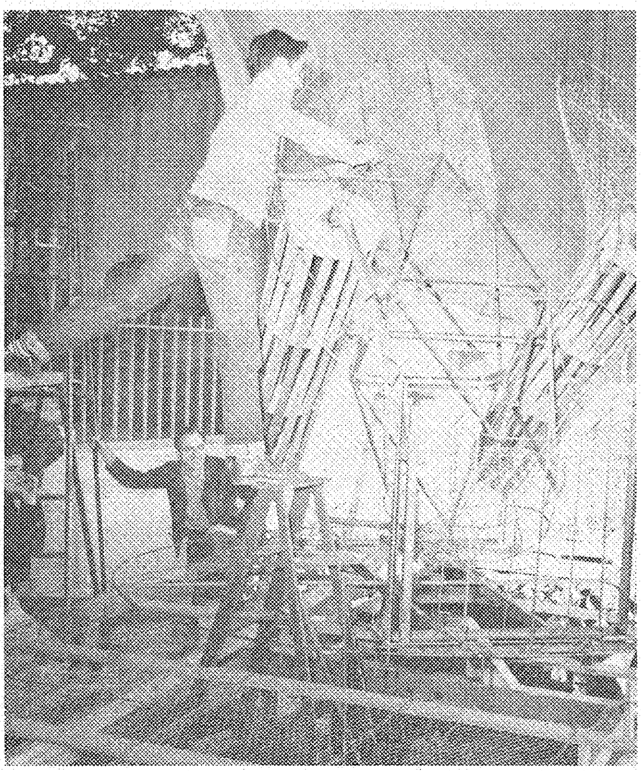
THE MONTH AT CALTECH



After five days work jeep is almost hidden by framework



Meanwhile, construction is underway on telescope section



Telescope section is now ready for mounting on turntable

Palomar on Parade

■ A HANDFUL OF CALTECH STUDENTS got an intensive, but liberal, education during the Christmas vacation by building a float for the 1950 Rose Parade. It was the first time the Institute had entered a float in the 61-year-old Tournament of Roses.

The float was almost entirely student-sponsored and built. More specifically, it was almost entirely the work of nine students—Mike Sellen '50; Robert Cobb, Richard Libbey, Anthony Malanoski, Dallas Peck, Peter Price, Noel Reed, all '51; Henry Clutz '52; and Ronald Willens '53.

Though most of the work was feverishly crammed into the period from December 17 to January 2, there had been talk of a Caltech float this year as far back as last October. When the Tournament of Roses committee invited the Institute to enter a float in this year's parade, the students o.k.'d the idea at a meeting last fall. Mike Sellen became general co-ordinator of the project.

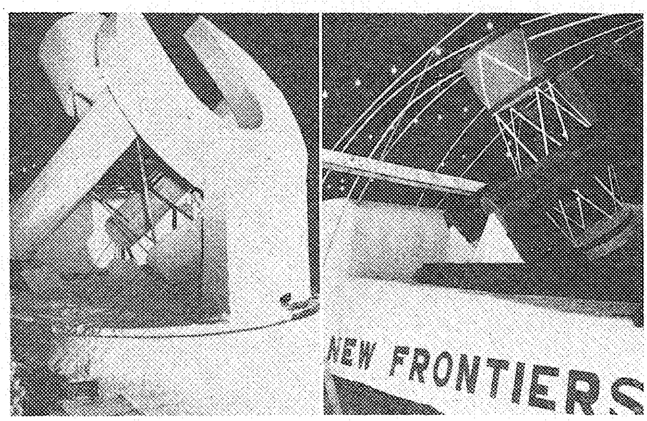
From the beginning Palomar was favored as the subject of the float. Henry Dreyfuss, the industrial designer, who lives in Pasadena, agreed to design the float, and by Thanksgiving he turned out some rough sketches. Then, supplied with a stack of photographs of Palomar, shot from every conceivable angle, he settled down to the final design.

Meanwhile Sellen had shopped for a florist, who agreed to supply all the flowers and materials for putting them on the float—but no labor. And he had arranged for the transportation for the float—a truck, which would back down the whole line of march in the parade. But at this point Sellen paid a call on an old hand in the float game, Roger Tierney, who runs a business known as Floats, Inc.

From this visit, among countless other nuggets of information, came the decision to use a jeep, going frontwards, instead of a truck going backwads, and to cover the float with chrysanthemums, because they cost less. (Hardly anyone, it turns out, uses roses.)

Work got under way on the float as soon as final exams were finished, on Saturday morning, December 17, after most students had gone home for the Christmas holiday. All the men who worked on the float lived too far away from Caltech to go home for the vacation.

The float consisted of a basic wood frame made up

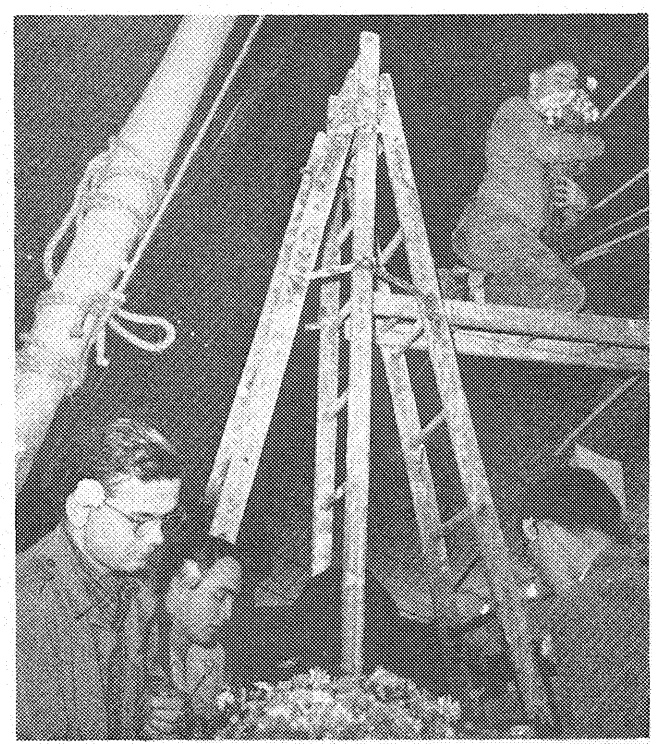


Float is covered with cheesecloth and plaster, then painted of load-bearing 4 x 4's with 2 x 4's around the skirt, and 1 x 4's to form the outline. Over this a lattice of ¼-in. steel rod, bent to give a smooth contour, was welded. The telescope itself was under construction inside the Astrophysics Shop while this framework was being built on the jeep in the archway between the Astro and Optics Shops. The 8-ft.-long tube and telescope were then set onto a turntable 9 feet in diameter and chicken wire was tied tightly over the whole surface of the float.

