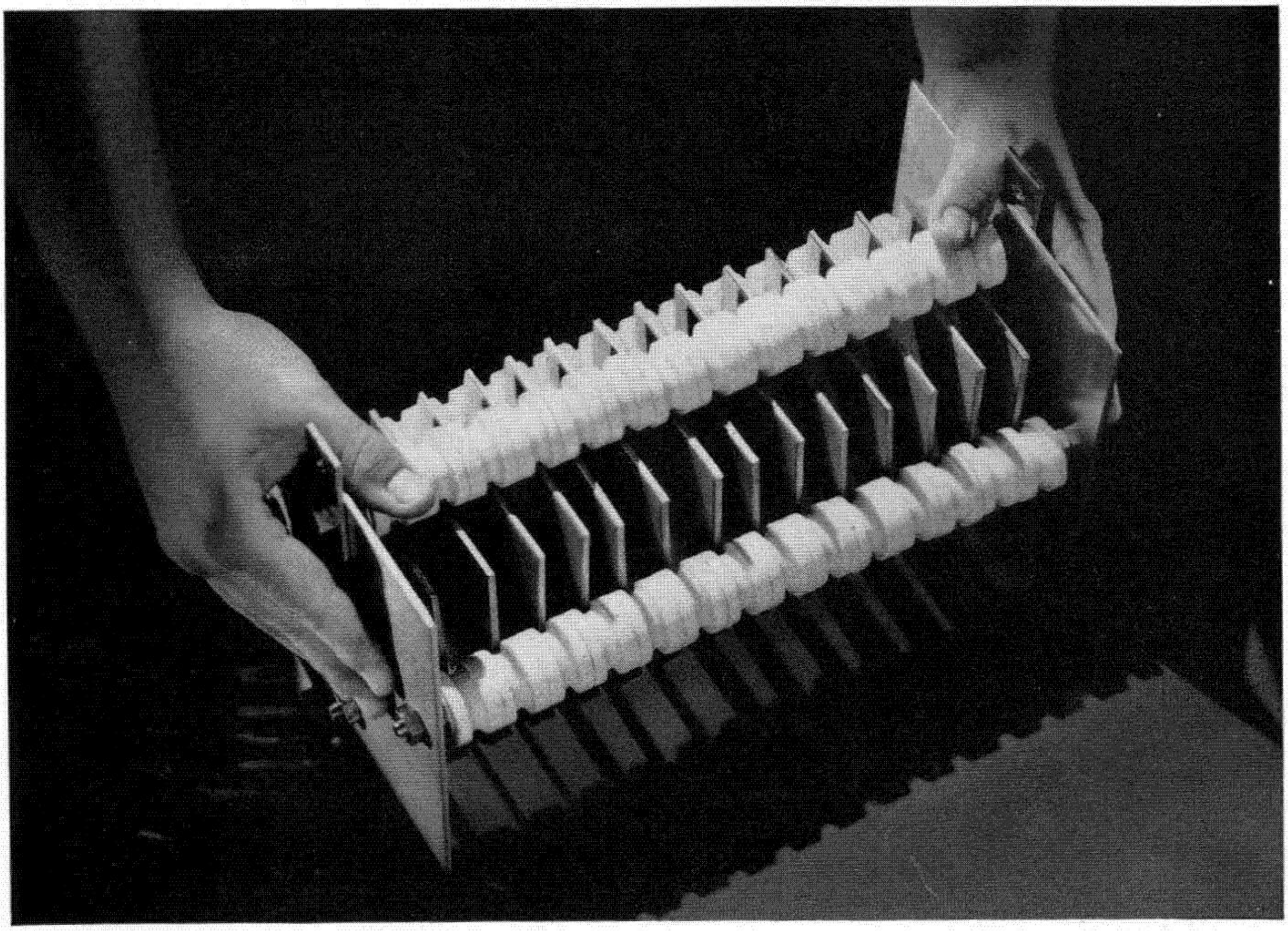
ENGINEERING AND SCIENCE

OCTOBER/1952

The Jet Propulsion Laboratory . . . page 11

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



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This guinea pig test is typical of the many and varied research projects sponsored by United States Steel. Trained metallurgists in the field and in dozens of research laboratories are working to develop new steel compositions, and to solve problems involving the more efficient use of steel. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.

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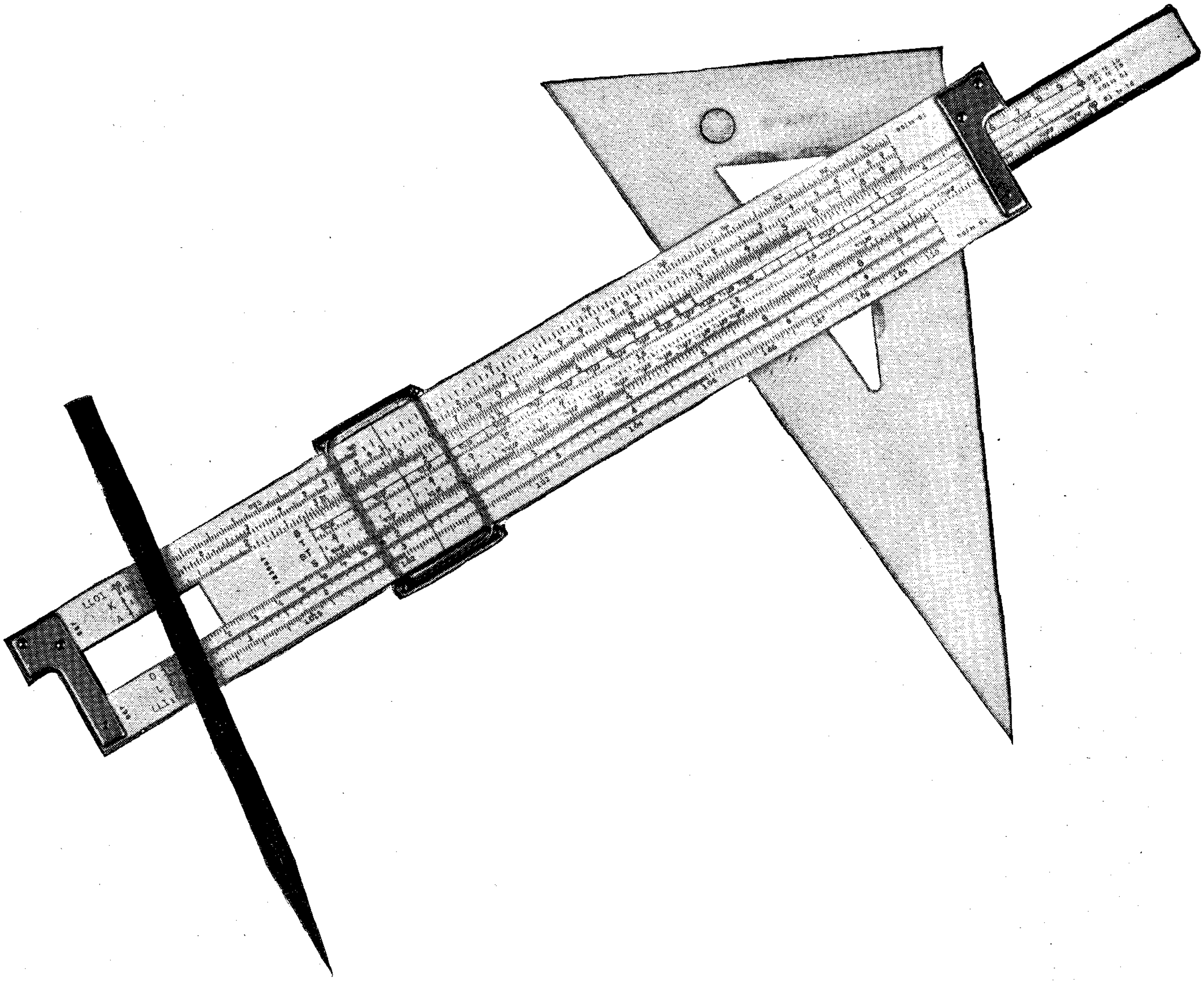

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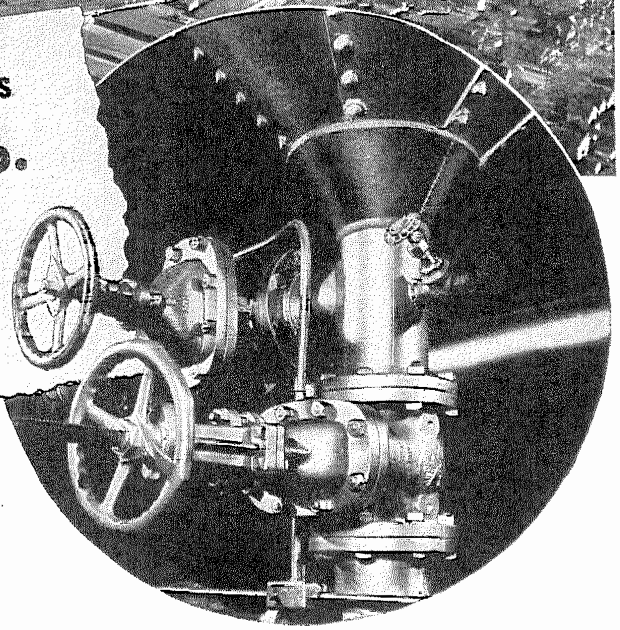
consults past performance records . . . repeats choice of JENKINS VALVES



If you set out to build an industrial "proving ground" for valves, it could include few tougher tests than those imposed in normal services at this 108-building plant for the manufacture of Staley's Corn and Soy Bean Products at Decatur, Illinois.

Processing heavy syrups and concentrates soon seeks out any weak spots in valve design and construction. The punishing work load on valves imposed by tremendous volumes of fluids handled is indicated by the water requirements alone,—over 20,000,000 gallons a day.

Previous experience with the low-cost performance of Jenkins Valves led to their repeated choice for 30 new buildings constructed as part of Staley's multi-million dollar post-war expansion program.

This confidence in the *extra measure* of efficiency and endurance built into Jenkins Valves is shared by plant operating managements in every type of industry.

Despite this extra value, *they pay no more* for Jenkins Valves. For new installations, for all replacements, the Jenkins Diamond is their guide to lasting valve economy. Jenkins Bros., 100 Park Ave., New York 17.

CONTROLLING FLOW from a syrup blending tank (above) requires valves that are "maintenance misers". These are some of the thousands of Jenkins Valves in the Staley plant on water, steam, and processing pipelines, and on compressed air piping serving pneumatic ducts for dry products.

JENKINS

LOOK FOR THE DIAMOND MARK

VALVES

SINCE 1864 — TRADE JENKINS MARK

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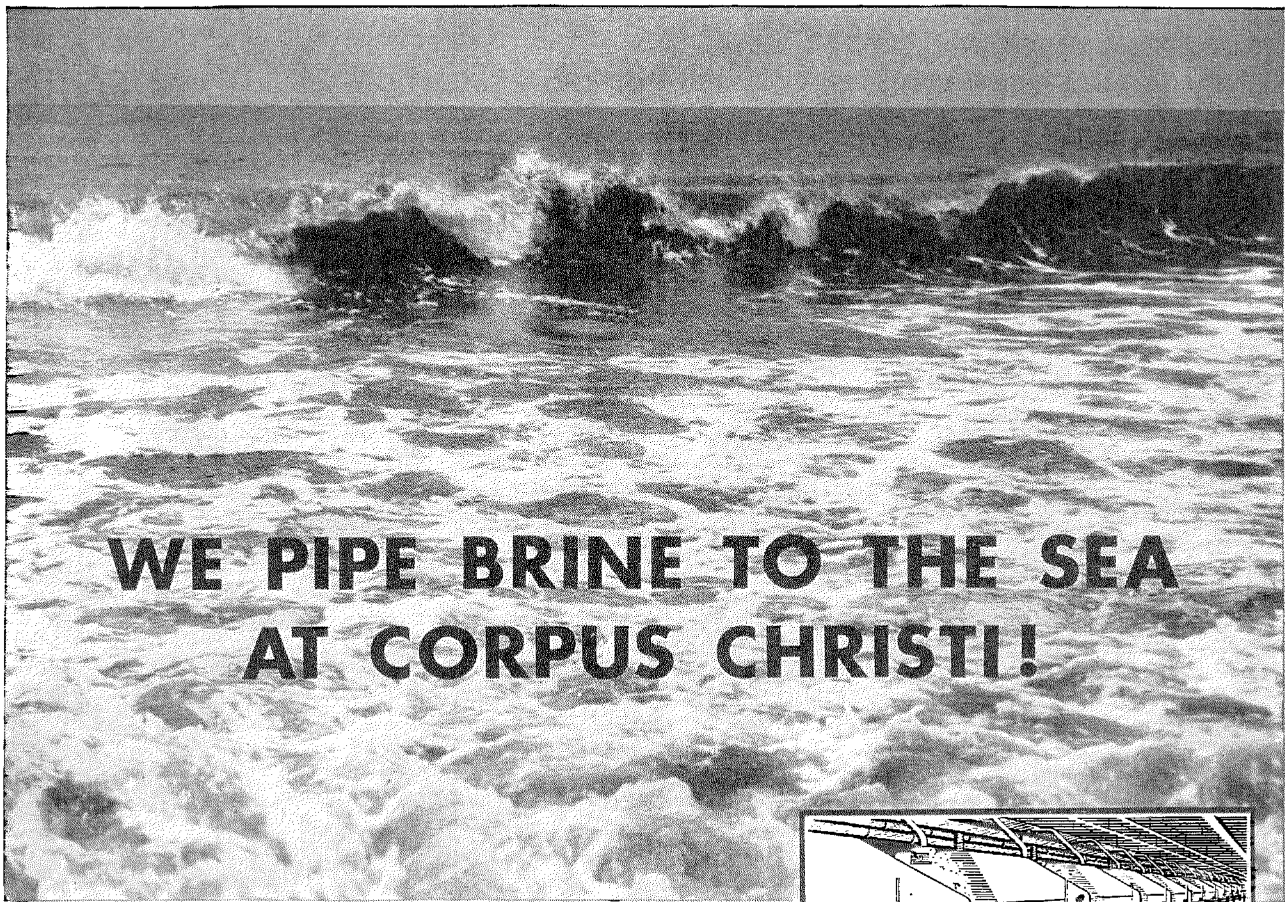
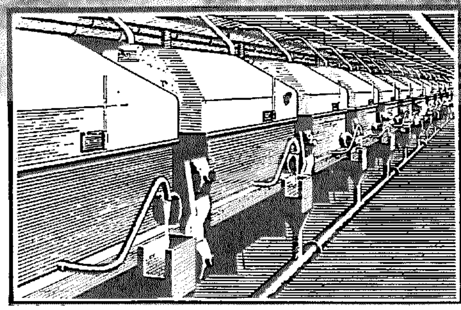


WE PIPE BRINE TO THE SEA AT CORPUS CHRISTI!



THE ELECTROLYSIS OF BRINE

Basis of most chlorine production—and therefore a large share of the production of its principal co-product, caustic soda—is the electrolysis of aqueous solutions of sodium chloride.

Using diaphragm cells of ingenious design, the electrical decomposition results in chlorine gas, hydrogen gas and liquid caustic soda.

Chlorine and caustic soda are essential in the processing and production of a multiplicity of products and rank among the most important of all the world's manufactures. Columbia-Southern is one of the major producers of chlorine, caustic soda and other alkalies and related chemicals.

Although Corpus Christi lies almost at the tip of Texas, on the shore of the salty Gulf of Mexico, Columbia-Southern has brought billions of gallons of brine to its plant there, from the great Palangana salt dome, 60 miles inland. This is less of a paradox than it seems, for with the huge quantities of brine involved in the manufacture of chlorine, caustic soda and other alkalies, it is far more costly to purify and produce saturated saline solutions from sea water on such a scale.

The brine is transported through a 14″ pipe line—the nation's longest cast iron line at the time of its construction in 1933. A down-hill flow the entire distance, the capacity is over a million gallons per day—equivalent to more than 125 tank cars of brine, or 30 freight cars handling 2,500,000 pounds of solid salt!

This is one of numerous unique features of Columbia-Southern's Corpus Christi plant—the pioneer alkali operation in the Southwest, and a forerunner of the tremendous chemical expansion in that area. Other Columbia-Southern plants serving industry's needs for alkalies and related chemicals are located at Lake Charles, Louisiana; Barberton, Ohio; Natrium, West Virginia; Bartlett, California.

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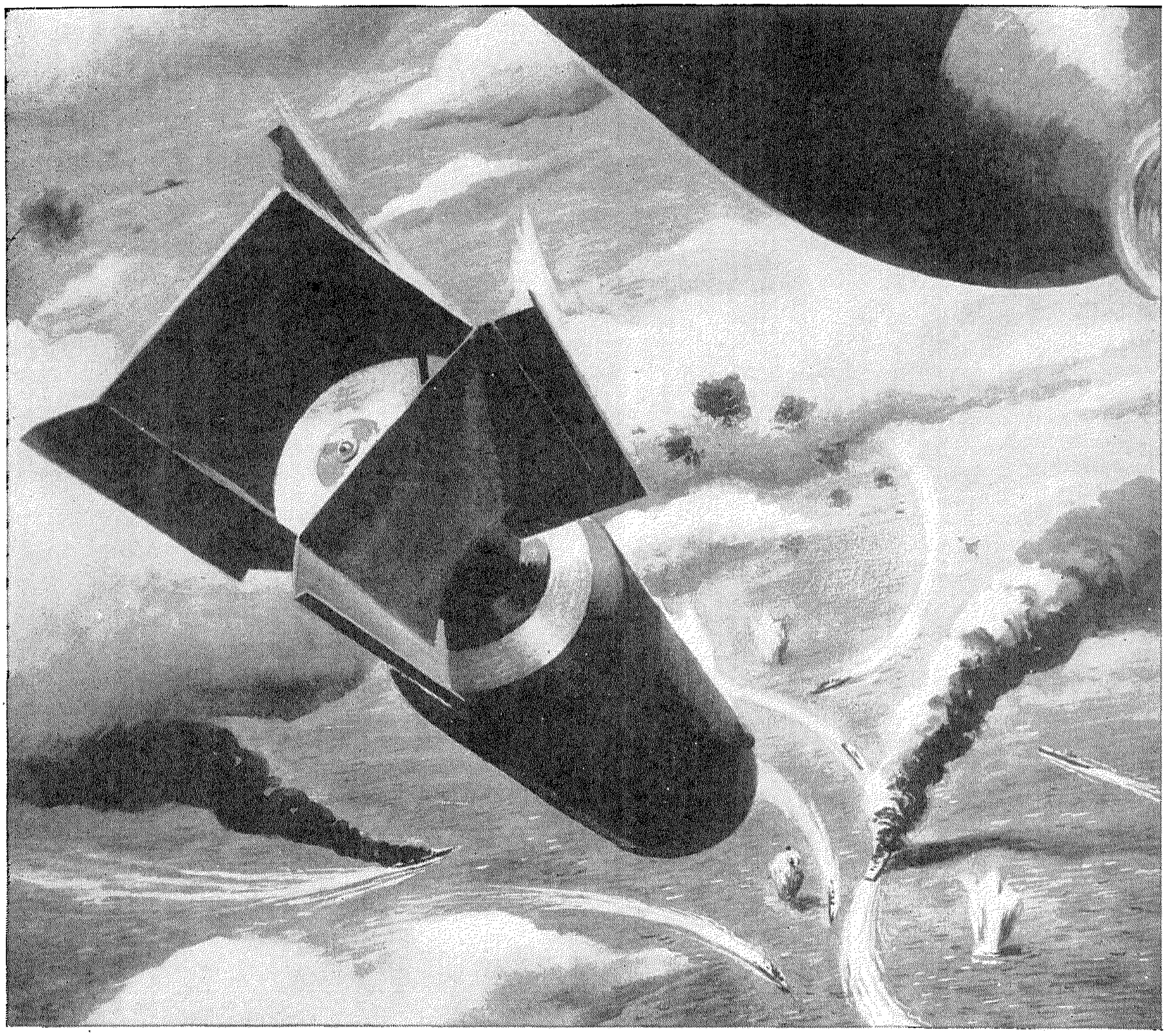

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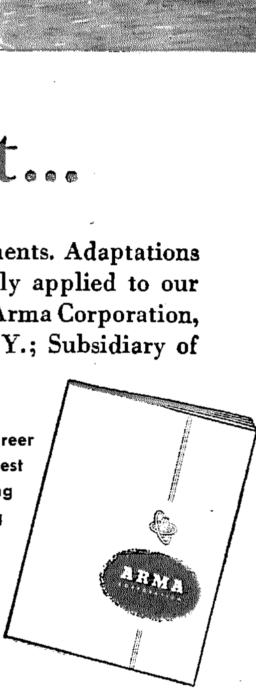

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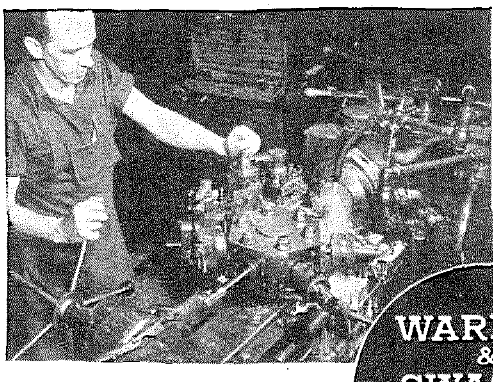
That's the sort of "prosperity" America has been "enjoying."