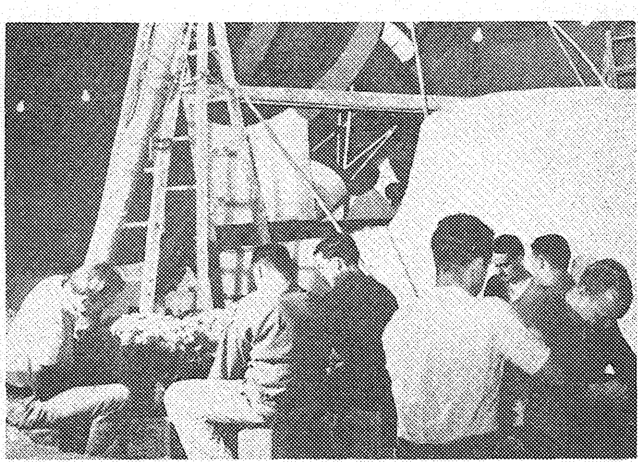
At this point the float moved precariously out onto California Street and headed into a huge circus tent set up on the grounds of the McKinley School at Hudson and Del Mar Streets, where it rendezvoused with several dozen other floats, all ready to be attacked by the florists.

The comet and stars and small 9-in. wood figures of men which further decorated the float were set in position now and the chicken wire was covered over with two layers of cheesecloth dipped in plaster of paris. When this was dry, the float was painted to look just as it would when covered with flowers. The flowers went on—and on—all through the day and the night of December 31, and the next day and the next night, until 4 a.m. on the day of the parade, January 2. Then the driver—and a man to operate the turntable which spun the telescope around—were sealed inside the float and it moved out of the tent to take its place in the parade.

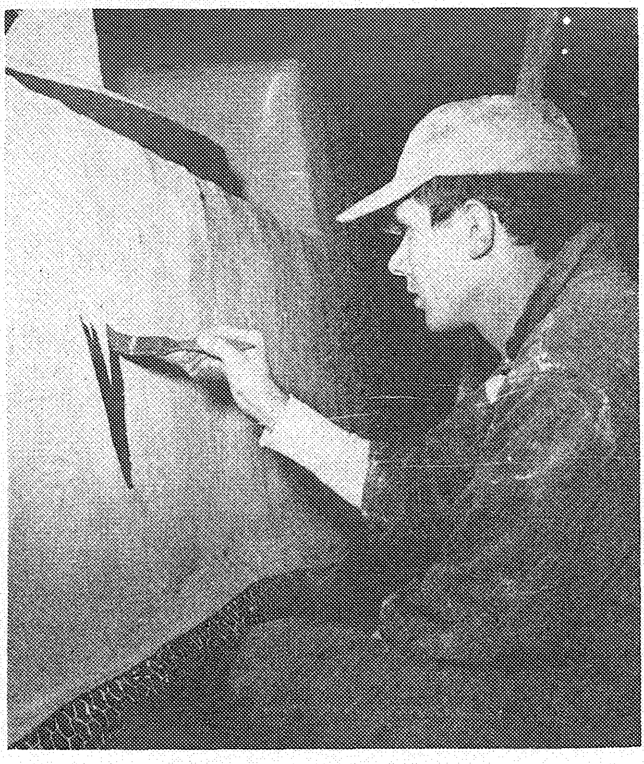
After all this, the parade itself was something of an anticlimax. The float was a great success with the crowd. Nothing broke, nothing bent. (The float-examiners, incidentally, had been awed at the craftsmanship and solid construction of the Caltech entry.) The driver and turntable-operator not only lived through it, but even managed to make their way back across town after it, to join the other workers on the float in their free seats at the Rose Bowl Game.



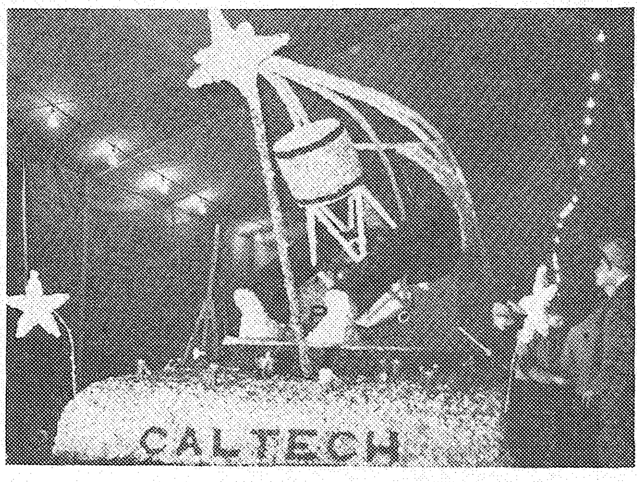
Workers went on night shift for job of applying flowers



Labor reserves had to be called out to finish job on time



Project Chief Mike Sellen paints legend on front of float



Float was finally ready for parade at 4 a.m., January 2

ALUMNI NEWS

Tau Bate Election

■ Two Caltech alumni and eighteen junior and senior students at the Institute were formally initiated into the campus chapter of Tau Beta Pi, national honorary engineering and science fraternity, on December 2.

The two alumni elected for their outstanding records of achievement in engineering since graduation were Howard B. Lewis, partner in the Lewis-Larson Company, Los Angeles industrial design consulting firm, and ex-president (1948-49) of the Alumni Association; and Dean E. Wooldridge, Research Associate in Electrical Engineering at the Institute, and head of the electronics division of the Hughes Aircraft Company.

Fall Social Season

■ The Alumni Association ran off three highly successful functions this fall. The season's opener was an open house held in Dabney Lounge after the Oxy game on October 28. Because the student houses were all having their own parties, this one was set up especially for alumni (and their friends) who attended Tech before the student houses were opened. A crowd of about 120 turned out—and stayed around until nearly 12:30.

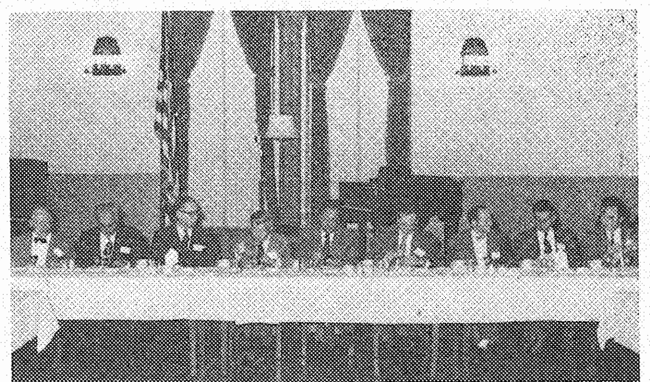
On November 16 a dinner meeting at the Pasadena Athletic Club drew some 60 alumni, who heard Henry Duque, President of the Los Angeles Police Commission, speak on the problems of municipal police work in general—and in Los Angeles in particular.

Last month's (December 2) square dance at the Pasadena Athletic Club had the ballroom jammed to the rafters with about 80 couples—and a lot of the alumni who turned up hadn't been seen at any Caltech functions for years.

The Alumni Association's next big date is Saturday, February 25, when there's to be a dinner dance at the Country Club Hotel in Los Angeles.

Chapter Notes

■ The Caltech Club of New York had its first meeting this year on the 19th of October at the International Headquarters of I.B.M., which had kindly arranged a demonstration of its Selective Sequence Calculator, a



At the speakers' table at the Alumni Association's November 16 dinner meeting — Sorensen, Lewis, Whitworth, Lewis, Duque, Barry, Clark, Hoge, Wetmore.

truly amazing representative of the new class of giant calculating machines. Twenty-seven members attended the meeting, presided over by Dick Brice.

■ THE SEPTEMBER MEETING of the San Francisco Chapter was held at the Alouette Restaurant in San Francisco. George Farly was the speaker of the evening and gave an interesting illustrated talk on the University of California's bevatron, a proton accelerator operating above the billion electron-volt range. There was an excellent group discussion following the talk which finally had to be broken up in order to get the members home at a decent hour.

The business part of the meeting was devoted to a discussion of the change in policy by the Alumni officers at Pasadena which had resulted in the withdrawal of the chief means of support of the San Francisco Chapter, namely the rebate to the chapter of a portion of the annual dues paid by alumni in this area. The necessity for this change had been explained at an earlier luncheon meeting by Mr. Nick D'Arcy, who explained that alumni funds were not adequate to meet expenses. By unanimous vote of the members present it was decided to establish San Francisco Chapter dues of one dollar per year, the first dues to be paid now and future dues payable to the local secretary at the same time as annual dues are payable to Caltech.

Promotion of the Alumni Fund for the new gymnasium was also discussed and it was decided to keep this project before the members at each of the future meetings.

Bob Loftness, ex-'43, dropped in to be with the group for the evening before continuing his trip to Los Angeles from Europe, where he had been studying for his Ph.D. Chapter members present were as follows: K. B. Anderson, G. Farly, W. E. Flavell, J. J. Halloran, H. P. Henderson, D. R. Jones, R. P. Jones, D. S. Nichols, C. Schraeder, W. H. Sigworth, L. P. Stoker, T. Vermeulen and C. H. Wickett.

The next meeting of the San Francisco Chapter will be a pot luck dinner-dance at the 20th Century Club, Berkeley, January 20th.

■ THE FALL MEETING of the Washington Caltech Alumni Chapter was held on the evening of September 4 at the Roger Smith Hotel. Sixteen members, several with their wives, attended the dinner and meeting. After the dinner, the group heard a very informative talk by Dr. Albert E. Lombard, Jr. on Air Force activities, illustrated by a motion picture.

Alumni square dance — at one of its more placid points.

PERSONALS

1919

M. Reginald Coles, after seven years as tool engineer for Douglas Aircraft, has returned to the Wagner-Woodruff Co., Los Angeles manufacturers of lighting equipment, as plant superintendent.

1921

Richard E. Hambrook has been vice-president in charge of operations of Pacific Tel and Tel since July. He has two daughters — one a sophomore at Mills, another recently engaged.

1923

John H. Puls reports that his daughter, Diane, is now in her second year at Whittier College, while his son, David, is in the 11th grade at Muir College.

John R. North, Chief Electrical Engineer of the Commonwealth and Southern Corporation, Jackson, Michigan, has been elected a vice-president of Commonwealth Associates, Inc., engineering subsidiary of Commonwealth Services, Inc. and successor to Commonwealth and Southern. He has been with C & S for 25 years. As Chief Electrical Engineer, he is in charge of system planning, technical studies and the design of substations, generating plants, transmission and distribution systems.

1925

A. Preston Collins, ex'25, has been hospitalized in Los Angeles for more than three months but should be back on the job by now.

1928

Frank Noel is an Assistant Maintenance Engineer with the California State Division of Highways. He lives in Redding, has a 13-year-old daughter and a 9-year-old son.