Most Americans feel they're worth more today than a few years ago; actually their savings have been whittled away 23% in the 7 years since the war. *More money without more goods* always bids prices up and up to the sky.

If you like what's been happening to you, if you think this is prosperity, let's make a *good* job of it; let's make every bill a *million* dollar bill— or a *billion,* as Germany did. If inflated money makes everybody happy, let's be hysterical!

But Germany didn't find it much fun, the morning after.

Source: "How to Keep Our Liberty" by Raymond Moley. Published by Knopf, 1952



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CEREBRAL MECHANISMS IN BEHAVIOR

The Hixon Symposium

Edited by Lloyd Jeffress

John Wiley and Sons, N. Y. $6.50

Reviewed by John S. Stamm
Research Fellow in Biology

How the brain functions has alwas been a great puzzle to both laymen and experts. It is interesting, therefore, to see what a group of 19 outstanding scientists had to say on this subject when they met at the California Institute of Technology in the fall of 1948. These men, who came from several different disciplines (mathematics, chemistry, physiology, neurology, psychology and psychiatry) shared their research findings and theoretical formulations during the week of this symposium. This book contains six of the seven papers which were presented there, and records of the discussions, which have been ably edited by Lloyd Jeffress, who was Hixon Visiting Professor here in 1947-48.

Unfortunately, there is no introduction to the symposium, so that the reader is never quite certain what purposes and goals the participants had set for themselves. Since, moreover, they talk mainly to one another, the uninitiated reader will find it difficult at times to follow the proceedings. This difficulty has been increased by the order of presentation of the papers (the first three are almost entirely of a theoretical nature) and only in the latter part of the book does one find well organized presentations of the more factual material.

John von Neumann, the mathematician, starts the symposium off by presenting a logical theory of automata which is applicable both to machines (mostly high speed computing ones) and to the central nervous system. Warren McCulloch then discusses "Why the Mind is in the Head," but never really explains why it *is*, unless one is satisfied with his statement that "There (in the head) and only there are hosts of possible connections to be formed as time and circumstances demand." K. S. Lashley presents a conceptual scheme of how the brain might perform such complex temporal tasks as speech and writing. Wolfgang Koehler gives an interesting presentation of his work on figural aftereffects, then theorizes about his "field model" of the brain, and fiinally presents some rather preliminary findings of slowly changing electrical brain potentials. Of these four largely theoretical papers only von Neumann's presentation gives a coherent and logical formulation of a brain model.

The remaining two papers make more factual contributions to the symposium. Heinrich Kluever summarizes his work of many years on the functions of the occipital and temporal lobes and he marshals a substantial amount of evidence from psychological, physiological, and anatomical findings. Ward Halstead, in his paper on "Brain and Intelligence," demonstrates how psychometric techniques can be applied to

CONTINUED ON PAGE 8

ENGINEERING AND SCIENCE

OCTOBER 1952 VOLUME XVI NUMBER 1

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IN THIS ISSUE

This month's cover shows Max Mason, Jr. checking the position of a model in the working section of the 12-inch flexible throat wind tunnel at Caltech's Jet Propulsion Laboratory.

You'll find more about the wind tunnel — as well as everything else at the Jet Propulsion Laboratory — in the article on page 11 of this issue. *E&S* hasn't had a report on the Lab since 1946, when we covered the Lab's war work. There have been a lot of changes since then — as you'll see when you read our article this month.

Howard S. Seifert, author of the JPL article in this issue, has been at the Lab since 1942. He received his B.S. and M.S. degrees in Physics, at Carnegie Tech. In 1938 he got his Ph.D. at Caltech. He was Assistant Professor of Physics at Kalamazoo College in Michigan for several years, and, from 1940 to 1942, a research physicist at the Westinghouse Labs in Pittsburgh. At JPL he has served as Chief of the Liquid Rocket Section (1942-47), Chief of the Applied Physics Division (1947-50), and, since 1950, Staff Engineer. From 1944 to 1947 he was Lecturer in Jet Propulsion in the Aeronautics Department of the Institute. Since 1951 he has been serving as Associate Editor of the Journal of the American Rocket Society.

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Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena 4, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879.

the study of brain lesions and then defines the intellectual functions of the prefrontal lobes.

About two-fifths of the book is devoted to verbatim accounts of the discussions which followed the presentation of each paper, and of two "General Discussion" sessions. During these meetings the participants, particularly those who did not present papers, made many valuable contributions to the symposium, and only rarely was an attempt made to integrate and summarize these.

Again one raises the question of the goals of the symposium. The reader will be disappointed if he expects to find final answers about brain mechanisms, or even if he looks for wide areas of agreement on these extremely difficult questions. He will, however, be well rewarded if he expects to find contributions from many different sources which are otherwise not available in one volume.

One is impressed by the tremendous amount of research that has been carried out during the last 50 years, which has yielded a substantial amount of information on the structure of the nervous system, and has given us some knowledge about its physiological function and its relation to perceptual and intellectual phenomena. On the other hand, very little is known about cerebral activity in "higher" psychological processes such as motivation, personality integration, and social interaction. Finally, throughout the symposium one is impressed by the complexity of the problem. The absence of final answers does not seem as important as does the tremendous progress which has been made toward our understanding of cerebral mechanisms in behavior.

AN INTRODUCTION TO AESTHETICS

by Hunter Mead
Ronald Press, New York $4

THIS VOLUME, by Caltech's Professor of Philosophy and Psychology, *Hunter Mead,* is a well-written elementary presentation of aesthetics as a pleasurable absorption in the perceptual aspects of phenomena.

The central theme of the book is the aesthetic experience itself. This experience is carefully taken apart and looked at from various angles: what it is, what its significance is, and how it is related to various other important human experiences. About one third of the book is devoted to kinds of aesthetic value and their sources. Three kinds of value are found in aesthetics: material, formal and associational. Of these three, formal values are regarded as central.

The final section presents various philosophies of art—as representation, as emotional expression, as formal design, and as social evaluation and influence. The author unifies these viewpoints with his own interpretation of art as integration. To anyone wishing a clear, readable guide to aesthetics, this book should prove both interesting and rewarding.

INVERTEBRATE FOSSILS

by Raymond C. Moore, Cecil G. Lalicker, and Alfred G. Fischer
McGraw-Hill, New York $12.00

Reviewed by Charles E. Weaver
Research Associate

AS STATED BY the authors, *Invertebrate Fossils* was planned, not as a reference work, but as an accompanying textbook to supplement lectures, discussions and laboratory work in a comprehensive introductory course in invertebrate paleontology, offered as a part of the training of those desiring to become professional geologists.

The general plan and organization of the book is based largely on a consideration of the procedures followed by the authors over a period of years in presenting the fundamental principles of paleontology to beginning students in university courses, and on a critical appraisal of the subject as outlined in the older and contemporary textbooks. Realizing that many students who begin the study of past life have never had previous courses in biology, the authors have tried to present the necessary biological aspects of living organisms in an understandable manner, in order to point out the morphological relationships of the skeletal remains of fossils to former existing soft parts.

The reviewer gains the impression that this has been accomplished successfully. The book should be welcomed by those engaged in teaching the fundamental principles of invertebrate paleontology for professional purposes, as well as by students, who have before them the significant information concerning fossils, including a clearly defined technical vocabulary, accompanied by explanatory line drawings.

ENGINEERING IN PUBLIC HEALTH

by Harold E. Babbitt
McGraw-Hill, New York $8.00

Reviewed by Jack E. McKee
Associate Professor,
Sanitary Engineering

INTENDED TO MEET the needs of the engineer practicing in the field of public health, this book introduces the reader to the myriad subjects involved in this profession. Professor Babbitt has done a remarkable job in assembling, evaluating, and condensing the abundant literature in each subject, with the result that the book touches lightly on all phases of this broad field without elaborating on any. Fortunately, the condensed material is thoroughly documented and the references at the end of each chapter are numerous.

In compressing so much material into 550 pages, the author chose to omit discussions of fundamentals in the major branches of science and engineering. For example, the practice of disinfection by chlorine is discussed at several places in the book, but nowhere is the theory of chlorination presented. As a textbook for students, therefore, this new volume has many deficiencies. As a handy reference of condensed descriptive material, however, it should be extremely valuable to the practicing engineer.

PERSONNEL ADMINISTRATION

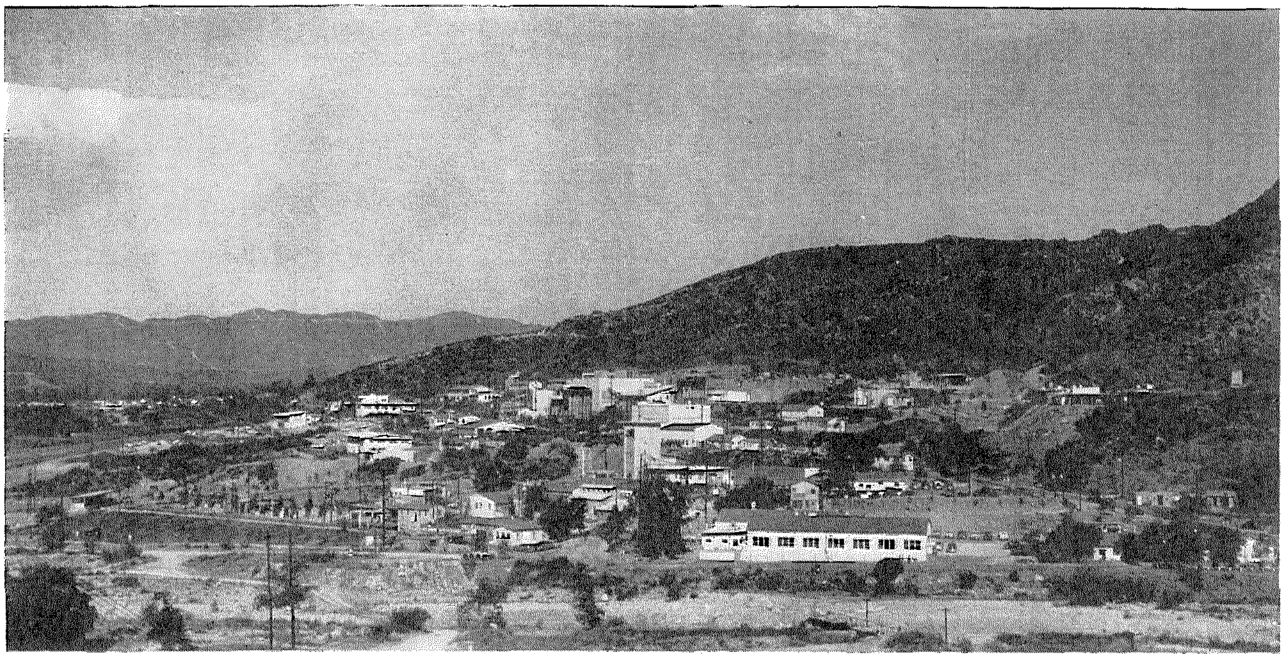
by William W. Waite
Ronald Press, New York $7.00

Reviewed by L. Robert Sorensen
Assistant Director, Industrial Relations

MR. WAITE'S book is intended primarily as a college text, but would be helpful to any person starting in the field of personnel, and would be useful as a ready reference for the more experienced personnel administrator.

The reader won't discover anything particularly new here, but will find that many ideas, theories, and methods have been collected from numerous sources and well organized under one cover.

Personnel Administration presents a comprehensive coverage of the field in an informal and practical manner.



The Jet Propulsion Laboratory, three miles north of the Rose Bowl in Pasadena, now covers 64 acres

THE JET PROPULSION LABORATORY

What it is, what it does — and how it does it

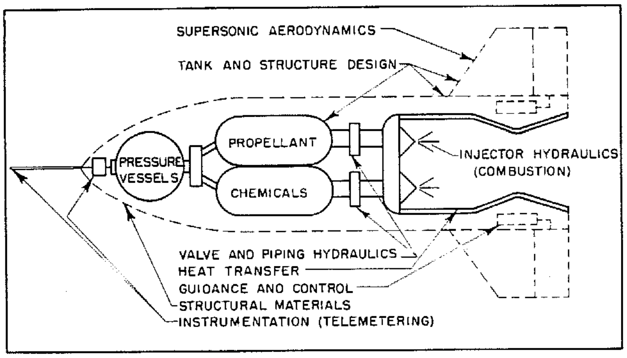
By HOWARD S. SEIFERT

WORLD WAR II, the "Physicists' War," naturally inspired a number of defense activities at the California Institute of Technology. Although this war has now receded almost a decade into the past, one defense project, the Jet Propulsion Laboratory, has proved itself to be of such continuing value that it has not only survived, but has grown tremendously.

The need for a propulsion plant for the assisted take-off of aircraft and for sounding rockets brought the Laboratory into existence in 1940, as an extension of work begun in 1936 by a small group of Caltech students under the direction of Dr. Theodore von Karman.

Starting from this specific practical problem, the interests of the Laboratory have extended in many directions. What was once a program to develop a simple thrust-producing device has grown to include aerodynamic tests of missile configurations in special supersonic wind tunnels, development of electronic guidance equipment, and fundamental research in fluid dynamics, combustion, chemistry, and materials.

It has been found wise to share the time of the staff between the preparation of immediately useful hardware and the acquisition of ultimately useful information in the sciences related to jet propulsion. The interaction between the applied and fundamental research has been to their mutual advantage. Practical experience turns up new problems of broad significance, and the solution to these results in new applications.



Schematic diagram of a guided missile shows which components are the subjects of research investigations

I. THE RESEARCH PROGRAM

The field of jet propulsion embraces most of the engineering sciences. As a result, the research program at JPL covers many diverse problems—all related in some way, however, to propulsion, guidance or fabrication of missiles. The schematic diagram of a rocket vehicle, above, shows the locus associated with some of these problems, which may be classified under the following headings:

A. Chemistry of Propellants
B. Combustion
C. Fluid Dynamics
D. Heat Transfer
E. Materials
F. Mechanical Design
G. Instrumentation
H. Guidance and Control

A. Chemistry of propellants

The ideal liquid rocket propellant should release the maximum possible heat into combustion products of the lowest possible molecular weight, in order to provide maximum momentum in the exhaust jet. It should be stable against shock and temperature changes. It should ignite quickly and burn rapidly, in order to reduce the necessary volume and weight of the combustion chamber. It should have a high density to permit small storage tanks, and a low vapor pressure to avoid the need for thermal insulation. If it is to be used as a coolant, its specific heat and thermal conductivity should be high. In addition, it would be convenient if it were non-toxic, non-corrosive, available in large quantities, and cheap.

Although no one fluid exists with all these desirable properties, several possess enough virtues to be acceptable. The search for such substances, and the measurement and modification of their properties, are the chief concern of the chemistry research program. The oxidizers nitric acid, hydrogen peroxide, and liquid oxygen, reacting with the fuels aniline, alcohol, ammonia, gasoline, and hydrazine, have been among the most promising systems studied.

Solid propellants, because of the simplicity of their use, are no less interesting than liquids. The ideal solid propellant should possess most of the qualities of the ideal liquid. In addition, the rate at which the surface burns away should be controlled within wide limits. There should be no smoke, and the charge should retain good mechanical properties under extremes of temperature, stress, and acceleration.

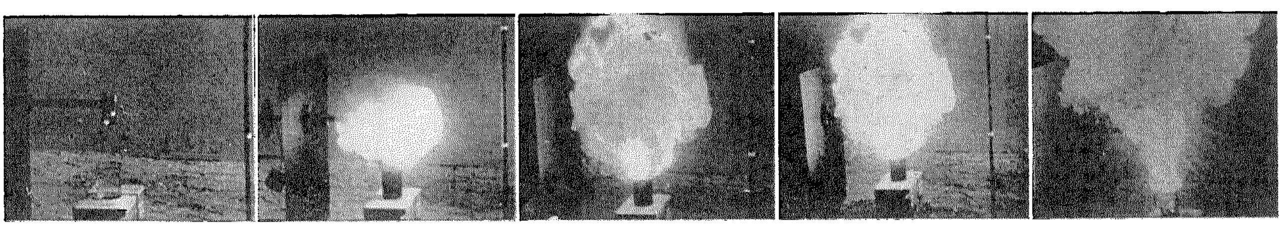
Originally, JPL solid propellants were made of simple mixtures of potassium perchlorate, asphalt, and lubricating oil. Present-day propellant production is more sophisticated, and involves careful process control.

B. Combustion

The general phenomena of combustion have long received the attention of investigators, but understanding of the subject is far from complete. Rocket combustion is particularly complex. In a typical liquid rocket the propellant enters in the form of a number of small streams travelling with a speed of about 100 ft/sec. The reaction begins immediately at the interface between the two liquids, which soon evaporate from the heat of the already established flame. The reaction is completed in the vapor phase at a pressure of several hundred pounds per square inch, and at temperatures ranging from 3,500° F to 5,000° F.

Pictures taken through a window in the combustion chamber show that the interior space distribution of temperature and velocity is quite irregular. Superimposed on this turbulent holocaust is a time variation, an oscillatory rise and fall in pressure which may range in frequency from twenty or thirty cycles per second to many thousands, and which is in part responsible for the rocket's notorious efficiency as a source of sound. As one British investigator put it, "What goes on in a rocket chamber is just nobody's business."

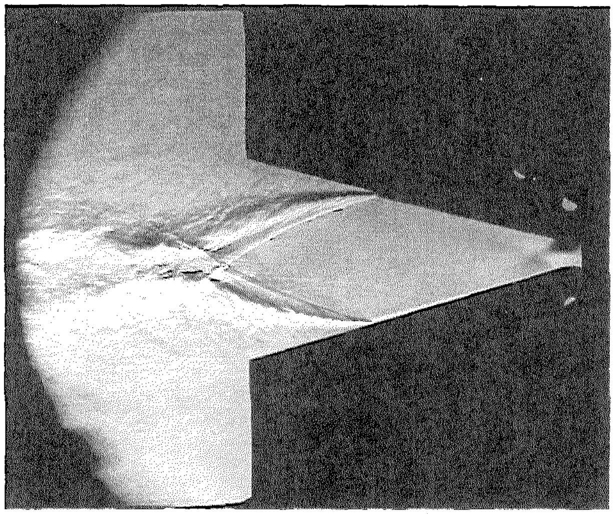
Experimental work at JPL on combustion includes interior measurement of rocket temperature patterns with movable probes, and extraction of gas samples with these



The ideal liquid rocket propellant should ignite quickly and burn rapidly — as in this spontaneous contact ignition of red fuming nitric acid and aniline. The consecutive pictures above were taken at intervals of 1/64th of a second.

same probes for subsequent analysis in a radio-frequency mass spectrometer. Studies of the kinetics of the individual steps in the reaction of HNO_3, for example, have shed light on the time required for combustion to be completed. Spectroscopic study of the absorption bands of various rocket combustion products has led to independent means for estimating the temperature of the reaction.

Another aspect of combustion which is important for jet propulsion generally is *air-fuel combustion.* The technique of introducing fuel into a rapidly moving airstream in such a manner as to complete its burning in the shortest possible time, and to maintain this flame over wide variations of stream velocity, pressure, and air-fuel mixture ratio, is essential to the operation of a ram-jet propulsion plant. At JPL experimental work is being carried out on the properties of the low-pressure (few mm) flame, which spreads out the combustion zone and reduces its temperature, enabling a study of its structure and sampling of the chemical species present. In addition studies are being made of the effect of turbulence on flame propagation, and the mechanism of "flame-holding"—i.e., stabilization of a flame front in the vicinity of a solid surface submerged in a flow field.



Schlieren photograph of the separation of flow of cold gases in the expanding portion of a deLaval nozzle.

C. Fluid dynamics

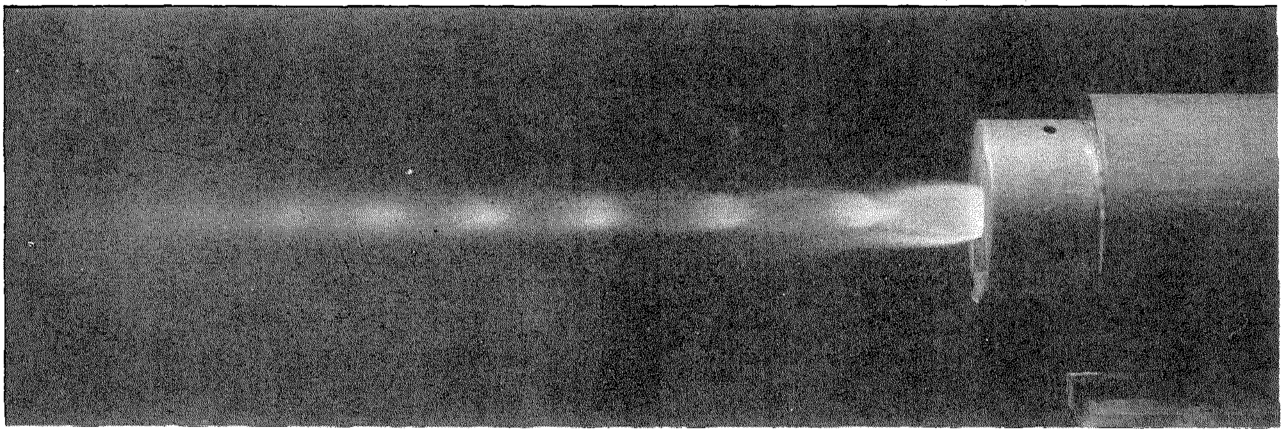
It is obvious that a device which propels itself through a gaseous environment by the expulsion of gas will present many problems in fluid dynamics. Let us consider the aerodynamic and hydrodynamic problems separately.

1. *Aerodynamics.* Rockets travel at supersonic speeds, and the necessary empirical information on lift, drag, interference effects, and the like is scarce and expensive to acquire. Quantitative theoretical analysis is difficult to perform. New physical effects become important, such as aerodynamic heating of the skin of the vehicle. The vehicle now travels not at a relatively uniform speed, as does an airplane, but is constantly accelerating or decelerating. In the course of a single flight it may travel through air whose density varies from standard sea-level value to zero, and during this time the weight of the vehicle may reduce to 25 percent of its original value, with corresponding troublesome changes in the relative position of its center of gravity and center of pressure.

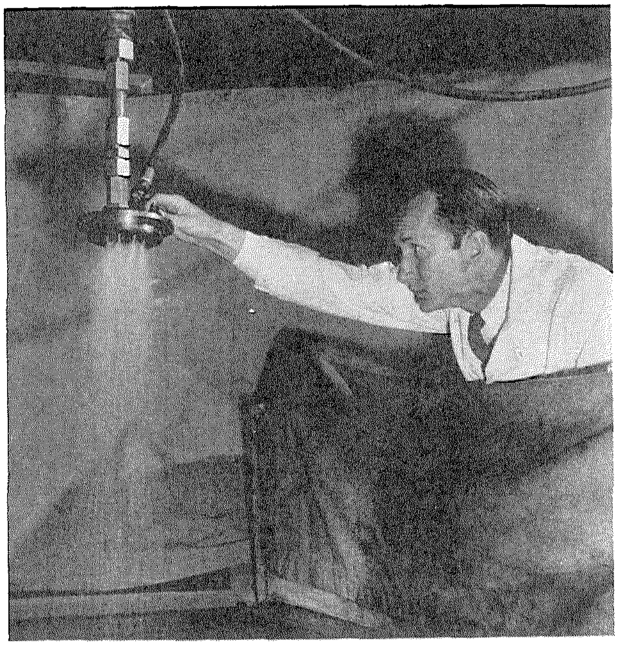
JPL is fortunate in possessing two large supersonic wind tunnels—one of 12-inch-square working area, and the other of 20-inch-square working area. Both have air velocities in the vicinity of four times the speed of sound. With these a considerable amount of "routine" measurement of aerodynamic coefficients is done for military contractors. However, a significant fraction of the operating time is devoted to basic study of boundary layers (skin friction), heat transfer, turbulence, and the behavior of simple wing shapes in supersonic streams.

The nature of the supersonic flow through deLaval nozzles has been studied experimentally, using both hot and cold gases. Also, an analytical group works in conjunction with the wind tunnel and missile design groups, calculating trajectories, drag coefficients, heat transfer and similar quantities.

2. *Hydrodynamics.* The large amount of "plumbing" associated with liquid propellant rockets gives rise to a number of special problems. The proper performance of a rocket system depends upon accurate knowledge and



Various supersonic flow phenomena are studied experimentally at the Lab, using hot gases (as in this picture) and cold gases (picture at top of page). Here is the shock wave pattern in the jet of a small 25-lb. thrust test rocket.



Workers in JPL hydraulic lab run water tests to check the accuracy of impingement of rocket injector jets.

control of all hydraulic flow parameters. There is no margin for inefficiency in a guided missile. At JPL a large hydraulic laboratory is devoted to checking and measuring the performance of valves, injectors, and similar components.

The operation of the "injector"—the set of orifices through which jets of propellant are introduced into the combustion chamber—presents many complex problems. At JPL studies are made of the spatial distribution of the atomized spray resulting from two impinging jets (as shown in the picture above), as well as the distribution of droplet sizes and the degree of "mixing" or intermingling of the propellant components.

D. Heat transfer

There is no ordinary furnace hotter than the combustion chamber of a rocket and, even though only two or three percent of the propellant energy passes through the walls as heat, its removal poses a difficult question. About three BTU/in^2-sec (or 1.5×10^6 BTU/ft^2-hr.) pass through the throat region of a rocket nozzle. Thus, guiding the exhaust gases through the nozzle throat is somewhat like asking a snowman to swallow a cup of hot coffee. Cooling is usually accomplished by circulating part of the propellant outside the combustion chamber. This coolant often reaches the boiling point. At JPL considerable work has been done on the study of boiling and the mechanism of boiling heat transfer, concerning which little information is available, particularly for propellant liquids.

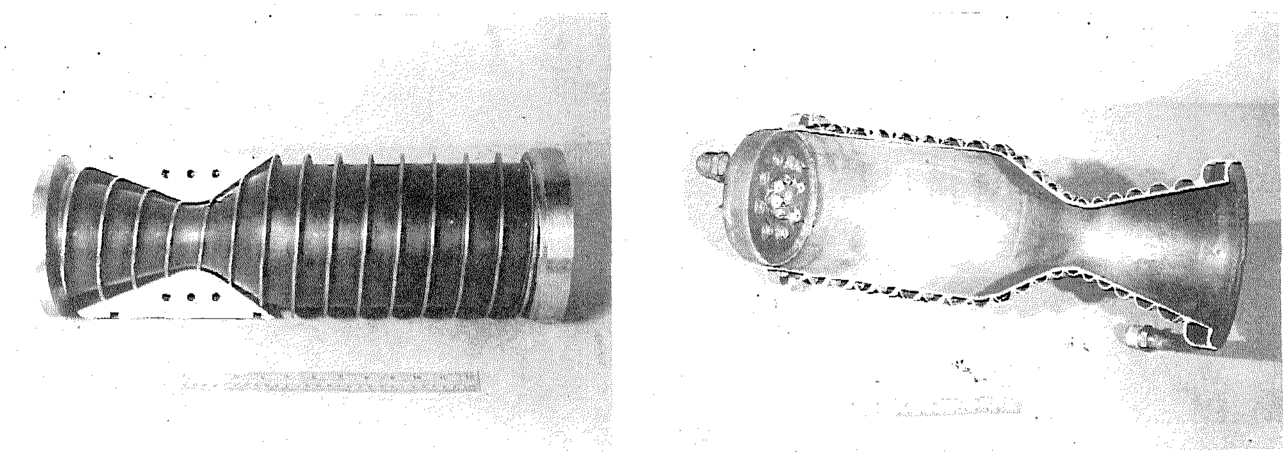
Other techniques of fluid cooling, such as the introduction of liquid films on the interior surface through small orifices (a technique used by the Germans in the V-2 rocket) and the "oozing" of a coolant fluid through porous metal walls, have also been investigated experimentally at JPL.

E. Materials

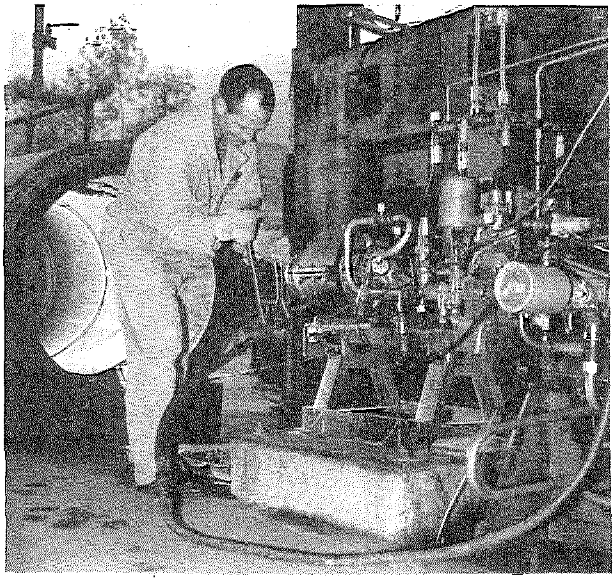
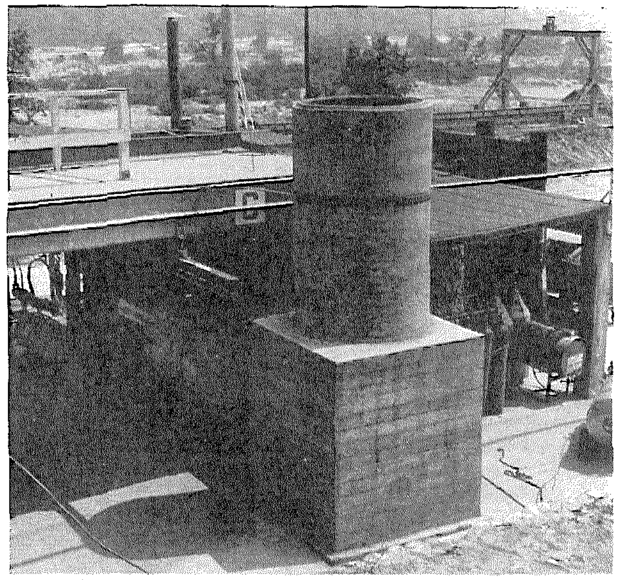
The high melting-point, strength, and corrosion resistance required in jet propulsion applications directs the rocket engineers' attention to refractory substances. The materials program at JPL particularly emphasizes the *fundamental* aspects of refractory research. Recent materials studied at JPL include titanium and titanium alloy systems, in particular those containing chromium, molybdenum, vanadium, and a few of the more complex ternary systems. Also investigated was the crystal structure of new intermetallic compounds in various titanium and zirconium alloys.

Additional high temperature substances studied were the chromium base alloys with iron, molybdenum, and vanadium (especially the brittle sigma phase). The properties of the ceramic zirconium oxide, stabilized with lime, magnesia, or other rare earth oxides, were also examined.

A particularly interesting application of materials research has been the development of the so-called "sweat cooling." This involves the preparation of a metal filled with connected pores, through which a coolant fluid can



Rocket motor development work reduced weight of this 1500-lb.-thrust rocket motor from 50 lbs. (left) to 12 (right).

Research information on rocket characteristics is acquired in elaborate test set-ups like this. Sound suppressor, shown behind worker in picture at left, is one of main features of rocket-firing test cells, as shown by exterior view at right.

be forced. By this technique a surface exposed to flame can be kept quite cool with only a small expenditure of fluid. At JPL the production of porous metals by powder metallurgy techniques was pursued vigorously. Related work was carried out on the mechanism of sintering and diffusion of mixed powders during alloying. Coordinated with this work was the study of the laws of liquid and gas flow, as well as heat transfer, through porous metals.

F. Mechanical Design and Development

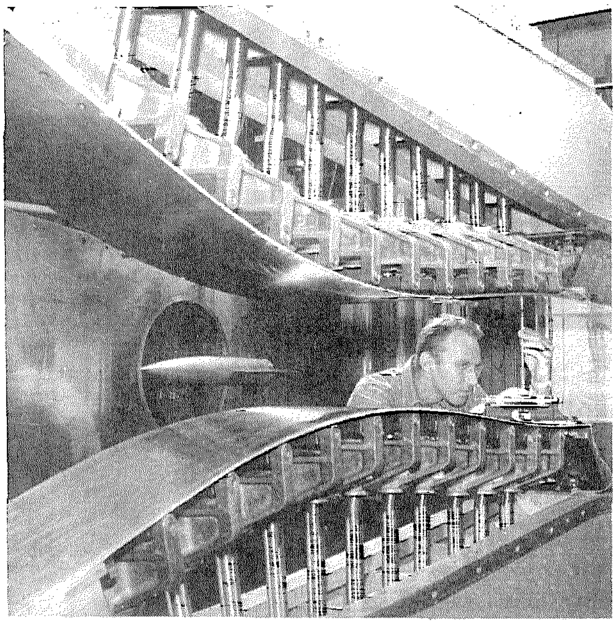
The producers of "hardware" at JPL are of two types. The first type is exemplified by the rocket research engineer, who wishes to know, for instance, whether a particular injector will operate well. He does not worry about the weight of his test motor, or whether it can be fuel-cooled. His attention is focussed on only one aspect of the problem, and his objective achieved when his data are secured. Of course, the information should not be allowed to lie dormant at this point. Before a rocket can be demonstrated to the military services, or transferred to commercial production, a prototype or "Mark I" version incorporating the new injector design, together with much additional information from other research engineers, must be synthesized by a "development" engineer. He is the second type of mechanical designer referred to, and his trials and tribulations are fully as great as the "research" man's.

Liquid rocket research at JPL involves devising and testing propulsion systems which combine some choice of cooling technique, materials of construction, combustion chamber configuration, propellant chemicals, injector design, and fabrication procedure. Shall it be a water-cooled liquid oxygen-alcohol motor using a shower-head injector in a cast spherical aluminum chamber with an inserted copper nozzle? Or, would it be preferable to use a fuel-cooled nitric acid-aniline system and impinging-jet injector in a spun steel cylindrical chamber with spot-welded cooling jacket? Since there are at least a dozen choices of each of the variables, a morphological array of all possible rocket motors would number at least several million. Obviously, some less ambitious number is selected as worthy of experimental investigation.

Work on solid propellants for rockets at JPL parallels in many ways the work done on weapon rockets at Eaton Canyon during the war — a project which was administered by Caltech for the National Defense Research Council (NDRC). Among the many research problems are how to control the burning rate, and the mechanical properties of the solid charge.

Turning from research engineers to design and development men, we see that their responsibilities are broad. At JPL these men perform the integrated function of design, development, fabrication, assembly, inspection, and check-out testing of complete missiles. Their tasks include aerodynamic, thermodynamic, heat transfer, vibration, and ballistic calculations. Their program also includes optimization studies; particularly reduction in weight of all components. The great importance of minimum weight in rocket flight may not be generally appreciated. A rocket which is 50 percent expendable fuel may have a range of 50 miles. If the rocket can be redesigned to have 90 percent of its initial mass expendable, the range will be extended to 500 miles! The smaller the percentage of dead weight left after the fuel has been burned, the farther this remnant will go.

Typical of the work of this group at JPL is the search for heat-resistant surface coatings for protection against the aerodynamic heating (temperatures to 1,000° F) which a missile experiences upon reentering the atmosphere at the end of its flight.



Lab's 20-inch supersonic wind tunnel features an adjustable throat section positioned by servo-controlled jacks.

Other problems include the design of light-weight pressure vessels, pressure regulators, special valves, and numerous structures and fixtures; for example, radio antennae. An outstanding example of their work was the design of the rocket separation mechanism for the Bumper WAC, the two-stage rocket which set the so far unbroken altitude record of 250 miles.

G. Instrumentation

The testing of a rocket, involving as it does high temperatures, pressures, and fluid flow rates, as well as ballistic flight, naturally creates a demand for measuring devices of high accuracy and short time resolution. The flood of data accumulated with these instruments in turn creates a demand for computing equipment which can reduce and plot data or solve complex systems of equations quickly.

Among examples of work on measuring instruments done at JPL are: a high-speed camera of the Kerr-cell shutter type, a recording potentiometer capable of 20 measurements per second to 0.1 percent accuracy, a counter for the measurement of the number and size of droplets in a spray, and a flowmeter for low-temperature liquids. Test cells at JPL are scattered over the plant at widely separated points. These have been interconnected with a telephone-type network capable of transmitting 22 channels of information to a central recording center. This system makes an expensive array of recording equipment (oscillographs, potentiometers), together with its operating crew, readily available to any test cell on short notice.

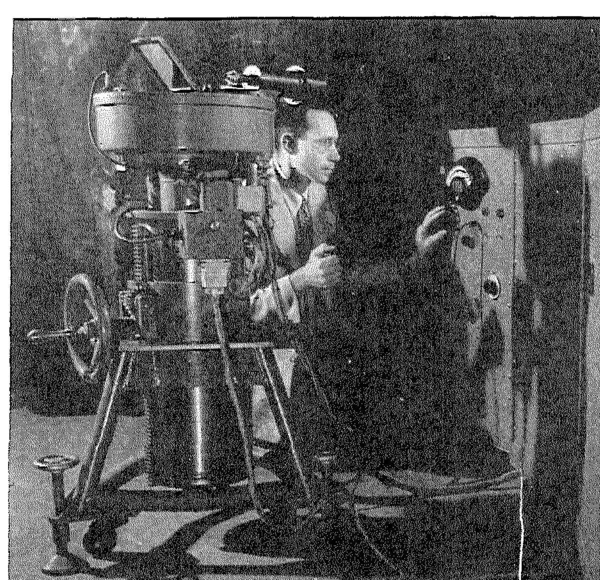
Computing equipment available at JPL includes a large Reeves analog computer (REAC). By now most engineers are aware that these computers make possible the solution of otherwise unmanageable differential equations, and bring forth solutions in a day which would otherwise require months of hand computation, and therefore would probably not be attempted. It should not be assumed that the operation of these computers is simple or routine. Each new problem is a challenge to the ingenuity of the operator, who must combine mathematical talent with the skill of an expert television repairman.

H. Guidance and control

Early in JPL's history, it became necessary to evolve an air-to-ground radio link, or telemetering system, for the transmission of data from the sounding rockets then being used to proof-test propulsion systems. Later the Department of the Army requested that a missile guidance and control system be evolved, which made it necessary to establish a complete research division devoted to electronics. Today a substantial part of the JPL engineering staff is devoted to this activity.

The stability of the missile in flight (its ability to maintain a more or less steady orientation, as well as its ability to change direction in response to signals) depends on the development of a suitable auto-pilot, resembling that used in conventional aircraft, but responding more rapidly than the aircraft type. This stability and maneuverability is what is accomplished by the "control" system of a missile.

In addition to the orientation of its axis, the position in space of the missile's center of gravity must be both measured and modified. This function is termed "guidance." Evidently a high degree of precision as well as rapid action will be demanded of the guidance system for a missile moving at supersonic speeds. Various techniques exist for achieving this end, some of which are described qualitatively in open literature.



Lab's high-speed camera lives up to its name by taking exposures of less than one-millionth of a second.

II. LABORATORY FACILITIES

A. Research equipment

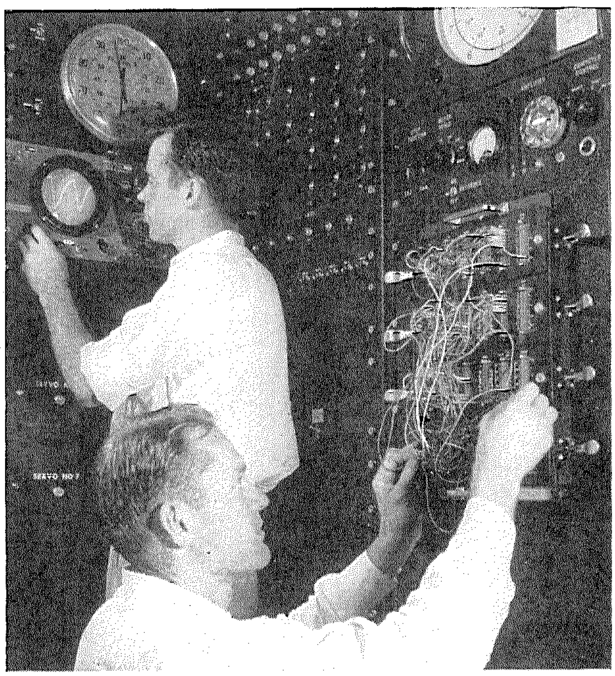
In the descriptions of experimental apparatus to follow, the problems in which they are used will not be discussed. The applications will be evident from the research program outlined above. The items chosen here by no means form a complete catalog.