1929

Phil Murdoch, Ph.D. '32, received the Publications Award of the South Texas Section of the American Institute of Chemical Engineers at its recent meeting in Galveston. The award is a bronze plaque given to the member who has had the best paper published in a technical journal during the year. Phil is Professor of Chemical Engineering at Texas A & M and teaches graduate courses and directs research.

Charles A. Bosserman has been re-assigned to a new Boeing Project Staff as Test Engineer at the Seattle plant. For the past three years on the Boeing B-50 Bomber he has been in charge of hydraulic, fuel, oxygen and other piping system installations and specifications for, or the design of, such system equipment. His earlier assignments, during almost 12 years at Boeing, Seattle, were direction of engineering design groups for plumbing on the B-17 Flying Fortress, the Clipper Flying Boats for Pan American, and the Sea Ranger Patrol Bomber for the Navy. On the B-29 Superfortress he directed a group which prepared the Production Testing Procedures for equipment and functional systems.

1933

Lee T. Carleton is doing research with the Aerojet Engineering Corporation in Azusa. He has one son, Page, 12 years old.

Gregory K. Hartmann is Chief of the Explosives Division, Naval Ordnance Laboratory, outside Washington, D. C. He is carrying on work in the physics and chemistry of high pressures, temperatures, shock waves, plasticity, and other explosives phenomena and applications.

1934

Willis R. Donahue, still with General Petroleum as foreman of the Burrel Gas Absorption Plant, has been elected Secretary-Treasurer of the Coalingo-Kettleman Chapter of API for 1950.

1935

Adrian H. Gordon, M.S. '36, is serving as a principal scientific officer in the Marine Branch of the Meteorological Office, Air Ministry, London. He has a son, Martin Niel, born in December, 1947.

1936

David Harker, Ph.D., is head of the Crystallography Division of the General Electric Research Laboratory in Schenectady, New York. He has two daughters, one a sophomore at McGill University, and another in grade school.

Robert A. McIntyre, M.S. '38, and his

wife are expecting their first child in February. Bob is manager of the Calmec Manufacturing Co. in Los Angeles.

1937

Richard L. Ridgway is chief electrical engineer for the Frequency Conversion Division of the Canadian Comstock Co. Ltd., with headquarters in St. Catharines, Ontario.

1938

William B. Elconin is West Coast representative of the United Electrical, Radio and Machine Workers which was recently expelled from the CIO.

1939

William M. Green has been working since 1946 as an electrical engineer with the Bureau of Reclamation, first at Sacramento and, since the fall of 1947, in Fresno. The Greens have two children.

Jose Pulido Ortiz, M.S., is president of the Joint Council for Public Works in Nogales, Son., Mexico. He has two sons who have just finished two years at Randolph Macon Academy in Front Royal, Virginia.

Richard A. Fischer, development engineer at the Airesearch Manufacturing Co. in Los Angeles, announces the arrival of his third child—and second daughter—Kathleen Anne, on November 20.

John C. Evvard, M.S. '40, was recently appointed chief of the supersonic propulsion division, NACA-Lewis Flight Propulsion Laboratory in Cleveland.

1940

Jerome Kohl and his wife announce the arrival of a daughter, Joyce Eileen, on October 1.

1941

Glyn Frank-Jones is with the transmitter engineering department of the Federal Telephone and Radio Corp. in Clifton, N. J. He and his wife have a year-old daughter.

John Jordan is living in Kingman, Arizona, and working as a consulting mining engineer and geologist. He, too, has a small daughter.

Joe Lewis and his wife announce the birth of a daughter, Katharine Anne, on August 16. They already have two sons—Jeff, 5, and Jack, 3.

1942

Carter Hunt is Assistant Superintendent at the San Francisco plant of Hiram Walker & Sons, Inc. The Hunts have a second child, a girl, born in July.

Thomas G. Curtis, M.S. '44, after spending a year at UCLA as a teaching assistant in the engineering department, has started his own general contracting and design firm for western Los Angeles County. He has a year-old son, Daniel.

1943

Chuck McGee has accepted a position at the new Indian National Chemical Laboratory at Poona. He left for India late in December.

1944

Robert Randall was married on July 17 to Janice Peterson and is now living in Arcadia. He is with the Engineering Department of the Southern Counties Gas Co. in Los Angeles.

William Harland was married in November to Neolene Lattin of Vancouver, B. C. in the Harvard Memorial Church in Cambridge, Mass. They will live in Quebec.

Garman Harbottle received a Ph.D. from Columbia last spring. He's now employed at the Brookhaven National Laboratory in Upton, New York.

1945

Mark Macomber, Lt. (jg) USN, writes, "I am working in the Hydrographic Department of the vessel U. S. S. Tanner, which is one of two working for the Hydrographic office of the Navy survey work. The work which I am to do is something that, until recently, I supposed some other agency of the government did — namely, surveying ashore. I might as well join the Army, except that occasionally I will be permitted to return to the ship and clean up and get a good meal."

Robert Schmoker is attached to the academic staff of the U. S. Naval Academy, Annapolis, Maryland, as Instructor of Physics in the Electrical Engineering Department. He lives in Bay Ridge, Maryland, with his wife and daughter, Linda, age three.

1947

Walter Ogston, M.S., was married in April to Freda Gibson and is living in Northamptonshire, England. He joined the staff of the English Electric Co., Ltd. (steam turbine research department) in August.

Joseph Rosener is on leave of absence from the Columbia Steel Co., and is attending the Stanford Graduate School of Business.

Lu Pascoe is an office engineer for the Pacific Gas and Electric Co. in San Francisco. He was married in June, 1948, and is now the father of an 8-month-old daughter, Donna Lee.

Paul Atkinson, M.S., received an M.S. in Business Administration from Ohio State University in December.

1948

James Tostron, M.S., has been employed since April by Los Angeles County as a design engineer in the Sanitation Division. The Tostrons had a second baby girl, Lorraine Elizabeth, in May.