Major pieces of equipment are the two supersonic wind tunnels and their associated balance and compressor equipment. These tunnels are of the unique flexible throat construction, which enables quick change in operating conditions and a rapid rate of collecting data. The tunnel air supply is also made available to air-fuel combustion test cells. Another major installation for fluid dynamics work is the hydraulics laboratory, which contains pump, valve, metering and reservoir equipment for large liquid flows and high pressure.

Two facilities of general utility are the shops, which have a number of large machine and sheetmetal power tools, and the library, which receives about 100 periodicals and is a repository for an extensive collection of technical reports.

Materials research is aided by two large hydraulic presses (the larger of 3.6 million lbs. capacity) for powder metallurgy work, as well as several X-ray diffraction units, an electron microscope, and high temperature furnaces of various types, as well as equipment for radioactive tracer research.

Combustion research is carried on with the help of a radio-frequency mass spectrometer of the type recently originated by the Bureau of Standards, which requires no fixed magnetic field. The spectroscope part of the work uses a Perkin-Elmer infra-red prism spectrometer



Lab's electronic computer quickly solves equations which would involve months of hand computation.

The JPL Administration Building — hub of the lab.

(to 25 microns) and a Dietert 1½-meter concave grating spectrograph for the ultra-violet.

Instrumentation, guidance, and control activities employ a large amount of commercial electronic gear. One major piece of electronic equipment is the Reeves analog computer. It is planned to augment this with digital computing equipment, and work is currently proceeding on equipment to convert physical magnitudes from analog to digital form and back.

B. Buildings

JPL now possesses a considerable number of permanent buildings of high quality and substantial size. The total area of office and laboratory facilities today covers about 64 acres. Among major JPL structures are a large administration building, a modern cafeteria, and separate laboratories for fluid dynamics, combustion, chemistry, metallurgy, electronics and instrumentation. In addition there are central shop, assembly, and storage buildings as well as several minor shops and concrete test cells (equipped with sound-suppressingd evices) for small experimental rockets.

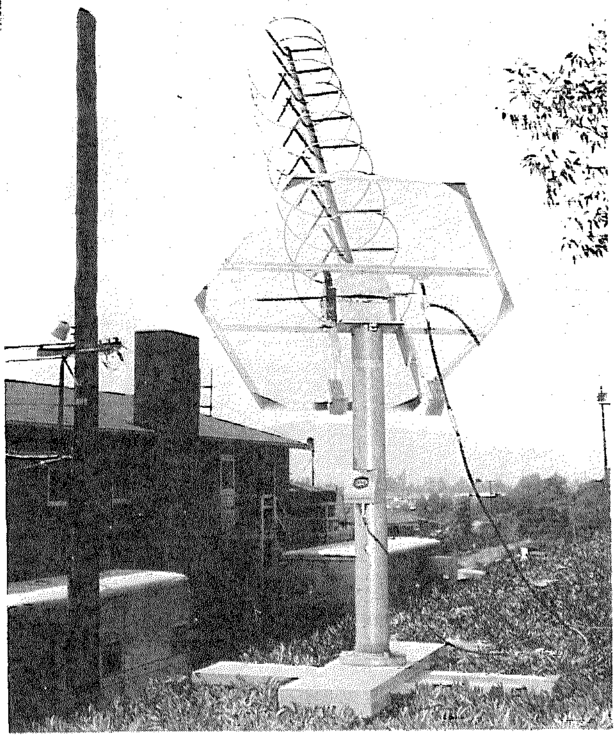
JPL also operates or administers three external facilities—a static test stand for large rockets in the desert north of Pasadena; a field test crew in New Mexico, to supervise actual flight tests; and a school for training military personnel in guided missile techniques.

III. PERSONNEL

A. Leadership

The original interest in rockets at Caltech was inspired almost sixteen years ago by Dr. Theodore von Karman. The early days of the "Galcit" (for Guggenheim Aeronautical Laboratory of the California Institute of Technology) project, as JPL was then called, were guided by Doctors F. J. Malina and H. S. Tsien of the Aeronautics Department, and by Dr. Martin Summerfield, a graduate of the CIT Physics Department.

In 1947 the directorship of the laboratory was assumed



This unique telemetering antenna, circularly polarized, is used to communicate with missiles while in flight.

by Dr. L. G. Dunn, and Chairmanship of the Board of Directors by Dr. C. B. Millikan, both of the Aeronautics Department. From that period on, a number of Caltech faculty members have shared their time with JPL, acting as Chiefs of JPL research sections. Among these are Dr. W. H. Pickering, Electrical Engineering; Dr. H. J. Stewart, Aerodynamics; Dr. Pol Duwez, Materials and Metallurgy; and Dr. Frank Marble, Applied Mechanics.

B. Professional staff

More than half of the large professional group at JPL hold degrees beyond the B.S. About one-third are Caltech graduates. The group is fairly evenly divided among mechanical, aeronautical, chemical, and electrical engineers, together with a somewhat smaller number of mathematicians and physicists.

It goes without saying that the JPL staff derives much profit from the proximity of the Caltech campus and the opportunity for attendance at seminars and ready exchange of ideas with men working on the campus.

C. Administrative and technical staff

For every professional employee, there are three staff members assisting him in various capacities such as computer, fabricator, test operator, clerk, editor, draftsman, accountant, or librarian. This group of men and women has its own news bulletin (*The Lab-oratory*) and has established a number of clubs and hobby groups, such as baseball, tennis, bridge, rod and gun, short wave radio, and sound recording. Evening classes for these employees are held at JPL in certain technical subjects. The professional staff is deeply indebted to the skill and integrity of this group for making possible the embodiment of scientific ideas.

IV. PUBLICATIONS

The necessity for preparing written reports of his work is usually irksome, if not actually painful, to a busy research man. JPL endeavors to alleviate this difficulty by providing a reports staff to assist the engineer in preparing figures, typing, and editing. During the year 1950-51 over 100 reports were published, of which approximately one-third were unclassified or presented in the open literature.

A small number of these publications are given herewith in a brief sample bibliography:

Altman, D., and D. Wise: The Measurement of Chemical Equilibria by Means of the Critical Flow Orifice, *J. Chem. Phys.*, Vol. 19, No. 4, April 1951.

Bowersox, R. B. and C. G. Hylkema: High-Speed Recording Potentiometer, *J. P. L. Memo* No. 20-69.

Dunn, L. G., W. B. Powell and H. S. Seifert: Heat-Transfer Studies Relating to Rocket Power-Plant Development, *Third Anglo-American Aeronautical Conference*, 1951.

Hibbs, A. R.: Optimum Burning Program for Rocket-Propelled Missile in Horizontal Flight, *J. Am. Rocket Soc.*, Vol. 22, No. 4, July-August 1952.

Lehan, F. W.: Expected Number of Crossings of Axis by Linearly Increasing Function Plus Noise, *J. Appl. Phys.*, Vol. 22, No. 8, August 1951.

Martens, H., and Pol DuWez: Phase Relationships in the Iron-Chromium-Vanadium System, *Trans. American Soc. Metals*, Vol. 44, 1952.

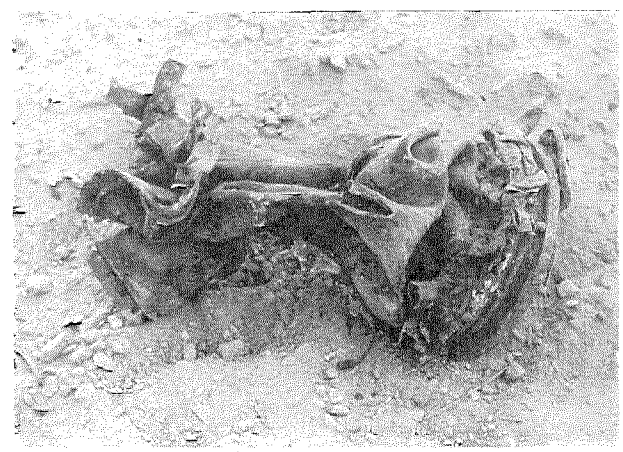
Penner, S. S. and D. Weber: Absolute Values for the Integrated Absorption of Diatomic Gases. I. Carbon Monoxide, *J. Chem. Phys.*, Vol. 19, No. 7, July 1951.

Seifert, H. S., M. M. Mills, and M. Summerfield: The Physics of Rockets, *Am. J. Phys.*, Vol. 15, No. 1, Jan-Feb. 1947; Vol. 15, No. 2, March-April 1947; Vol. 15, No. 3, May-June 1947.

Stewart, J. L.: A General Theory for Frequency Discriminators Containing Null Networks, *Proc. I.R.E.*, Vol. 40, No. 1, January 1952.

Stewart, R. M.: A Simple Graphical Method for Constructing Families of Nyquist Diagrams for Multi-Loop Control Systems, *J. Aero. Sci.*, Vol. 18, No. 11, November 1951.

Wright, F.: Measurements of Flame Speed and Turbulence in a Small Burner, *Phys. Rev.*, Vol. 81, No. 5, March 1, 1951.



Months of effort and hundreds of thousands of dollars go into every rocket firing — and this is the end result.

In the wake of the July 21 quake — David L. Durham '51 checks vertical displacement on a hill outside Tehachapi.

EARTHQUAKE REPORT

At 4:52 A.M. on Monday, July 21, 1952, southern California experienced a strong earthquake, felt from San Francisco to Mexico. Once again, Californians were rudely reminded that they live in a seismologically active belt of geologically young, developing mountain ranges and valleys.

Principal damage to buildings, pipelines, irrigation systems, and to the large Paloma petroleum refinery, centered around Arvin, a few miles south of Bakersfield; the towns of Arvin and Tehachapi suffered most.

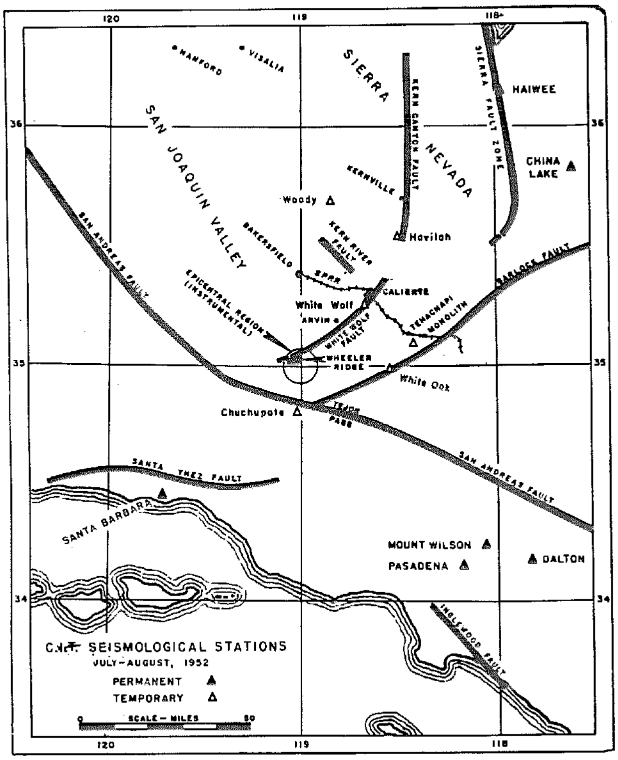
Intermediate in magnitude and intensity between the Long Beach shock of 1933 and the San Francisco earthquake of 1906, the Arvin disturbance took at least 14 lives and resulted in damage which presumably aggregates several tens of millions of dollars. Fortunately the area most strongly affected is one of relatively sparse population; had this shock occurred in a densely settled portion of the country the loss of life and property destruction would almost certainly have been very large.

Shortly after the initial shock the entire staff showed up for work at the Caltech Seismological Laboratory in Pasadena. Some of the staff went on telephone duty; others developed and studied seismograms. Emergency preliminary statements were given out to the press. Field parties were organized. For days—and to some extent for weeks—the Laboratory was like an engine house after a three-alarm fire has started.

At Pasadena, most of the sixteen instruments recorded the beginning of the main shock, plus an uncountable number of aftershocks. One torsion instrument had its suspension broken — which is something that hasn't happened before in all the Lab's 25 years. The Laboratory's strong-motion instruments were the only ones in California to write complete records of the big shock; their light-spots were deflected about two and a half inches, corresponding to actual ground motion of over half an inch.

All records of the start of the shock were good at the Lab's auxiliary stations at Mount Wilson, Santa Barbara, China Lake, Haiwee, Tinemaha, Barrett, and Big Bear. At Riverside the drum recording the vertical component had stopped; at La Jolla records had not been changed over the weekend, so that the main shock was missed; at Dalton the clock had unfortunately stopped the day before; and at China Lake the vertical pendulum was slammed against the stop by the main shock so hard that it froze until freed three weeks later.

A field party, headed by Dr. Charles Richter and carrying recording equipment, left Pasadena at 7:15 a.m., two hours and odd minutes after the first shock on July 21. A continuously-recording temporary station was established that afternoon at the Chuchupate Ranger Station in the Frazier Mountain area. Other temporary stations were set up to record aftershocks at the Havilah



Map shows the location of the Seismological Laboratory's auxiliary recording stations, as well as the principal faults, in the region of the Arvin earthquake.

Ranger Station in the Kern River country (on July 26), and at Woody, northeast of Bakersfield (on August 5). Short runs were recorded at nine other locations.

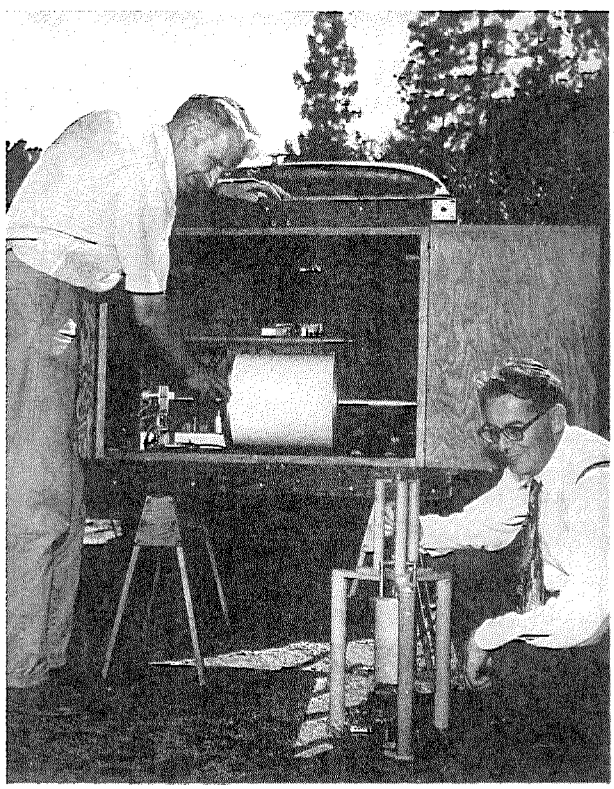
All field parties kept in touch with Pasadena headquarters, where Dr. Beno Gutenberg, director of the Lab, was in charge. In the first few days, at the Pasadena Lab, Dr. Hugo Benioff, as the most available of the staff, spent much of his time on the telephone. The Lab secretaries, along with the regular Caltech switchboard, tried to handle or detour the less important incoming calls—which wasn't easy to do. Too many people telephoned on the excuse of asking for information—but actually to tie up the line by *telling* the Lab about the earthquake. It was a sizable job to make way for legitimate inquiries from the press and radio news services, officials, or persons with valuable information.

Some of the staff had to work odd hours or away from the Lab in order to dodge the flood of inquiries. It was most urgent to analyze the first records brought in from the field stations, so as to use the results for further planning. The natural eagerness of the press — and the public — for every crumb of news sometimes interfered with the very work that produces news. The staff had to repeat over and over that it was unable to stop to count the hundreds of small shocks being recorded, or to work out exact times and magnitudes for any but the largest. By August 25, a little more than a month after the main shock, there had been about 188 shocks of magnitude 4 or over — and the Pasadena Lab was still recording over 40 small shocks a day!

In describing this group of earthquakes the Laboratory and the press have used the magnitude scale developed here about 20 years ago. This scale proves to give the best answer to "How big was the earthquake?" Seismologists contrast the magnitude scale with the intensity scale, which is older.

An earthquake intensity number is just a horseback rating of the amount of shaking at a given place, judged by effects on buildings, crockery, windows, women and children, dogs, horses, herds of elephants or whatever. II means that few people felt the shake; IV that it rattled windows; VII that there was slight damage; X that it was destructive; XII (the highest rating) that it razed almost all structures to the ground, threw stones into the air, and shot posts out of postholes (believe it or not!). On July 21, intensities around Arvin and Tehachapi were VII to VIII; at Bakersfield, about VII; at Pasadena and Los Angeles, V to VI. These intensities vary with distance and the nature of the ground.

Magnitude, on the other hand, is a rating of the whole earthquake. It is calculated from the size of the seismogram written by a standard type of instrument (the horizontal short-period torsion seismometer operating at many of the Lab's stations) at a standard distance of 100 kilometers (62 miles). If the recording station is at some other distance from the epicenter, its records are reduced to 100 kilometers by means of tables or charts. Magnitudes calculated for the same earthquake from different stations usually agree closely.



Dr. C. F. Richter, right, and John Nordquist check portable recording equipment after Tehachapi field trip.

Here are some typical magnitudes (note that the magnitude numbers have nothing to do with intensity at the places named, which are mentioned only to help identify the earthquake).

Bakersfield	Aug. 22, 1952	6
Santa Barbara	June 29, 1925	6.3
Long Beach	March 10, 1933	6.3
Kern County	July 29, 1952	6.5
Imperial Valley	May 18, 1940	6.8
Kern County	July 21, 1952	7 ½
Nevada	Oct. 2, 1915	7 ¾
San Francisco	April 8, 1906	8 ¼
Tibet	Aug. 15, 1950	8.6
South America	Jan. 31, 1906	8.6

The last two in the list are the largest known earthquakes. The smallest shocks recorded by instruments are about magnitude 1; the smallest which cause a little damage, about 4½.

The magnitude scale is logarithmic. That means that every step up of one unit on the magnitude ladder multiplies the size of the seismogram by 10. Seismograms of the San Francisco earthquake were about 100 times as large as those of the Long Beach earthquake at the same distance. If the largest and smallest earthquakes could be recorded by the same seismograph, one record would be over ten million times as large as the other.

Seismograms for the main shock of the July 21 quake led to an epicenter near the Wheeler Ridge oil field, at

Weak brick and concrete buildings fared badly in the recent quakes. Cracks in this hotel front in Santa Barbara are the result of improper design or construction.

Extensive building damage in Tehachapi was not so much due to violent shaking as to the fact that it was an old town, with a good many old brick structures.

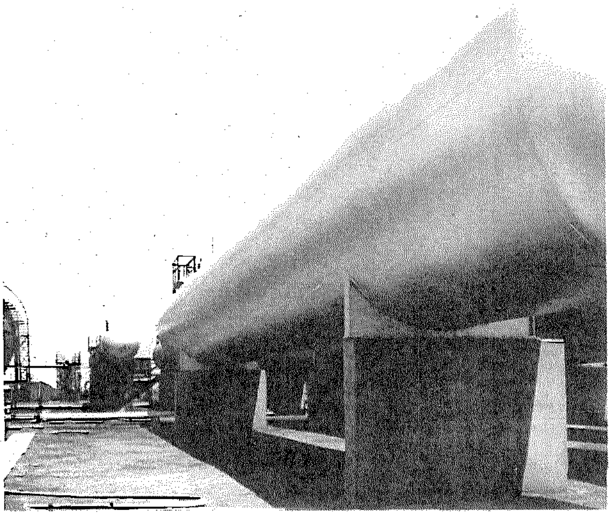
the south end of San Joaquin Valley west of U. S. Highway 99. Here the rupture of the rocks started probably at a depth of about 10 miles. It traveled northeastward under the valley, passing east of Arvin along the west front of Bear Mountain, following the White Wolf fault. Where the disturbance crossed the Southern Pacific line near Bealville and Caliente, it wrecked three tunnels, putting the track out of service for weeks.

What happened at the surface is not exactly what happened to the rocks a few miles down. Some of our California earthquakes, as in 1906 and 1940, have broken the ground with a continuous offset of fences and roads. The 1952 earthquake produced long zones of cracks and even long ridges like the one east of Arvin that looks like a road embankment — but most of these are due to shaking. The cracks are due to opening and closing of the ground and lurching from side to side during the shaking; the ridges, very likely, to sliding on the slopes.

Dr. John Buwalda, Professor of Geology, has been investigating these effects for weeks; and he has serious doubts whether there is anywhere a true fault trace like that of 1906. Such conclusions as that "Bear Mountain has risen three feet" go a long way past the known facts.

The epicenter of most, but not all, the shocks have been on or near the White Wolf fault. Those of magnitude 6 and over (to date) are:

			Mag.	
July	21	4:52 a.m.	7½	Main Shock
	21	5:05 a.m.	6	Unlocated
	22	5:38 p.m.	6	North of Caliente
	25	12:10 p.m.	6¼	East of Caliente
	25	12:43 p.m.	6	East of Caliente
	29	12:04 a.m.	6½	East of Bakersfield
	31	5:09 a.m.	6	Near Caliente
Aug.	22	3:41 p.m.	6	Near Bakersfield



Paloma Oil Refinery was hard hit in July 21 quake. Note how oil tank has moved relative to concrete pier above.

The earthquake on July 29, although part of the aftershock group, was on a different fault system, known as the Kern River fault, which runs across the mouth of Kern River canyon and cuts through the foothills not far from Bakersfield. The one on August 22 presumably originated even closer to that city; at least, so says Dr. Richter, who had been running the portable seismometer in the hills and sleeping in a pasture, but turned up at Bakersfield that evening, disheveled, unshaven, and with hay in his hair, to look over the damage and broadcast a statement.

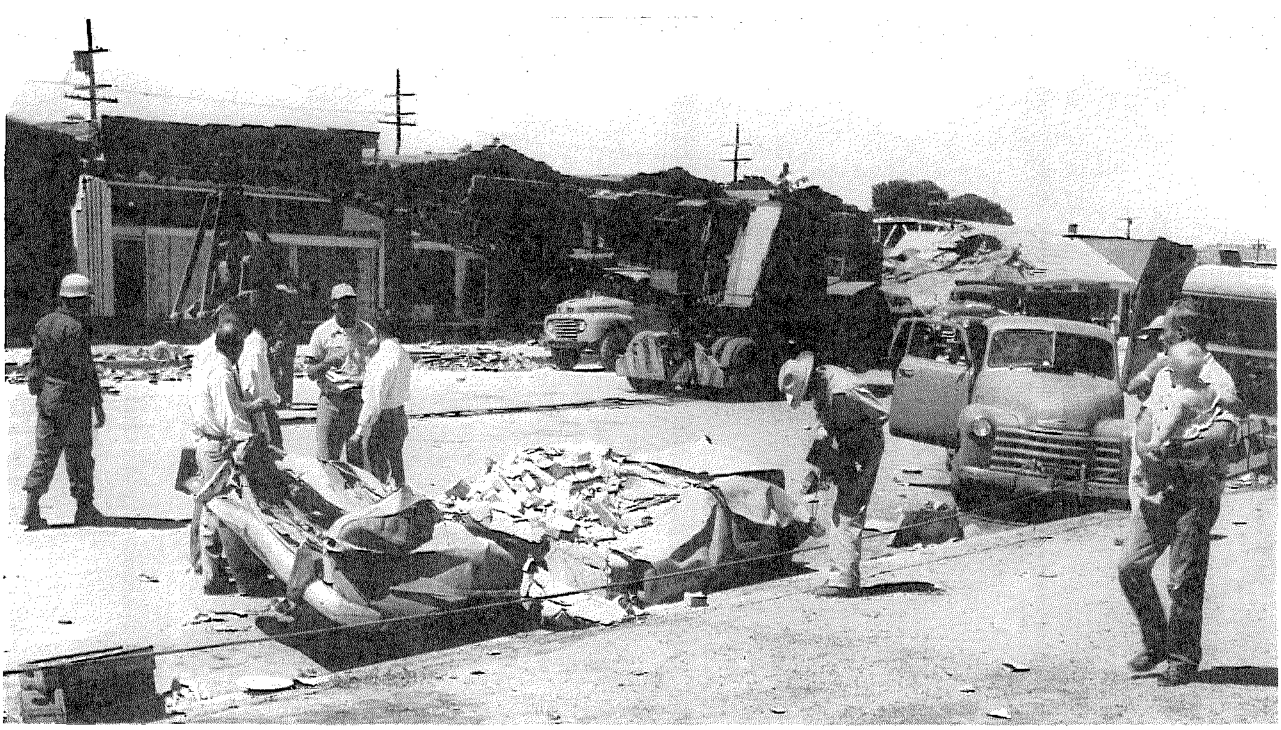
Everyone asks how long this will last. We can only judge by past experience, which is confirmed now by Dr. Benioff's method of plotting a curve of aftershocks. Shocks of this group down to magnitude 4 are usually noticeable in the Los Angeles area. These may be expected to go on at the rate of one or two a day for some months. Minor shocks may continue for two or three years.

The future?

An occasional shock stronger than usual is to be expected from time to time. An aftershock of magnitude 6 may well happen a year from now; but the intervals between such shocks will be longer and longer. Moreover, there is no reason now to expect another shock in the same region equal to the first major earthquake of July 21. Of course, there is always the possibility of a really great earthquake (magnitude 8 or over) in California.

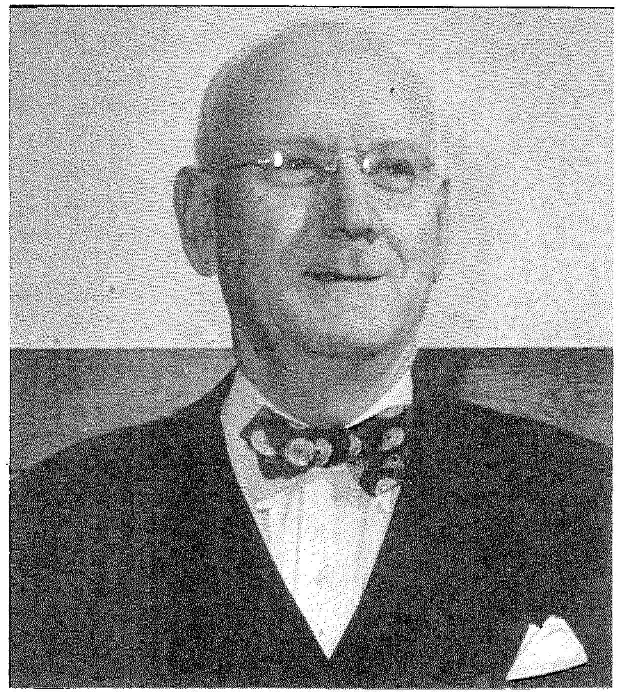
Secular strains have been building up along the northern portion of the great San Andreas Fault since the 1906 San Francisco quake, and along the southern portion since the quake of 1857. (The latter produced damage for at least 100 miles to each side of the town of Gorman).

It is these strains, accumulating for nearly 50 years on the northern San Andreas, and for almost a century on its southern portion, that lead Caltech seismologists to expect a great rift to slip again some day in the indeterminate future. The Kern County shocks have probably not done much either to delay the big one or speed it up.



Above — all that was left of a new Ford, after the July 21 quake hit Tehachapi. An entire building front fell on it.

THE SUMMER AT CALTECH



Franklin Thomas 1885-1952

FRANKLIN THOMAS, Dean of Students and Professor of Civil Engineering, died in Pasadena on August 27, after a short illness. He was 67 years old. He leaves his widow, Marie Planck Thomas; two daughters, Mrs. Eleanor Champion of San Diego and Mrs. Katherine Langille of San Gabriel; two sons, Richard, who lives in Pasadena, and William, of Venice, Calif.; and fifteen grandchildren. Two other sons, Edward and Robert, were killed in World War II.

Franklin Thomas joined the Caltech faculty 39 years ago. Born near Red Oak, Iowa, on May 19, 1885, he was graduated from the University of Iowa in 1908, and received his C.E. degree there in 1913. He came to the Institute in that same year as Associate Professor of Civil Engineering, to develop that department. He was made a full professor in 1915. In 1917, and again in 1920, he acted as chairman of the administrative committee of the faculty which ran the Institute during the absence of the President. From 1924 to 1944 he served as Chairman of the Division of Civil and Mechanical Engineering, Aeronautics and Meteorology. In 1944 he became Dean of Students at the Institute.

Franklin Thomas' interests outside academic circles were many and varied. He was the outstanding authority on water supply in the West—and he probably did more than any other single individual to get Colorado River water for southern California. In 1947 he was appointed to the Colorado River Board of California by Governor Earl Warren, and a year later he was made Chairman of the Board. He was a member of the Board of Directors of the Metropolitan Water District of Southern California from the time it was organized in 1928, and he was vice-chairman of the Board from 1929 to 1947. He also served as consultant on flood control and sanitation projects for the city of Los Angeles and for Los Angeles and Orange Counties.

He was a great civic leader, and served at various times as a member of Pasadena's Board of Directors, as head of its Chamber of Commerce, Community Chest and Civic Orchestra Association.

Professor Thomas was a lifelong member of the American Society of Civil Engineers, and served as its president in 1949. He was a former vice-president of the American Society for Engineering Education, and held membership in the American Water Works Association, the California Sewage Works Association, Sigma Xi, Sigma Tau and Tau Beta Pi. He also belonged to the Kiwanis Club, the Cauldron, Twilight, New Century, and University Clubs. He was a member of the Board of Trustees of the First Congregational Church of Pasadena.

In 1939 Franklin Thomas received the Arthur Noble Medal for distinguished service to the city of Pasadena. In 1949 he was awarded an honorary Doctor of Engineering degree by the University of Southern California for his "tireless contributions to the welfare of his community and state." In March of this year the Los Angeles Chamber of Commerce presented him with its fourth annual Construction Industries Achievement Award and named him "Man of the Year" for having done the most to "further the interests of industry and the entire community."

"Franklin Thomas," said Caltech's President Lee A. DuBridge, "was a great teacher, a great engineer, an invaluable citizen and a beloved friend. Caltech will forever be proud of his record of service to the Institute, to the community, and to the nation."

In his eulogy, at funeral services in Pasadena's First Congregational Church, Reverend Raymond Waser said:

"Franklin Thomas was a good man. That simple adjective, touched with the sturdiness of the good earth, applies to few men, for it is an adjective that must be earned in the heat of the day and the dark watches of the night. And in this hour there is no benediction greater that a man's fellow men can bestow . . .

"Honors were to come to him at home and abroad, and he accepted them in the spirit of a debtor to others. Success was to crown the aims and training of his early years. His dreams became visions, and he saw them become foundations in the community, the college, and the profession he loved. But nothing was ever bought or won at the price of Franklin Thomas' character . . .

"And now the journey is over. What shall be the last word? I do not think it should be praise as praise; neither do I think it should be that we should imitate him. His own modesty forbids both. I think the last word should be gratitude . . . Be we of the family, of his friends, or of his colleagues, that is the last word for each—gratitude—a gratitude that can never be fully expressed, yet which should move us and compel us to be more true to ourselves and to this beloved community."

Synchrotron

CALTECH'S $1,250,000 synchrotron, which has been under construction for two years, went into preliminary operation this summer and produced X-rays of 460 million electron volts, traveling at a speed of almost 186,000 miles a second. This not only broke all records for electron and X-ray energies; it was the highest speed ever reached by man-accelerated matter.

The synchrotron, built under a contract with the Atomic Energy Commission, is the most powerful atom-smasher of its type in existence. The next stages of work on the machine will involve raising its output to over 500 million electron volts. In another year or two, output is to be increased to around one billion electron volts.

Two other high energy electron machines are now under construction—a linear accelerator at Stanford and a non-ferromagnetic synchrotron at the General Electric Company in Schenectady. Previous highs in electron energies (325-340 MEV) have been produced by synchrotrons at the University of California, Cornell, the Massachusetts Institute of Technology, and by the betatron at the University of Illinois.

According to Einstein's theory of relativity the mass of a body increases as its speed increases. Therefore, when electrons in the Caltech synchrotron travel at a speed just one-tenth of a mile per second slower than the speed of light, they are 900 times heavier than when they are at rest. In the preliminary runs of the synchrotron, these electrons, bombarding a 1/8-inch lead plate, produced X-rays with energies of 460 MEV. In future research the electron beam will be used to bombard plates of platinum, tungsten and other heavy metals. The X-rays which are produced will, in turn, be used to bombard various materials for experiments on atomic nuclei. The research will be aimed at a better understanding of the structure of atomic nuclei and the nature of the forces that keep their constituent protons and neutrons locked together.

In particular, researchers will try to find out what particles are created when nuclei are bombarded with very high energy X-rays.

Members of the synchrotron team include Robert F. Bacher, Chairman of the Division of Physics, Mathematics and Astronomy; Robert V. Langmuir, Associate Professor of Electrical Engineering; Matthew Sands and Robert L. Walker, Assistant Professors of Physics; Vincent D. Peterson, John G. Teasdale, and Alvin V. Tollestrup, Research Fellows in Physics; and Bruce H. Rule, Chief Engineer for both Palomar Observatory and the synchrotron project.

Geology Chairman

ROBERT P. SHARP, Professor of Geomorphology, has been appointed Chairman of the Division of Geological Sciences to succeed the late Chester Stock, who died in December, 1950.

Sharp was graduated from Caltech in 1934 and received his M.S. here a year later. After he got his Ph.D. from Harvard in 1938 he joined the faculty of the University of Illinois. In 1943 he was commissioned into the Arctic, Desert and Tropic Information Center of the Army Air Forces, and after the war he taught at the University of Minnesota. He joined the Caltech faculty in 1947.

Said Dr. DuBridge: "The Division, with the addition of two outstanding men in Professors Harrison Brown (*E&S*—Nov. 1951) and Heinz Lowenstam (see below), has now embarked on an enlarged program of research and teaching in the newest and most rapidly developing phases of earth science arising from application of nuclear chemistry to problems of geology. Dr. Sharp's outstanding abilities as a scholar, teacher and administrator make him the ideal man to lead the Division as it enters this new stage of its development."

Paleoecologist

DR. HEINZ A. LOWENSTAM, an outstanding invertebrate paleontologist and paleoecologist, has been appointed Professor of Paleoecology at the Institute. Now an Associate Professor of Geology at the University of Chicago, he will take up his duties at Caltech this fall. He succeeds Dr. Charles W. Merriam, who has returned to the United States Geological Survey.

Professor Lowenstam, 39, studied at Frankfort and Munich in his native Germany, came to this country for graduate work at the University of Chicago and was naturalized in 1943. After receiving the Ph.D. degree in 1939, he served as curator of paleontology at the Illinois State Museum and in 1943 became an associate geologist of the Illinois State Geological Survey. He was a research associate in geology at the University of of Chicago, 1948-49, and was appointed Associate Professor in 1950. He is married and has three children.

As a paleoecologist, Professor Lowenstam has studied ancient fossils to determine the relationship and interdependence of species which lived in the same environment in prehistoric times. He has also studied the variations of biologic environment with time through investigations of sedimentary rock strata. He has investigated the origin of chert, a type of fine-grained silica occurring in some limestone deposits, and believes it may have been precipitated originally by marine organisms, particularly sponges.

He is known widely for his research on tropical reefs found below the earth's surface in some areas of North America by oil drillers and in quarrying operations. He and other workers have shown them to be true reefs made by organisms — corals and certain types of algae — similar to those that built the Pacific atolls.

The reefs interest oil geologists, for in certain fields a direct relationship seems to exist between them and the occurrence of oil. The porous reefs themselves would have provided good oil reservoirs, and scientists are speculating whether decay of the reef-building organisms provided some of the raw materials for oil.

Professor Lowenstam's intensive studies are expected to provide helpful information on the problem, even though his direct concern is not the origin of oil. He is primarily interested in the information the structures provide on climates of the past.

He has been able, for example, to trace the pattern by which the extensive Marine Reef in Madison County, Illinois, grew perhaps 370 million years ago. At one time, he believes, some of it extended above the surface of the ocean which long ago covered central North America. He has found indications that when the reef was formed the prevailing winds blew from the south, unlike those of today. He suggests that these winds may have brought water from the tropics and warmed this area of the ocean enough to permit the chemical changes involved in reef building.

Professor Lowenstam has also collaborated with Professor Harold Urey and Dr. Samuel Epstein of Chicago in pioneering research on the temperatures of prehistoric oceans. He will continue this work at Caltech with Dr. Epstein, who joined the Geology Division this summer as a research fellow. The research involves measuring the relative abundance of isotopes found in marine fossils to determine the probable temperatures at which the organisms grew.

Lowenstam has been a frequent visitor to California, primarily as a geological consultant to the California Research Corporation of the Standard Oil Company of California at its La Habra laboratory. He conducted an informal geology seminar at Caltech last January.

He is a member of the Paleontological Society of America, Society for the Study of Evolution, Ecological Society, American Association of Petroleum Geologists and the Illinois Academy of Science, and is an associate of the Society of Economic Paleontologists and Mineralogists.

Sorensen Retires

ROYAL W. SORENSEN, Professor Emeritus of Electrical Engineering, enters full retirement this fall, after a 42-year career at Caltech (*E&S*—January 1952).

Professor Sorensen, who has the longest service record of any Caltech faculty member, has been on half-time retirement from his professorial duties for the past two years. He plans to continue his high voltage equipment research on campus, and will also supervise the construction of 200,000-ampere current-testing equipment, being built on the campus to his design, under the auspices of industrial companies.

Professor Sorensen came to Caltech, then known as Throop Polytechnic Institute, just after the move to the present campus site in 1910, with the purpose of starting a department of electrical engineering. He has served on many important committees on campus, was faculty chairman for one year, and chairman of the department of physical education for many years. After his appointment as Professor Emeritus in 1950, a group of his former students honored him by inaugurating the Royal W. Sorensen Graduate Fellowship in Electrical Engineering (*E&S*—June 1950).

Faculty Additions

FOUR NEW FACULTY members join the Institute this term: William H. Corcoran as Associate Professor of Chemical Engineering; Francis B. Fuller, Instructor in Mathematics; Henry D. Piper, Assistant Professor of English, and James N. Thurston, Associate Professor of Electrical Engineering.

Dr. Corcoran received his M.S. from Caltech in 1942, and joined the research staff of the Cutter Laboratories. In 1943 he returned to Caltech to serve as development engineer on its rocket development program. After the war he resumed his graduate studies here, was awarded a National Research Council fellowship, and in 1948 was one of the first men to receive the Ph.D. degree with a major in chemical engineering. He then returned to the Cutter Laboratories, where he has served as head of the Technical Development Division.

Dr. Fuller received his Ph.D. this spring from Princeton University, where he was a graduate assistant in the mathematics department. At Caltech he will continue his research in topology and teach a course in the subject.

Dr. Piper received a B.A. in chemistry from Princeton in 1939. After graduation he was employed by E. I. du Pont de Nemours Co. as a research chemist. In 1943 he was loaned by Du Pont for special research on the atomic bomb at the University of Chicago, and to help supervise various operations in establishing the Richland, Washington, plutonium plant. He also was a special assistant to the Manhattan Project research director, supervising preparation and editing of a report on non-military applications of atomic energy. After the war he returned to Princeton for graduate study in English, then transferred to the University of Pennsylvania, where he was appointed Harrison Scholar in American Studies. He received his Ph.D. in English in 1950 and was appointed an instructor at Columbia University. He has published a number of articles in literary magazines and is presently writing a book, *A Critical Study of the Work of F. Scott Fitzgerald.*

Dr. Thurston received his M.S. and Ph.D. degrees from M.I.T., where he was Assistant Professor of Electrical Engineering from 1947 to 1949. In 1949 he joined the faculty of the University of Florida. He was assistant director of a guided missile project at M.I.T., and has been project leader on an Air Force research program at the University of Florida. His industrial experience has included work as test engineer for the General Electric Co., geophysical work in Venezuela for the Mott-Smith Corporation, and consulting work in electronics for various organizations. He is a member of Sigma Xi and Tau Beta Pi, and a senior member of the Institute of Radio Engineers.