Chan Rypinski is employed by the Western Division of the Collins Radio Co. in Burbank, and is engaged in engineering work concerned with antenna and servo design.

1949

Don Six is a graduate assistant in the Department of Geology at Indiana University, Bloomington, Indiana.

James D. Malone is doing graduate work at the University of Wisconsin.

Theodore Crater, M.S., is Instructor in Electrical Engineering at the Michigan College of Mining and Technology, Houghton, Mich.

Kenneth Gardiner is employed by the Motorola Radio Co. in their new research laboratory in Phoenix. "I find Phoenix a fine place to live and invite anyone tired of the smog over for a few clear days and fresh O_2."

Books CONTINUED FROM PAGE 4

Communist Party and therefore of the Soviet government. Following a period of some uncertainty as to the outcome, the issue was recently resolved. Genetics has been proscribed in the USSR and has been banned from the schools and research institutes, and its supporters have either recanted or been removed from their positions.

In his new book, Julian Huxley, biologist and first director-general of UNESCO, undertakes to explain for the general reader the nature and history of this controversy in both its ideological and scientific aspects. The book is an expansion of an excellent article written by the author for the British journal *Nature*. It is, on the whole, the most dispassionate account of the Russian affair that this reviewer has seen.

Probably no one is in a worse position than the professional scientist to forecast the probable degree of success of an author in presenting the subject matter of his own field to the public. Whether or not this book will make the concepts and methods of genetics clear to the general reader I cannot say. But this is a matter of relatively minor importance. What is important, and what Huxley makes very clear, is that this whole affair is not, strictly speaking, a scientific controversy at all, but is an ideological and political one. It is not only a biological theory that has been rejected, but the scientific method, and the situation therefore has the widest implications.

To convince himself of the truth of this statement, the reader should turn to the stenographic report of the Proceedings of the Lenin Academy of Agricultural Sciences, July 31-August 7, 1948, recently made available in an English translation. This meeting marked the climax of the genetics controversy in the USSR. Numerous quotations from the report are to be found in Huxley's book, but to grasp to the full the flight from reason now under way in Soviet biology, the document itself is almost indispensable.

Through the looking-glass

One need not be a specialist in genetics to realize that here one is through the looking-glass and in a dream-world where, to quote Huxley, "they neither demand nor accept the same kind of evidence as professional scientists elsewhere; they confuse fact with doctrine and theory with hypothesis or with belief; they misuse or redefine terms to suit themselves; they appeal to past authority instead of to present established fact and to utility instead of truth; they accept other than scientific criteria, or even insist upon them, in what purports to be a scientific argument."

The scientific aspects of the controversy, such as they are, can be summed up briefly. Chiefly on the basis of two poorly documented experiments (one claiming to show certain hereditary effects of vernalization, the other of grafting) it is proposed to abandon the gene theory and all that goes with it (including the personal verification of the basic experiments of genetics by countless individuals all over the world) in favor of a slightly modified form of Lamarckism, called Michurinism. The central point in this hypothesis, suggested by Lamarck in 1809, is that the characteristics which an organism acquires during the course of its life are transmitted to its offspring. This idea was widely accepted in the 19th century. Darwin was one of its adherents. Not only did it sound plausible, but it seemed to be a practically indispensable element in evolution theory. The only difficulty was that no convincing evidence could be found in its favor.

With the discovery of the real nature of inheritance by Mendel in 1865 and the development of the gene theory by T. H. Morgan and his coworkers, the Lamarckian hypothesis became unnecessary. Mendelian genetics plus natural selection account for everything that Lamarck set out to explain and much more besides. Moreover, the gene theory is based on a massive foundation of internally consistent, mutually supporting experimental evidence.

The gene theory has grown far beyond the stage where it can be annihilated by an inspired experiment. That it will, in the course of time, be improved and elaborated and eventually included in some more general formulation, there is little doubt. But to imagine that any scientific developments of the foreseeable future will necessitate that it be scuttled is to misunderstand the nature of scientific progress. To quote the late Morris R. Cohen, "If every discovery simply replaced all previous knowledge, we should have something like an oriental dynastic change where the new regime kills off all the remnants of the old regime which it displaces. The progress of science is not a complete replacing of the old by the new, but a process of continual self-correction."

It is just such a dynastic change which is now taking place in Soviet biology, ostensibly on the basis of experiments the interpretation of which is not merely dubious, but indeterminate, since they have not been properly described. How is this to be accounted for? Does it mean Russian scientists have forgotten how to evaluate evidence? I think not.

The prime consideration

The explanation is rather that the scientific evaluation of evidence is no longer considered of prime importance in Soviet biology. The prime consideration is conformity to the position adopted by the political leaders of the Party. This position was announced by Academician T. D. Lysenko, leader of the anti-Mendelian forces, at the closing session of the meeting of the Lenin Academy: "Comrades, before I pass to my concluding remarks I consider it my duty to make the following statement. The question is asked in one of the notes handed to me, 'What is the attitude of the Central Committee of the Party to my report?' I answer: 'The Central Committee of the Party examined my report and approved it.' (*Stormy applause. Ovation. All rise.*)"

The Central Committee is apparently the ultimate authority in scientific matters. The situation was summed up by I. M. Polyakov in his speech of recantation following the above announcement: " . . . One must frankly say that the Michurinian trend is the highroad of development of our biological science, and this is the road we must follow. It is the only possible road for Bolsheviks, Party and non-party, who desire to work in the field of our biological science and bring benefit to our Soviet people, to our Country . . . It is necessary to understand the chief and fundamental thing, namely, that our Party has helped us to effect a profound and radical reconstruction of our science, has shown us that the Michurinian theory defines the basic line of development of Soviet biological science, and from this we must draw the conclusion and work to promote the Michurinian trend."