Merrill Retirement

Paul W. Merrill retired from the staff of the Mount Wilson and Palomar Observatories on September 1, after a 33-year astronomical career. A foremost authority on spectrum analysis, Dr. Merrill's work on long-period variable stars, class B stars, peculiar stars, and interstellar gas has received wide recognition.

Paul Merrill never planned on an astronomical career. After he received his B.A in mathematics at Stanford University in 1908, he was offered a job with the Lick Observatory at Mount Hamilton, California. Convinced, after a year and a half, that astronomy was a worthwhile occupation, Merrill accepted a fellowship from the Observatory to the University of California, and received his PhD. there in 1913.

For three years he taught astronomy at the University of Michigan, then worked at the Bureau of Standards in Washington for a short time as a physicist. During World War I he made an important scientific contribution with his work on aerial photography, using red-sensitive plates.

Dr. Merrill joined the Mount Wilson Observatory staff in 1919. He became editor of the Observatory publications in 1939, and in 1949 he was appointed a member of the Observatory Committee, which determines scientific policies for both Mount Wilson and Palomar.

Dr. Merrill has received a number of honors during his scientific career. He is a member of the National Academy of Sciences, the American Philosophical Society and a foreign associate of the Royal Astronomical Society. In 1946 he was awarded the Draper Medal by the National Academy of Sciences for his contributions to astronomical physics. In the same year, the Astronomical Society of the Pacific presented him with the Bruce Medal for his distinguished services.

Stebby to Caltech

World War II Ace Major Robert F. Steffy joins the Caltech Air Force R.O.T.C. Staff this term as Assistant Professor of Air Science and Tactics.

Steffy, an Air Force Reserve officer, holds the Distinguished Service Cross, Distinguished Flying Cross, and the Air Medal with six clusters for his Pacific Theatre operations during World War II. He has four confirmed victories to his credit and three probables.

A 1950 graduate of the University of Detroit, he was studying for his master's degree in social science when he was recalled to active duty. He comes to Caltech from Luke Air Force Base in Arizona, where he was director of academic training for the Jet Pilot Training School.

Major Steffy replaces Lt. Colonel Marvin D. Fleming, who has been transferred to the Air Command Staff School at Maxwell Air Force Base in Alabama.

Fowler's Award

William A. Fowler, Professor of Physics, was recently awarded the Lamme Medal of Ohio State University, his alma mater. The citation is made annually to an outstanding graduate in engineering and the technical arts.

Dr. Fowler was Scientific Director of the Department of Defense's secret Project Vista in 1951-52. He received his Ph.D. from Caltech in 1936, was active in research on the proximity fuse, rockets and atomic weapons during World War II, and received the Medal for Merit in 1948.

Peache

The Institute lost one of its favorite employees this summer when Peache Nickerson, head telephone operator for 17 years, left to join her husband, who is now personnel director at the Naval Proving Ground in Dahlgren, Va.

When she came to Caltech in 1935, Peache was not only the whole telephone staff; she was the mail room too. When she left this summer, she headed a department of seven operators.

At a farewell tea for Peache, Dr. William A. Fowler, on behalf of the faculty and staff, presented her with a wrist watch and a testimonial letter assuring her that everyone at the Institute would remember her as a girl who always lived up to her name.

THE CALTECH SAILING CLUB

Sailing may be a minor sport, but this new organization looks like a major entry on the Caltech sports program

By JIM WYMAN '53

SAILING ACTIVITIES of one form or another have existed at Caltech for the past twelve years. Three years ago a loosely organized sailing club was able to participate in the Pacific Coast intercollegiate dinghy championships at Newport Harbor, and to travel to Berkeley for an invitational regatta with the University of California.

Last November, three or four undergraduates and a graduate student decided to organize some sort of formal sailing club. The first major achievement of the new organization was in talking Hal Musselman, of the Athletic Department, out of $10 for dues in the Pacific Coast Intercollegiate Yacht Racing Association, and a similar national organization.

The primary purpose of the new sailing club was to represent Caltech in intercollegiate sailing competition. In order to do this effectively, the Tech sailors needed boats to practice with. Small sailing dinghies were occasionally borrowed from neighboring colleges. In spite of these obstacles, the rapidly growing sailing club was able to participate in five regattas at Newport Harbor, and to travel again to Berkeley to make a good showing against the Pacific Coast champions.

By this time it was obvious that the sailing club would have to obtain boats of its own, if its purposes were to be achieved. The plan was: first to strengthen the organization and gain further recognition; and second, to find someone who could provide some dinghies and equipment.

The club was able to gain the approval of the associated students and the athletic council — and thus became a candidate for status as a minor sport. Weekly meetings of the club provided sufficient interest for twenty-five members. A constitution was drawn up, a club burgee designed, and regattas were planned and discussed. The most significant event in this program was the consent of Dr. Clark B. Millikan to act as faculty adviser to the sailing club. The sailing club's growth and progress are due mainly to Dr. Millikan's efforts on behalf of the organization.

It was realistically assumed from the beginning that not much financial help could be expected from the Institute. But a meeting with Commodore Don Barber of the Los Angeles Yacht Club revealed that the LAYC had been considering the idea of sponsoring a junior yachting organization for some time.

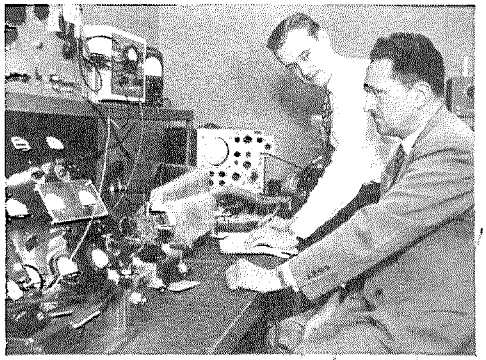
Early last June, three members of the LAYC met together with Dr. Millikan and two members of the sailing club to discuss the terms of sponsorship. It was agreed at that time, pending approval by the LAYC Board, that the LAYC would loan Caltech $1250, interest free, if the sailing club could raise the balance of the $3000 required for the purchase of six racing dinghies. The loan would be repaid from membership dues of the sailing club.

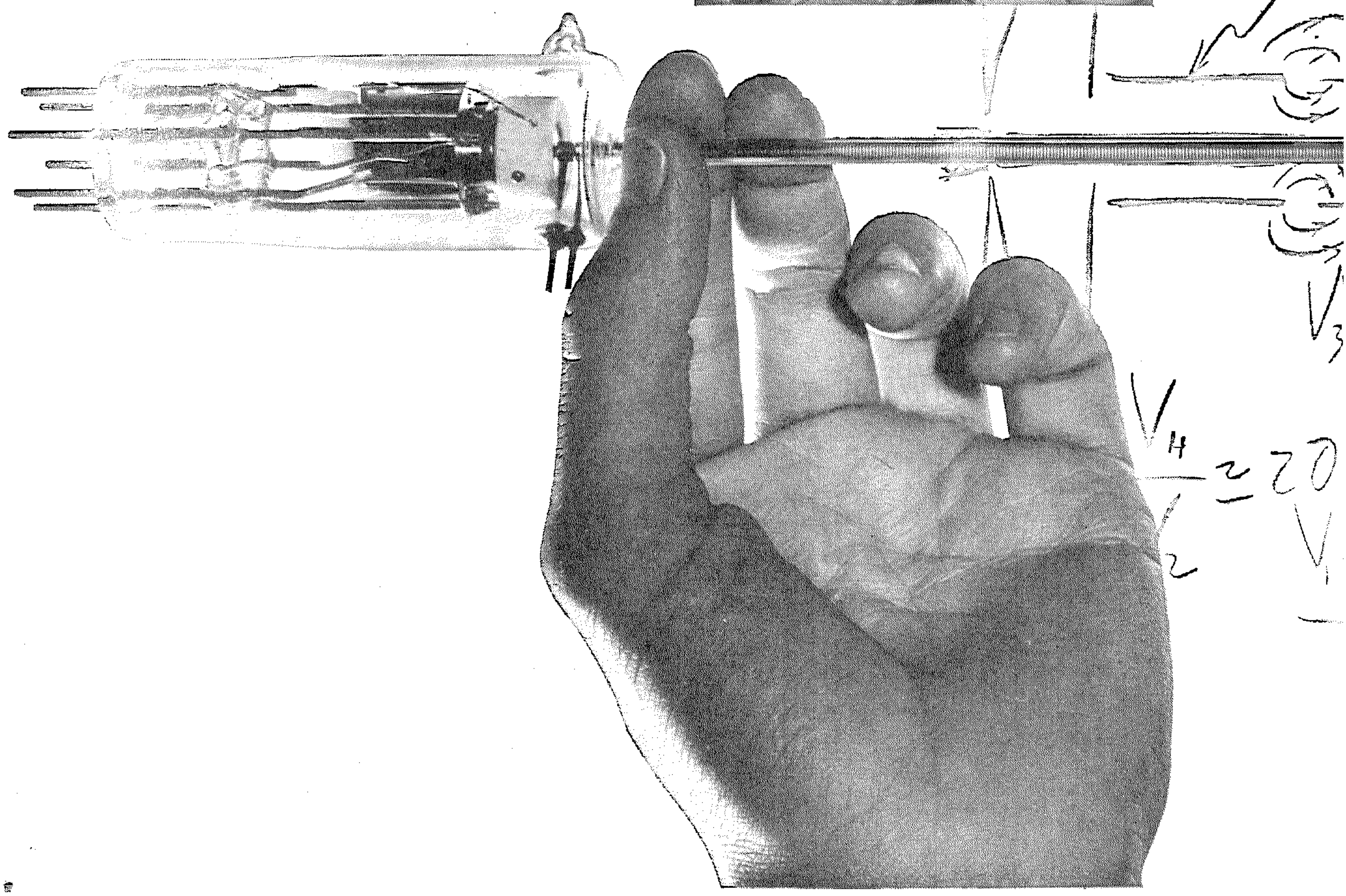
Dr. Millikan then decided that the money could best be obtained through tax-deductible gifts to a special Caltech Sailing Club Fund. Letters went to some 160 Institute faculty members, trustees, associates and alumni. The results were extremely gratifying, and the desired amount of money was obtained. In addition, Mr. P. G. Winnett, an Institute Trustee, and Mr. Dana Smith, an Institute Associate, both donated 16-foot Falcon-class sloops to the sailing club. It is contemplated that six 13-foot Fiberglas racing dinghies will be purchased with the $3000 that has been raised.

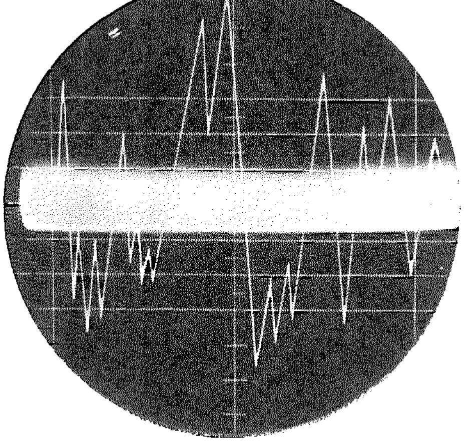
CONTINUED ON PAGE 30

Reducing noise in radar...

Measuring the noise figure of an experimental traveling-wave tube are Dr. A. V. Haeff (right) head of the Electron Tube Laboratories at Hughes, and Dr. Dean Watkins (left) one of his co-workers.



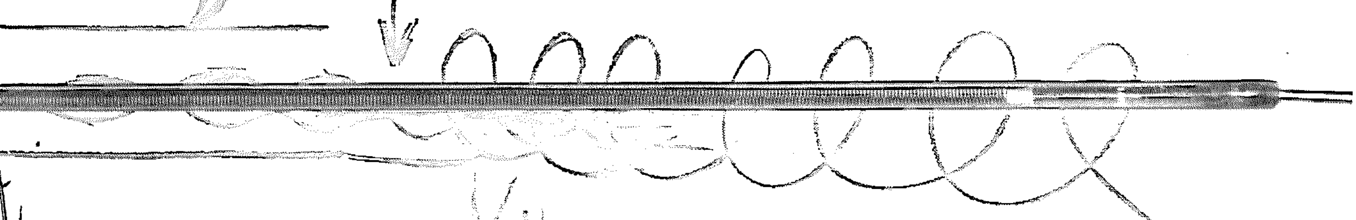




In the operation of a radar system, the amount of energy reflected from small targets is very minute. The over-all sensitivity and range of radar depend equally upon effectively generating and transmitting considerable power at microwave frequencies—and upon effectively receiving and amplifying very weak echo signals.

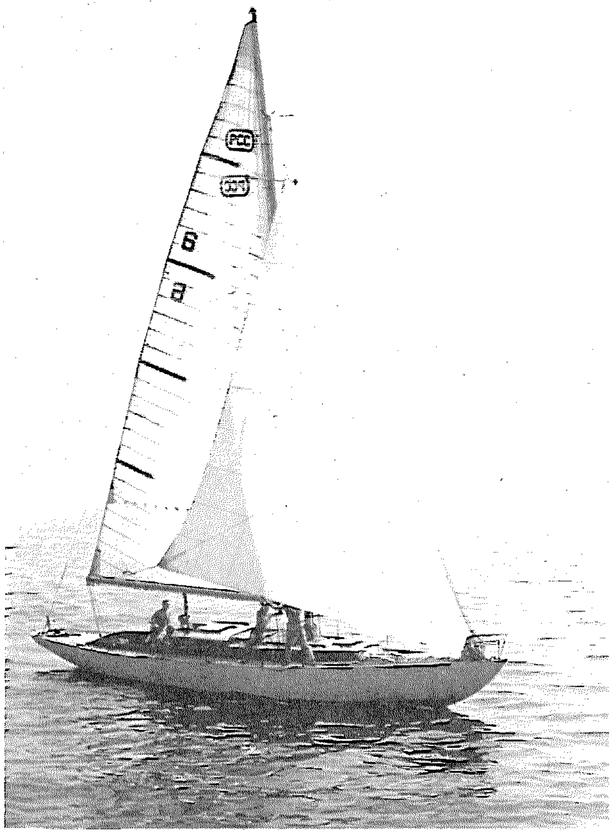
An important limitation in receiver sensitivity is imposed by noise that is created within the receiving tubes—and caused by random motion of electrons. Because the reduction of tube noise could make available improved techniques to the designer of many types of microwave systems, a project is under way at Hughes Research and Development Laboratories to expand our understanding of noise phenomena at high frequencies.

Studies in tube noise are being made with the newly developed *traveling-wave tube,* shown on this page in actual size. This tube has the unique ability to amplify microwave signals over a wide frequency range, but its excessive noise has hitherto prevented its extensive use. Methods of reducing noise in the traveling-wave tube are being devised and tested at Hughes, and the recently obtained noise figure of 13 decibels at a frequency of 10,000 megacycles is proving of considerable interest to systems designers.



Positions for engineers and physicists are available in the Research and Development Laboratories. If you would like to learn more about these positions, and are not now engaged in an urgent military project, write to:

Hughes Research and Development Laboratories
Engineering Personnel Department
Los Angeles County
Culver City, California



During the summer, members of the newly organized Caltech Sailing Club crewed on ocean racing yachts like this Pacific Coast Cruiser owned by Patent Attorney Fred Lyon. The yacht, named "The Kitten," won the Honolulu Race in 1949.

The Los Angeles Yacht Club has three major reasons for sponsoring the Caltech Sailing Club. First of all, the sailing club would provide small boat sailing activity at the LAYC during the fall and winter — which are otherwise periods of relative inactivity. Secondly, trained members of the sailing club would provide a reliable source of crews for LAYC members on their yachts during the spring and summer seasons. Thirdly, members of the sailing club might prove to be potential members of the LAYC.

In addition to the $1250 loan, the LAYC provides docking and storage facilities at the club for Caltech's new boats and equipment. John Wells and Earle Burt (Caltech '15) of the LAYC Board have been the principal advisers for the unique sponsorship.

Besides its new material assets, the Caltech Sailing Club now has a stronger, better-coordinated organization. There are seven club officers, each with distinct duties and responsibilities specified by a new constitution. Membership cards are provided for the three school terms; and all activities at the harbor are governed by a set of rules of conduct and procedure. The club expects to have about forty-five members during the first term of this year.

The new program of the Caltech Sailing Club provides, primarily, sailing training for inexperienced men; and secondly, an opportunity for others to participate in intercollegiate regattas, using Caltech's boats.

Caltech may challenge any of the ten major colleges in California, Arizona and New Mexico to a regatta. These regattas are held under the auspices of the Pacific Coast Intercollegiate Yacht Racing Association. In December, Caltech will again be represented in the Pacific Coast Championships at Newport. In February, the Caltech sailing team will again go north to Berkeley, and in May to Newport for the annual U. S. C. Invitational Regatta. Sailing races with local colleges will be held every three or four weeks.

Monthly meetings of the sailing club are also a significant part of the program. Last May, Mr. Howard Wright of the Transpacific Yacht Club (and LAYC) showed movies of the 1949 Honolulu Race, at a general meeting of the sailing club. At that time, Mr. Wright showed the existing curve which was used to determine the time allowances or handicaps of different boats in the Honolulu Race — and pointed out that the empirical results of the three post-war races did not conform to the time-allowance curve.

Members of the sailing club were asked to work on the problem; and the result has been a new curve based upon the empirical results of these three races. The Race Committee of the TYC has voted to accept this curve, and use it as a handicap standard for the 1953 Honolulu Race. This new standard for the greatest yacht race in the world will be called the Caltech Empirical Curve.

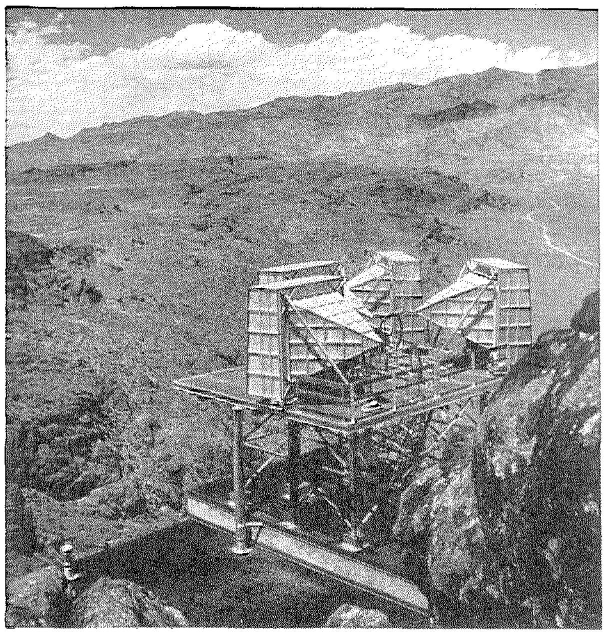
Two or three members of the sailing club already have bids to go on the next Honolulu race, in July; and others have been crewing on ocean racing yachts out of Los Angeles and Newport Harbors.

Ask a Radio-Relay Station How It Feels

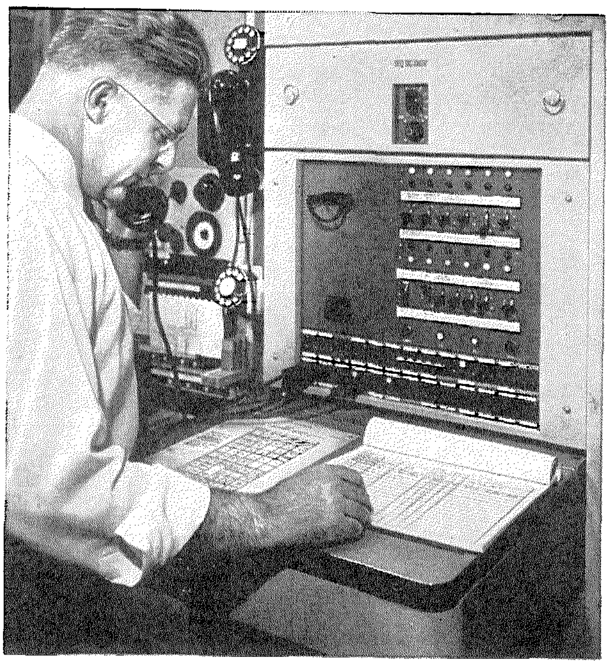
—and get an answer!

Bell System's 107 radio-relay stations — stretching between New York and San Francisco — have minds of their own. They have to. Most of them stand unattended on remote hills and mountains far from towns. But when they detect any condition that might lead to service difficulties, they call for help!

They do this through a new alarm system developed by Bell Telephone Laboratories. At regular intervals, a man in an alarm center in town, sometimes many miles away, sends a signal to the tower asking how things are going. The station automatically reports its condition through a pattern of lights on a chart.