The sentiments of the Lenin Academy were soon implemented by decrees from the USSR Academy of Sciences and the Ministry of Higher Education ordering the abolition of genetics laboratories, the dismissal of geneticists, and the revision of textbooks. To quote Kaftanov, Minister of Higher Education, in an editorial in *Izvestia*: " . . . The struggle in the field of biology has ended in a complete triumph of Michurin's doctrine, presenting a new stage in the development of materialistic biology. Thanks to the Bolshevist Party and, personally, to Comrade Stalin, ways for the further triumphant march of the most progressive Michurin biological science are now clear. The scientists of our colleges will apply, from now on, all their energy to the propaganda of Michurin's biology and to the support of the undivided rule of Michurin's biological doctrine in our higher institutions of learning." (From *Science*, Jan. 28, 1949.)

From science to oracles

The question remains: Why is it that the Soviet political leaders have adopted this particular line? This question is not an easy one to answer, and Huxley presents a discussion of the various contributory factors which were probably involved. At least one general conclusion is clear; namely, that errors of this sort are the inevitable consequence of authoritarianism in science. Wherever the principle is accepted that a higher authority exists for science than the authority of the scientific method itself, mistakes are bound to be made. For no matter how respected the authority and no matter how high its ideals, the deliverances of authority have, at best, the standing of hypotheses in science, to be doubted until proved. Where doubt is suppressed, science ceases to exist and gives way to oracles—and it has been the general experience of mankind that oracles do not always give the right answers.

SCIENCE IN THE NEWS

Rocket Ship

■ SPEAKING BEFORE THE American Rocket Society in New York last month Dr. Hsui-shen Tsien, Caltech's Goddard Professor of Jet Propulsion, startled his avant-garde audience with the announcement that transcontinental rocket ships were a lot closer than most engineers suspected. "The requirements," he explained, "are not at all beyond the grasp of present-day technology."

Specifically, Dr. Tsien enumerated some of the requirements for a rocket-liner capable of nearly 10,000 miles an hour which would fly from San Francisco to New York in less than an hour. It would be shaped like a pencil, about 80 feet long and 9 feet in diameter. It would have a pair of small wings set midway between the nose and the tail, with tail fins of about the same size and a vertical tail fin slightly larger.

At takeoff it would weigh about 50 tons, of which 37 would be fuel load. Fuel would be a combination of either liquid oxygen and liquid hydrogen or liquid fluorine and liquid hydrogen. It would be out of sight in a matter of seconds after takeoff and would not be visible again until just before landing. It would travel the first 1,200 miles as a rocket and then glide for 1,800 miles. The highest altitude it would reach on the flight would be 300 miles, and the top speed would be 9,140 mph. Landing speed would be slowed down to 150 mph.

The ships have been in blueprint design for some time, according to Dr. Tsien, and both the Army and Navy are experimenting with designs of a rocket vehicle that might some day carry passengers.

Shock Symposium

■ UNTIL SCIENCE finds a way to protect the human body from the exaggerated forces involved in rocket travel, however, not many people are likely to become coast-to-coast rocket commuters.

Nevertheless, this was one of the topics under discussion at a Shock and Vibration Symposium held at the Institute last month, December 14-16.

"Basic science has far outstripped the human factor," said Commander Robert J. Tranger, executive officer of the Office of Naval Research in Pasadena. "The limitations imposed by what the human body can stand are now approaching the limits of man's physical and psychological ability."

He was speaking at one of the two open sessions of the three-day meeting, which dealt almost exclusively with classified material and was closed to the public. Attended by more than 200 scientists and experts on rockets and guided missiles, the symposium was conducted by the Office of Naval Research for the National Research and Development Board.

Though it has always been known that men and machines are often endangered by the effects of mechanical shock and vibration, the full significance of these hazards has been recognized only in recent years. In any moving vehicle certain unwanted, destructive forces are generated because of vibration, shock and impact—on choppy seas, in bumpy air, over rough roads. All through the history of transportation a large assortment of cushioning devices and shock absorbers has been utilized, most of them on a trial-and-error basis. During the recent war, when men and machines had to be protected against the most severe conditions of shock and vibration which might be encountered, it became apparent that there was no prewar background of knowledge, so makeshift methods again resulted. After the war the Naval Research Laboratory got the job of centralizing current knowledge of mechanical shock and vibration. To perform this function a series of symposia was inaugurated. Last month's meeting at the Institute was the 14th in this series, and the second (the first was at Wright Field, in Dayton, Ohio, last September) to be held outside the Washington area.

Multi-Stage Rocket

■ EXPERIMENTS ARE NOW under way on a new type of missile which is expected to break the present 250-mile altitude record for rockets. The record-making two-stage rocket—a small WAC Corporal launched from a V-2 at about 20 miles altitude—was fired from the White Sands, New Mexico, Proving Ground last February (E & S, March '49).

The new missile, which has been test-fired at short, low ranges, is a multi-stage affair, presumably using a combination of three or more rockets to go off at intervals. Scientists believe that by adding still more stages to a missile, fantastic speeds may be attained in the region beyond the earth's atmosphere where there is no retarding friction of air.

Appeal for Funds

■ A DISTINGUISHED group of scientists—including six Nobel Prizewinners—made a public appeal recently for $75,000 to continue publication of the *Bulletin of the Atomic Scientists*. The *Bulletin*, they said, which was founded in 1945 by a group of scientists at the University of Chicago, was necessary to provide "an unbiased and thorough examination of the issues which crowd forward in the common field of science and public policy."

Originally, the monthly *Bulletin* was partly supported by grants from the Emergency Committee of Atomic Scientists. At the end of 1948 financing was taken over by a Board of Sponsors.

Among those who signed the appeal were Dr. Detlev W. Bronk, President of Johns Hopkins University; Dr. L. A. DuBridge, President of the California Institute; Dr. J. Robert Oppenheimer, Director of the Institute for Advanced Study at Princeton, New Jersey; Dr. Harold Urey of the Institute for Nuclear Studies at the University of Chicago.

Rain-Maker

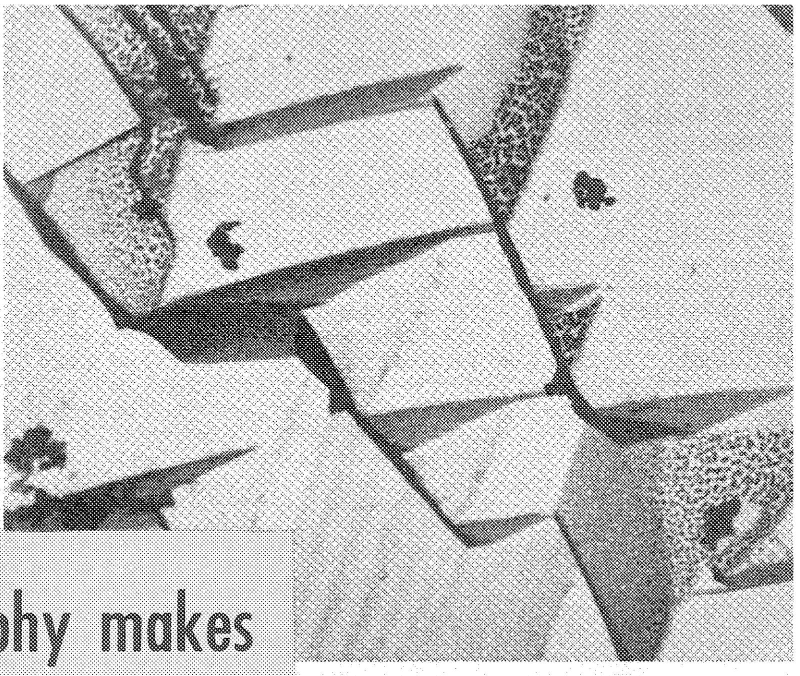
■ DR. IRVING P. KRICK, head of the American Institute of Aerological Research, last month reported on a new technique for producing rain which obviates the use of dry ice and airplanes. According to Krick, the new method, which uses mobile dispensers of silver iodide "smoke" on the ground, just about quadrupled the rainfall in a small Arizona area.

The use of ground dispensers makes rainmaking a more economic procedure. Krick estimates that a job which would cost a million dollars for seeding dry ice pellets and silver iodide by plane could be done as well or better for $100,000 from the ground.

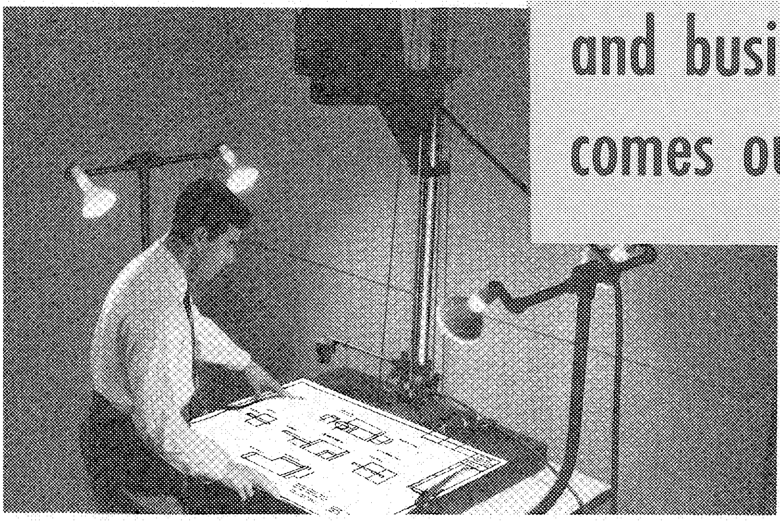
"Judging by the research operations in Arizona," he says, "large-scale surveys of the problem surely are in order."

Photography makes big things small—small things big—and business comes out ahead

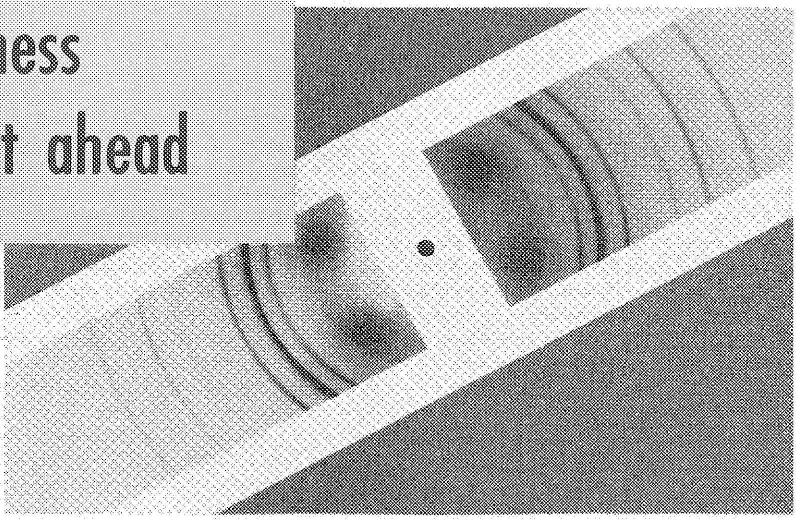
DISPLAYS MASSIVE PRODUCTS—A Diesel locomotive can roar across the Rockies—all on a movie screen in a prospect's office. All because photography can take huge things or small, and make them of a size for a salesman, teacher, or demonstrator to show.



MAKES MICROSCOPIC DETAILS CLEAR—Photography takes great magnifications produced by the electron microscope (20,000X) on fine-grain Kodak plates, enlarges and records them up to 100,000X on Kodak projection papers. Previously undetectable details and new facts are revealed.



REDUCES FILING SPACE BY 98%—With microfilming, bulky records can be reduced and stored on a few rolls of film. 675 drawings, 24" x 36", can be recorded on a 100' roll of 35mm. Recordak or Kodagraph Micro-File Film. And everything is quickly ready for reference in the Recordak or Kodagraph Film Reader.