Radio-relay station at Wendover, Nevada



Alarm-receiving bay. Lights on the chart report on 42 different conditions affecting service. Eleven Alarm Centers across the nation cover all 107 radio-relay stations.

But when serious trouble threatens, the station reports without being asked. It rings a bell at the alarm center. The attendant asks what's wrong. Through a pattern of lights, the station tells him — a power interruption, a blown fuse, an overheated tube, or even an open door.

Some things the attendant can correct by remote control. Others the station automatically "cures" itself. These things failing, a maintenance man is dispatched.

As the Bell System develops new and better methods of communication like radio-relay — new problems constantly must be overcome. This search for ways of giving better telephone service at lower costs calls for venturesome, alert engineering and scientific minds. Continual research provides great opportunities for enterprising, talented college graduates in the Bell System.

BELL TELEPHONE SYSTEM

ALUMNI NEWS

Chapter Notes

CHAPTERS IN San Francisco, Sacramento, Chicago, New York, and Washington, D. C. are now getting under way for their fall activities and new chapters are also being organized at China Lake and Detroit.

The San Francisco Chapter held its annual picnic and swimming party at Bob and Betty Bowman's ranch in Concord on August 30. Bob's new pumping system was christened and the weather was perfect for the event. There were 31 members and wives present.

After the barbecue, Ruth Vesper at the piano was the center of a crowd enjoying group singing and duets by Howard Vesper and Janice Heitz. The traditional poker game started early and ended late.

—R. W. Stenzel
Director in charge of Chapter Activities

Dinner Meetings

THE ALUMNI ASSOCIATION will launch a series of dinner meetings this fall. In all, three have been planned for the year ahead — the first, in October, at the Athenaeum; the second, in January, in the Santa Monica area; and the third, in March, in the Long Beach area. Speakers' topics will be of local, general, or international interest — and will generally be non-technical. The meetings are open to all alumni, but note that wives are not included in this invitation. Dates and speakers will be announced shortly.

Detroit Get-Together

CALTECH ALUMNI in the Detroit area are planning a get-together dinner on October 17 at the Engineering Society of Detroit. Wives are invited, and dinner will be at six p.m. Reservations may be made through Albert Chapman '25, whose address is 26235 W. Warren Street, Garden City, Michigan. The tab will come to $3.25 per person, and checks should be made payable to the Engineering Society of Detroit. For further information, if you're in the Detroit area, call Al Chapman at Logan 3-4730.

Harold Hill Retires

HAROLD C. HILL retired from the General Electric Company on August 1 after 41 years of service. A retirement dinner, attended by approximately 150 G.E. employees, was held in his honor at the company's Los Angeles offices.

After his graduation from Caltech, Hal was trained in G.E.'s eastern plants, but at the end of World War I

CONTINUED ON PAGE 34

he returned to Los Angeles and was given the assignment of covering the oil industry. Later he was placed in charge of User Sales, and at the time of his retirement was assistant to the industrial manager of the company's Los Angeles office.

Hal was one-third of the first class on the present Caltech campus, and, since graduation, has remained active in work to help the Institute and its students. Until recently he was a member of the board of the Alumni Association.

Presently living in Covina, although a long-time resident of Alhambra and San Marino, Hal is married and has one daughter and two grandchildren. His hobbies—which are going to get a lot more of Hal's attention from now on—include fishing, and growing avocados and camellias. He's a past-president of the Southern California Camellia Association.

Placement Activities

During the year 1951-52, there were 399 jobs filled through the Caltech Placement Office. This figure includes 83 students in part-time work, 191 students in summer jobs, 92 seniors and graduate students in permanent employment, and 33 alumni in new positions. The total number of alumni who applied to the Placement Office for assistance was smaller this year than at any time during the past six years, which probably reflects the great demand for men with engineering and scientific training.

Forty-six percent of all students who applied for part-time work were placed. This figure seems low, but includes requests for spring and Christmas vacation jobs, which aren't plentiful. Some students found employment on their own before referrals could be made, while others were very specialized in their requirements for a job. For part-time work, baby sitters were most in demand, with work in exchange for room and board, gardening, and tutoring following in that order. In summer jobs, the largest number of men (69 percent) were placed in technical work, while 11 percent were employed by government installations.

The number of organizations who sent interviewers to the campus to recruit men receiving degrees increased 38 percent over the previous year. Campus representatives of 132 organizations interviewed 200 men (58 percent of all who received a degree), and offered positions to 79 percent of them. Forty-two percent of that number accepted the offers.

Salaries offered this year are higher than last year. The maximum salary for a man with a B.S. degree was in the field of electrical engineering—about $520 a month; maximum for the M.S. degree was in physics—$520; maximum for the Engineer's degree was in mechanical engineering—$580; and for Ph.D.'s it was in physics—$750.

New RCA Victor record changer —easiest to play at all three speeds!

World's simplest 3-speed changer, this versatile Victrola combines new playing ease with the finest reproduction of sound. And it changes "45" rpm records *correctly*, on the same turntable used for other speeds.

Key to this advance is RCA Victor's *slip-on* "45" spindle, which fits over the permanent spindle and locks in place. No plugs or extra gadgets. Simply stack your "45" records on this fine instrument, and play up to fourteen of them—at the twist of a knob. Then, whenever you wish, remove the "45" spindle, flick the needle and speed controls, and the same Victrola changer will play records automatically at 33⅓ or 78 rpm.

More than a year of research and engineering went into this changer—further evidence of the leadership which assures you finer performance in any product or service of RCA and RCA Victor.

* * *

See the latest in radio, television, electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y. Tmks. ®

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World leader in radio—first in television

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

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

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

PERSONALS

1922

Howard G. Vesper, of the California Research Corporation, has been elected to the board of the Industrial Research Institute, Inc., in New York.

1924

Bill Holladay has resigned from the Hieatt Engineering Company and is with the Commercial Refrigeration Company in Los Angeles, where he is continuing his engineering of ultra-low-temperature altitude chambers and test cabinets.

1926

Bob Moodie and his wife announced the arrival in May of their first grandchild—a son, James G. Moodie. Their oldest daughter, Dorothea, received her B.A. this summer.

1927

Ralph M. Watson, M.S. '28, has been appointed director of research for the Worthington Corporation in Harrison, N. J. He joined the organization in 1936 as an engineer in the Centrifugal Pump Division. In 1942 he became chief engineer of that division, and three years later, assistant to the vice president in charge of engineering. He began his new job on July 1.

Vernon P. Jaeger had the honorary degree of Doctor of Divinity conferred on him by the Northern Baptist Theological Seminary in May, 1952. He is now an Army Chaplain in the Korean Communications Zone Headquarters.

1930

Homer B. Wellman, Ph.D. '30, resigned after 17 years with the California Research Corporation in Richmond, and in September, 1950, began a round-the-world tour by PAA. In Melbourne and Victoria, Australia, he spent two months sightseeing and visiting relatives. From there he went to Cape Town, South Africa, where he visited his brother and family for five months. In August, 1951, Homer married Doreen Margaret Box, who flew here from Melbourne. He is now a research chemist in the Central Research Department of the Food, Machinery, and Chemical Corporation in San Jose.

1931

Lucas A. Alden, Ph.D. '35, has been promoted to vice-president of W. R. Grace and Company. He has been with the firm since 1944, and was named assistant treasurer in 1947, and assistant vice president in 1949. Although his headquarters are in the home office in New York, Lucas spends about one-third to one-half his time on trips to South America—mainly Peru and Chile. Arriving there during their summertime, he not only avoids the New York winters, but also finds it beneficial to his golf game. The Aldens have a seven-year-old daughter who gives promise of becoming a good engineer—if by any chance CIT should become co-educational in another 10 or 15 years.

1932

Chet Keachie is teaching industrial engineering at the University of California at Berkeley, where he is an Associate Professor. The Keachies have three children, two boys and a girl.

R. E. Foss is the California Manager of the Sunray Oil Corporation in Los Angeles. The Fosses have two children and live in La Crescenta.

James E. Lipp, M.S. '34, Ph.D. '35, has been with Project Rand and the Rand Corporation at Santa Monica for the last five years. He's now head of the Missiles Division there. Jim and his wife have an eight-year-old son and live in Santa Monica Canyon.

Ray T. Oelschlager left the Douglas Aircraft Company and started with the Rand Corporation in Santa Monica last September. He'd been an engineer at Douglas for eleven and a half years. Ray lives in Bel-Air and has two boys, 12 and 17.

William H. Saylor is Associate Director of the Naval Ordnance Test Station in Pasadena. Last spring he spent three months at Harvard in an advanced management program.

Robert B. Freeman, M.S. '33, Ph.D. '36, has been made Assistant to the Vice President in Charge of Operations of the Columbia-Geneva Steel Division of United States Steel. He started as a metallurgist at the Torrance, Calif., Works of Columbia, and was transferred to the San Francisco headquarters office in 1938. In 1941 he was named Metallurgist at the Pittsburg, Calif., Works, and three years later became Works Metallurgist. He was appointed Chief Metallurgical Engineer in November, 1948.

Bob lives with his wife and two children at Millbrae, Calif.

Joseph Sheffet, M.S. '33, has a private practice as a structural engineer in Hollywood, and lives in Pasadena. He and his wife have two children—Mary Jane, 6½, and Laura Anne, 2½.

Grant D. Venerable is general manager of the George R. Healey Manufacturing Company of Los Angeles, which makes dining room table pads and chalkboard erasers. He has three children—Grant Delbert, Lynda Blaine, and Lloyd Dennis—ages 9, 8, and 7, respectively.

1934

James D. Davis has been appointed manager of the new Catalytic Cracking Department of Shell Oil Company's Norco Refinery. He joined the Engineering Department of the Martinez Refinery in 1934, and has been with Shell Oil since that time. He became manager of the Catalytic Cracking Department of the Wilmington Refinery in 1949.

Donald L. Cleveland is manager of the Effluent Control and Utilities Department of Shell Oil's Wilmington Refinery. Don began his career at Shell in 1934 as a junior chemist at the Martinez Refinery. In 1949 he was appointed assistant manager of the department he now heads.

Thomas P. Thayer, Ph.D., of the U. S. Geological Survey, has been made Commander of the Star of Africa in recognition of his work on the geology of the Bomi Hills iron deposits in Liberia. The order was conferred by Liberia's President Tubman in Monrovia, the nation's capitol. Tom returned to the U. S. in mid-June.

Fred Kurata has been promoted to professor of chemical engineering at the University of Kansas.

1936

Thomas J. Deahl, M.S., has been appointed a supervisor in research in the Shell Development Company's Catalysis and Surface Chemistry Department, Emeryville, Calif. Tom has been with the company for 15 years.

William E. Bingham was awarded his Ph.D. degree at the June Commencement of U.S.C.

1938

Duane W. Farnham, M.S., has been transferred from the Stanolind Oil and Gas Company's general office in Tulsa, Oklahoma, to the division office in Fort Worth, Texas, where he has been named division gas superintendent.

1939

David H. Scott has been promoted to head of the gravity department of the geophysical division of the Texas Company, and has transferred from Los Angeles to Houston.

J. Norton Wilson, Ph.D., previously in charge of the Physics Department, was recently appointed head of the Catalysis and Surface Chemistry Department at the Shell Development Company in Emeryville, California.

1940

Gerald P. Foster begins his fifth year with the Federal Civil Service this fall. He recently took over a new job as head of the engineering section, Product Engineering Branch, of the U. S. Naval Ordnance Test Station in Pasadena.

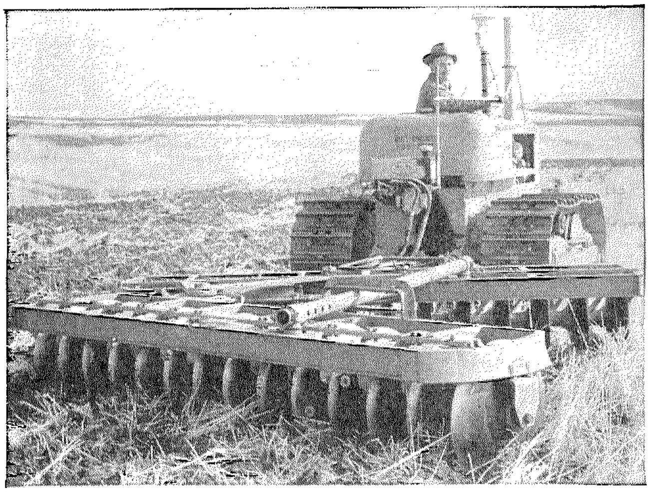
David M. Bonner, Ph.D., was awarded the Eli Lilly Award at the Milwaukee session of the American Chemical Society's spring meeting, for his work on the biosynthesis of amino acids.

Alan T. Waterman, Jr., received his Ph.D. from Harvard in June.

Jack Tielrooy is Supervisor of Chemical Process with the Union Oil Company of California at their new research center at Brea. He writes that he's still active at his hobby of amateur radio. The Tielrooys

CONTINUED ON PAGE 38

Another page for **YOUR BEARING NOTEBOOK**

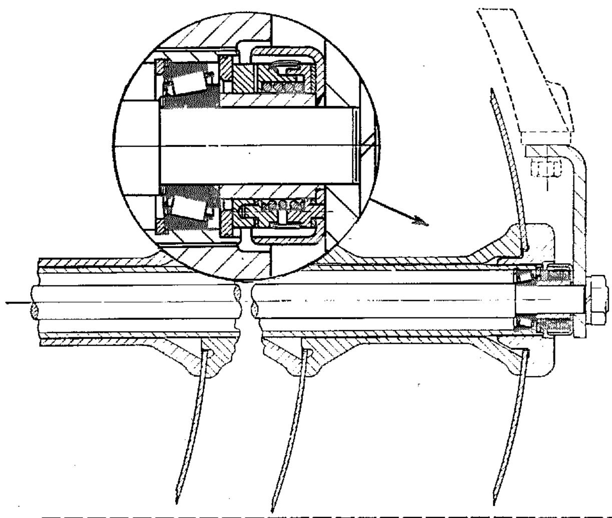


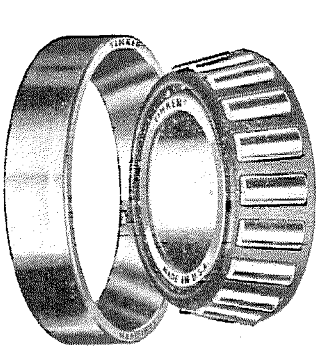
How agricultural engineers solve 3 design problems at once

Designing farm machinery applications like the through shafts of disk harrows presents three big problems to agricultural engineers: 1) combination loads, 2) dirt, 3) ease of operation. Engineers solve all three problems at once by designing the shafts on Timken® tapered roller bearings. Because they are tapered, Timken bearings carry both radial and thrust loads in any combination. They keep housings and shafts concentric, making closures more effective. Dirt stays out—lubricant in. And they keep shafts turning easily because of their true rolling motion and incredibly smooth surface finish.

How to mount disk harrow shafts on TIMKEN® bearings

Two single-row Type TS Timken bearings are indirectly mounted on a stationary shaft in a rotating disk assembly. The bearing cups are press-fitted against snap rings. The bearings are adjusted by means of shims between the bearing cone and shaft shoulder. A special spring-backed rubbing seal assures maximum protection to the bearings. The rubbing seal itself is protected by a shield fitted about the closure assembly.





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TAPERED ROLLER BEARINGS

How to learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For a copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

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

live in Fullerton and have two children, Gary, 10, and Diane, 11.

1941

Philip D. Brooks is now supervisor of the Structures Technical Staff at Northrop Aircraft in Hawthorne, Calif. Phil is the father of three children: Michael, 6, Daniel, 2, and Sally, 9 months.

C. C. Chang, M.S., Ph.D. '50, was awarded a Guggenheim Memorial Fellowship in applied mathematics to investigate "the application of mathematics to aeronautical problems in Europe." He has been serving as consultant to the Air Research and Development Command Office of Scientific Research, and has also been teaching graduate students at Johns Hopkins and directing their research projects. He left for Europe in September, to study in British universities and lecture throughout England and other European countries.

Robert G. Bowlus received his M.S. in education at the June 14th U.S.C. Commencement.

1942

William L. Rogers has been appointed assistant general manager of the Aerojet Engineering Corporation in Azusa, Calif.

Bob Merrick is still employed by Don Baxter Laboratories (manufacturers of intravenous solutions, blood and plasma containers, equipment, etc.) in Glendale, where he is administrative assistant to the director of research. Bob gave up competitive swimming about two years ago, after winning a professional race. Now he spends summer weekends surfing and winter weekends skiing.

1943

David E. Shonerd, M.S. '48, Engr. '49, is working in the advanced design group at Hughes Aircraft Company. The Shonerds are building a home in Playa Del Rey, Calif.

David Elmer, M.S. '47, Engr. '48, announces the arrival of a daughter, Catherine Margaret, on August 2. The Elmers' son, Douglas, is now three years old. David is working at C. F. Braun and Co. where he is Fabricating Department Welding Engineer and Metallurgist.

Cdr. Willard M. Hanger, M.S., AE, was transferred from Virginia to Philadelphia as Chief Engineer of the Naval Aircraft Factory.

John W. Otvos, Ph.D., was appointed head of Shell Development Company's spectroscopic department. John has been with Shell since 1946.

John R. Spencer has been promoted to the position of supervising reservoir engineer for Continental Oil Company in Ponca City, Oklahoma. John joined the company last year after serving on the faculty of the University of Texas as assistant professor of petroleum engineering.

John Cushing, Ph.D., came to Caltech last February to join Dan Campbell of the Chemistry Division in writing a book. The book is intended for advanced college students in biology who want to know more about immunology, and is expected to be completed this fall.

Peter A. Tileston announced the birth of a son, William Wilder, last March 15, in Manila.

Arthur D. Belmont, M.S., has received a Fulbright grant to study meteorology at the University of Oslo, Norway.

Arnold Nevis, who graduated from Harvard Medical School a year ago, is now completing surgical internship at Stanford Hospital in San Francisco. He will be at M.I.T. this fall on a Polio Foundation Fellowship in neurophysiology.

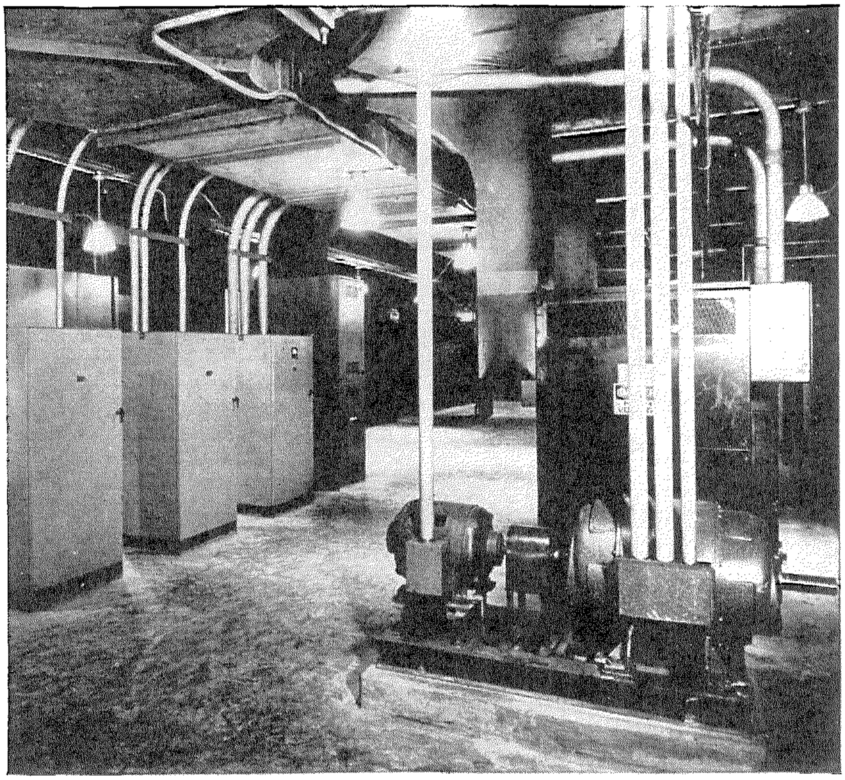
1944

Keith S. Ditman, M.S., has been recalled into the Navy to serve for two years. A physician in civilian life, Keith is now a lieutenant, stationed at the U. S. Naval Training Center in San Diego. His

CONTINUED ON PAGE 40

Make the First Job Count!