REVEALS STRUCTURE AND CONDITION OF METALS—X-ray diffraction patterns on Kodak films or plates provide important information concerning the crystal structure of metals. These patterns help show how alloys can be improved or new alloys made—give data on the effect of machining, drilling, and punching upon the structure of the material.

With the speed of a flick of light, photography can reduce or enlarge accurately to scale, and without missing the tiniest detail. And that's not all.

It can magnify time with the high speed motion-picture camera so that the fastest motion can be slowed down for study. It can record the penetrating x-ray and reveal internal conditions of materials and products. With movies and stills, it can repeat a story, time and again, without the loss of a single detail.

Yes, photography serves business and industry in many important and valuable ways. It can work for you, too. If you would like to know how, please feel free to write for literature, or for specific information which could be helpful to you. Eastman Kodak Company, Rochester 4, New York.

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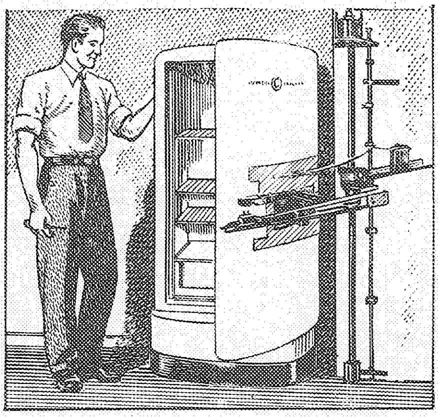
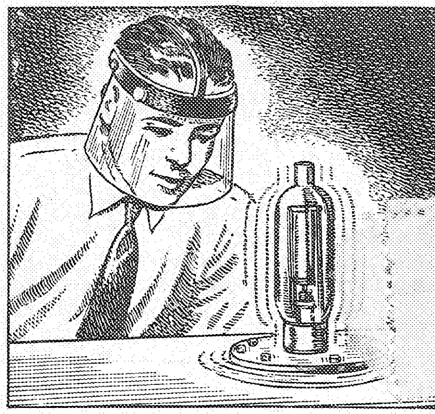
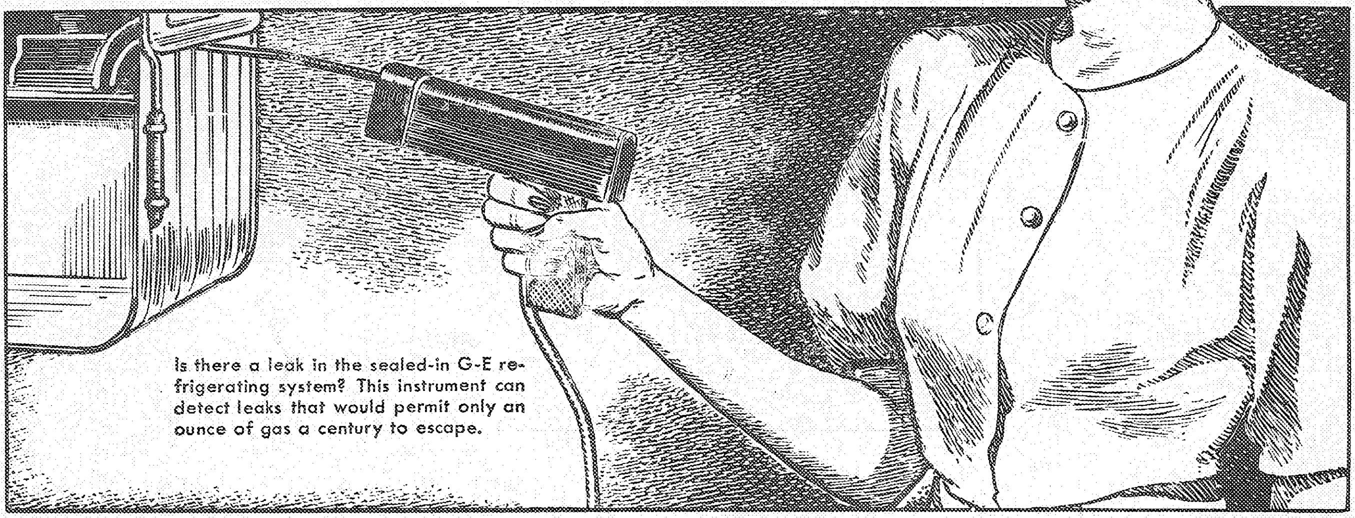


Will refrigerator doors stand up to years of slamming? This device slams them 350,000 times, equivalent to 25 years' average use.



Will vibration harm tubes for aircraft radio? G-E engineers developed equipment to shake them 25 times a second for 100 hrs.



Is there a leak in the sealed-in G-E refrigerating system? This instrument can detect leaks that would permit only an ounce of gas a century to escape.

These were also tough tests for G-E engineers . . .

A LEAK that would take years to deflate a tire is big enough to cause trouble in the cooling system of a refrigerator. How to devise test equipment sensitive enough to catch such microscopic flaws and eliminate them from General Electric units was also a tough test for engineering skill and ingenuity.

But the G-E engineer in search of solutions makes use of the stream of new ideas flowing from industry's largest technical staff—the more than 9000 scientists, engineers, chemists, physicists, and mathematicians employed by General Electric.

The principle for the new electronic leak-detector now being used to check refrigerators came out of the G-E Research Laboratory. Further development of it was carried on by the General Engineering and Consulting Laboratory. It was applied to refrigerator testing by engineers in the Company's Erie, Pennsylvania, plant.

To the consumer, this sort of teamwork means better, more dependable, longer-lasting General Electric products. To the engineer it means more varied opportunities, quicker development, the advantages of belonging to an organization where emphasis on research and incentives for creative thinking are the tradition.

You can put your confidence in—

GENERAL ELECTRIC