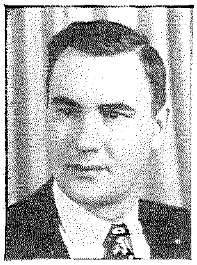
by PAUL CLARK
Application Engineer, Electric Control Section
WEST ALLIS WORKS
(Graduate Training Course 1950)
Iowa State—EE—1949



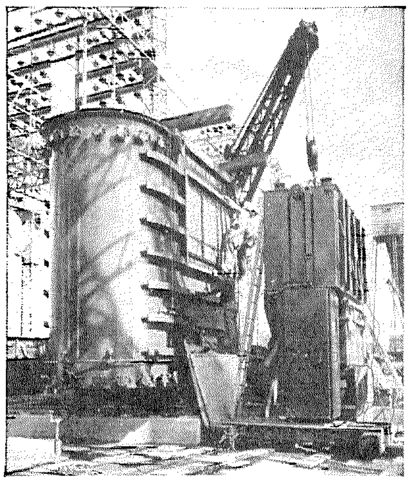
Brain of a giant 107,000-kw steam turbo-generator is this complex *Regulex* voltage control. Clark finds such control a fascinating problem.

IT SUDDENLY occurred to me while I was a senior, looking for a job, that my first job would be all important. In a way, it was going to be almost as much a part of my schooling as my last year at "State."

Since then, I've been glad I thought of it that way, because that's what the first year and a half was . . . schooling. Among other things, I learned what I wanted to do, and learned a lot about products and industry problems. But I give much of the credit for the great amount I learned to the Allis-Chalmers Graduate Training Course and consider myself very lucky to have chosen Allis-Chalmers. Perhaps a quick review of my own experience will show why I feel that way.



PAUL CLARK



Power Transformer being installed in Midwest utility.

After graduating from Iowa State in 1949

I started the Allis-Chalmers Graduate Training Course on the Steam Turbine erection floor. From there I went to the switchgear and pump departments to familiarize myself with other utility equipment; and from there, to the Motor and Generator section, which at the time was my goal.

Arrange Your Own Course

From this, you begin to see the freedom a GTC student has at Allis-Chalmers. You not only have complete freedom in arranging your course, but you can change your course as you go along and your interests develop. Best of all, you have a wide choice, because Allis-Chalmers builds such a wide line of products.

Even after getting to the Motor and Generator section, which had been my original goal, I had a chance to change my mind. While I found a certain glamour to the big motors and generators, I became *really* intrigued by the electrical brains of these giants, and decided to go to the control section to learn more about them. I have been working there ever since.

Today, I am in charge of pricing, applying and promoting the sale of three lines of control devices: *Rocking Contact* voltage regulators; *Regulex* voltage regulators; and liquid rheostats. Part of my time is spent traveling . . . visiting customers and helping district office salesmen.

The time spent in other departments has paid off too. It not only helped me find the work I liked best, but I met people in departments all over the plant that I now work with in coordinating jobs for utilities. Even time on the Steam Turbine erection floor proved valuable, because it helps me in talking shop to utility men.

Wide Choice at A-C

One reason you have such a wide choice is the fact that Allis-Chalmers makes equipment for every basic industry, including electric power, cement, mining, rock products, flour milling, and steel. Just to give you an idea, here are some of the products you might some day redesign, build or sell: transformers, steam condensers, pumps, motors, blowers, unit substations, steam and hydraulic turbines and generators, crushers, kilns, grinders, coolers, rolling mills, sifters, and many others.

That diversity can mean a lot to you in helping you find the job you want. It certainly helped me make my first job count.

duties are those of a psychiatrist and he does screening exams.

Richard E. Kuhns reports a new addition to the family—a son, Charles Terry. Dick was recently appointed Commanding Officer of the Organized Reserve CB Company 11-4 of Los Angeles. He's still working for the County Engineer in the Sanitation Division.

H. Brian Proctor reports that the first addition to his family, Robert Warren Proctor, arrived on November 2, 1951. The Proctors recently built a new home in San Marino. Brian operates his own company, manufacturing and wholesaling furniture frames.

1945

Melvin N. Wilson, Jr., M.S. '46, was transferred from the Los Angeles office of the Southern Pacific Company to the main office in San Francisco last May—and assumed the new title of Container Engineer with the Freight Protection and Station Service Department.

Donald L. Francis, M.S. 48, Engr. '49, is data analysis group leader in the Wind Tunnel section of the Jet Propulsion Lab. He says he's been doing some flying in sail planes lately.

Wayne A. Roberts, M.S. '48, has been working with the U. S. Geological Survey in the Pacific Northwest. When last heard from he was on the Blackbird cobalt project in Idaho. Last summer he worked in this district and in the Quartzburg district of Grant County, Oregon. He reports that he and his wife yearn for Pasadena, and that they have an "entourage" that has grown to tremendous proportions (no figures cited).

Stanley D. Clark received his LLB from Loyola Law School last June, and plans to take the bar examination this month. The Clarks now have another son, Kevin Scott, born in the summer of '51.

Merritt A. Williamson, M.S., is director of research for the Burroughs Adding Machine Company, in Philadelphia. In a letter received in June, he mentioned seeing *Commander Jack L. Shoehair*, M.S. '50, and *Thomas A. Dickey*, M.S. '45, both of whom are connected with the Philadelphia Navy Yard.

1946

E. Rechtin, Ph.D. '50, has been working at JPL since 1949. He was married in June, 1951, to Deedee Denebrink.

Howard Greenfield is sales and service West Coast representative for the Electronic Mechanical Products Company of Atlantic City. He is also an associate of King Television Company.

Jerry F. Daniels, Jr., M.S., received his Master of Business Administration degree from Harvard in June.

John O. Nigra, M.S., has resigned his position as research geologist with the New York Office of the Arabian American Oil Company. He is now living in Los Angeles, and available for consulting work.

Lt. j.g. Robert C. Siegel left for Tokyo in August to serve with the Fleet Weather Central. He expects to be stationed there for a year or more.

Edward E. Carr and *Robert E. Tucker* are reported as being with the Fleet Weather Central, in Manila. Also with FWC: *Howard R. Woods*, in Los Alamitos, Calif., and *Dale E. Bement*, in San Diego.

1947

George Shipway is still working at the Navy Electronics Lab, in San Diego, in the Shock and Vibration Section. The Shipways have three children—two girls, 5 and 3, and a boy, 1.

Herman Heidt, I.D., received his Master of Business Administration degree from Harvard in June.

1948

Robert G. Stokely has accepted a position as design engineer with the Convair Guided Missile Division in Pomona, after four years with Westinghouse in Pittsburgh and Baltimore. He and his wife, Jane, have a year-old daughter, Pamela.

Richard M. Roehm, after working a year as a physicist, went to Stanford Business School and is now an IBM salesman, handling a territory which includes Glendale, Alhambra, Monrovia, and Azusa. He finds his physics training helpful in applying it to the new IBM computing machines. So far, Dick says, he hasn't found time to get married.

Mitchell L. Cotton received his M.S. in electrical engineering last June from Washington University in St. Louis, Missouri.

Lt. William H. Shippee, in a letter received in June, said he hoped to be leaving France, and—at the same time—the Army, in the late summer. At the time of his writing, Bill had an interesting dual assignment in France. He was Chief Maintenance Officer at the Sampigny Chemical Depot (about 25 miles south of Verdun), where he had constantly new and varied mechanical problems to face. Also, once a month he was called on to represent the Chief Chemical Officer of EUCOM as the Chemical Team Chief on annual Post Technical Inspections. These included visiting such places as Garmisch in April, Nurnberg in May, and Munich in June.

Frederick B. Burt graduated from Johns Hopkins Medical School in June, and is now interning there in surgery.

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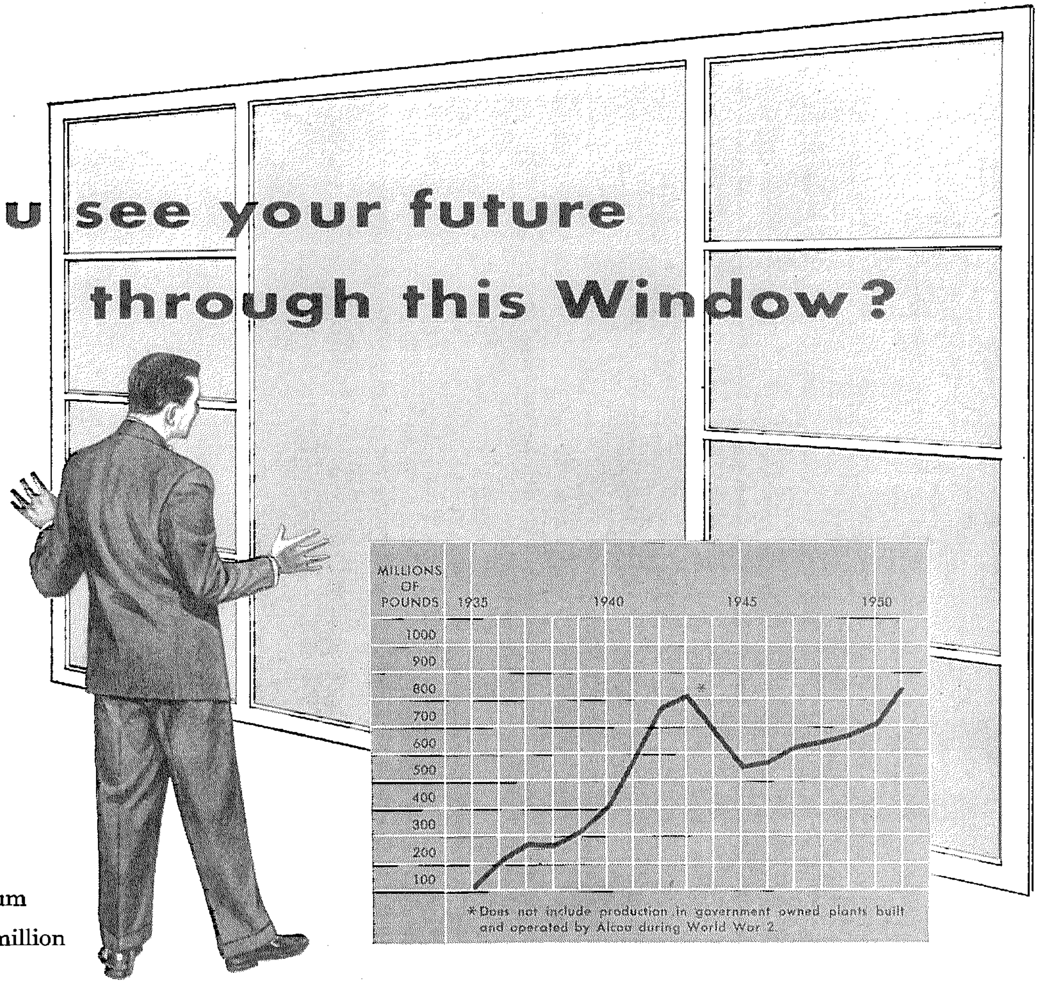
Can you see your future through this Window?



This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places", get in touch with us. Benefits are many, stability is a matter of proud record, *opportunities are unlimited.*

For more facts, consult your Placement Director.

The best things in aluminum come first in

ALCOA ALUMINUM

ALCOA ALUMINUM

By ALUMINUM COMPANY OF AMERICA • Pittsburgh, Pennsylvania

William A. Barker II, M.S., received his Ph.D. in physics and mathematics in June from St. Louis University.

1949

Lt. George W. Woodward entered the Air Force Medical Service Corps in July, 1951, and is now stationed at Randolph Air Force Base, Texas. During the summer he attended school at Gunter Air Force Base in Alabama.

Robert D. Forester, M.S. '50, is employed as a geophysicist with the Standard Oil Company of California at Bakersfield.

Walter J. Hirschberg, M.S. '50, married the former Sylvia Tanenbaum two days after receiving his Master's Degree. Nine months later they moved into their new home high up in La Crescenta. After a year with Consolidated Engineering Corporation in Pasadena, Walt was appointed plant manager of the newly opened West Coast plant of Essex Electronics. On July 8th the Hirschbergs became parents of a baby girl, Marianne.

Frederic T. Selleck was married in July to Phyllis M. McDowell of Pasadena. Phyllis is a graduate of Scripps College and the Los Angeles Art Institute.

Laurence H. Nobles, M.S. '49, received his Ph.D. from Harvard University at the June 19th Commencement. *Carl A. Price* was awarded his Ph.D. at the same time. And *Harold Jay Linderman* received his Master of Business Administration.

Joseph W. Schmit, M.S., reports the birth of a daughter, Diane Marie, on May 21, 1952.

David S. Hogness, Ph.D. '52, left Pasadena in September for Paris, where he will spend a year at the Institut Pasteur on a Lilly Postdoctoral Fellowship in the Natural Sciences, administered by the National Research Council.

Vernon L. Smith, who received his M.A. from the University of Kansas in 1951, has been appointed a Harvard Foundation Fellow for 1952-53 for advanced study in economics.

Robert R. Pilling was awarded an M.S. in education from the University of Southern California last June 14.

1950

Craig Marks is still at Caltech—doing research for a Ph.D. in mechanical engineering on combustion studies, on an Ethyl Corporation Fellowship. Last spring he helped Peter Kyropoulos organize observers on the Mobilgas Economy Run.

Roger A. Picciotto was awarded an M.A. by Harvard University last June.

Max Krauss, Ph.D., has taken a research post with the Biophysics Branch of the Medical Laboratories, Army Chemical Center, Edgewood, Maryland. For the past two years, Max has been teaching and doing research at Johns Hopkins' Department of Biology.

Donald O. Asquith received his M.S. from Kansas University last June.

Julian Brody has had a teaching fellowship at the University of Virginia for the past two years. He has been admitted to Princeton for the academic year 1952-53.

James B. Hendrickson, now in his third year at Harvard Graduate School, was recently awarded a $300 Bowdoin essay prize in the Natural Sciences. Jim's paper, entitled "Men, Motives, and Molecules," was one of six prize-winning essays to be selected from Harvard graduate and undergraduate student entries.

1951

E. B. Crichton has been working on a survey crew with the U. S. Forest Service, deep in the tall timber of Idaho.

Edwin E. Pyatt worked last summer for the State Health Department as a junior sanitary engineer, and returned in September to the University of California at Berkeley to complete work for an M.S. in sanitary engineering.

Robert J. Kurland has received a teaching assistantship in physical chemistry for the coming academic year at Harvard University.

Herbert Hull, Ph.D., and his wife, Mary, left Caltech in June to establish residence in Tucson, Arizona, where Herb has been appointed plant physiologist for the USDA Experiment Station there. He will work on the control of mesquite and other harmful plants which have been invading the cattle-grazing land.

John J. W. Rogers recently was awarded his M.S. degree from the University of Minnesota.

Paul E. Skoglund is assistant superintendent of installation and repair at Wintroath Pumps, Inc. in Alhambra, Calif. He's also president of the Pasadena Aquarium Society.

1952

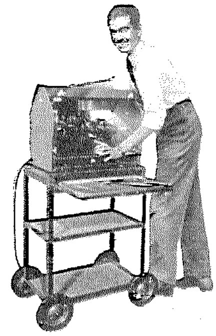
Philip M. Orville has received a Fulbright scholarship to enable him to study geography and geology at the Danish Graduate School for Foreign Students at the University of Copenhagen.

George Ellman, Ph.D., is now engaged in biochemical research at Dow Chemical Company in Midland, Michigan.

Fred Wolfgram, Ph.D., married Marilyn Kennett, received his Ph.D., and started work in a new job at Johns Hopkins University—all in the month of June. At Johns Hopkins he is studying the pathology and physiology of polio, with the aid of an NFIP Fellowship.

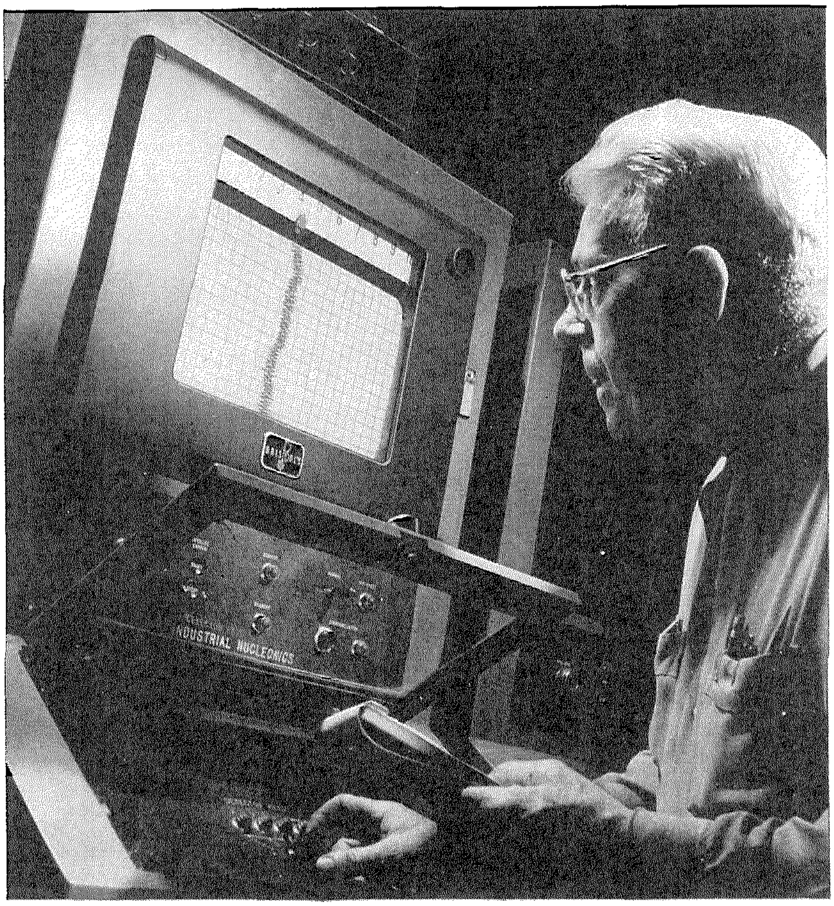
"MAN-MADE MINERALS"

contribute immeasurably to life's pleasures . . .



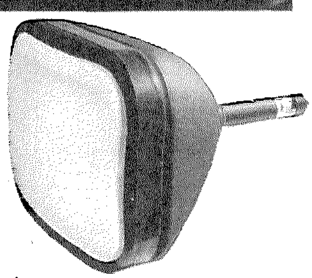
THIS PORTABLE OUTDOOR ROTISSERIE is equipped with GLOBAR electric heating elements made not of metal but of "man-made minerals." These elements reach maximum heat in seconds, thus help seal in meat juices for moist, succulent, tender steaks and roasts.

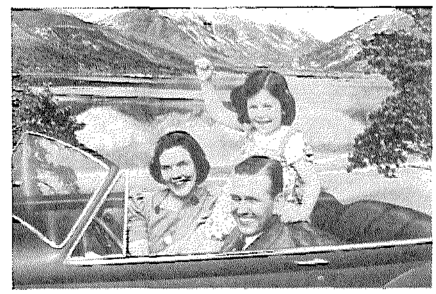
Heating Elements made by the GLOBAR Division



MAINTAINING UNIFORM HIGH QUALITY OF CARBORUNDUM abrasives is the process under observation here. Beta-ray gauges, the first ever installed by any abrasives manufacturer, have been adapted by CARBORUNDUM engineers to assure constant uniformity of product, *vitally essential in such critical operations as the* polishing of television picture tubes to provide a brilliant, distortion-free image.

A process of the Coated Products Division





AUTOMOBILE MASS PRODUCTION owes much to "man-made minerals." A remarkable form is FERROCARBO, a deoxidizer used in many metallurgical processes. Added to the molten metal, this product by CARBORUNDUM produces metal that yields stronger, cleaner, easier-to-machine castings, of which the motor car industry utilizes millions.

Product of the Bonded Products and Grain Division

SOFT DRINKS travel safely to eager consumers in glass bottles—are more inviting in glass that's free from discoloration, flaws and bubbles. *Leading bottle makers get this product* quality, since their melting tanks are lined with MONOFRAX fused cast refractories. More important, they get product *quantity*... longer tank life that means extra months of service, extra thousands of tons of glass.

Produced by the Refractories Division

"The pleasant life" is vastly more pleasant today than ever before—in large measure because of the "man-made minerals," silicon carbide and aluminum oxide by CARBORUNDUM. These products of the electric furnace have been put to work in an infinite variety of ways to lower the cost of luxuries and necessities alike, and so to make them available to more and more people.

Wherever you find a product which has been formed, shaped, drilled, enameled, baked, painted, polished or sharpened, you can be sure it's been helped on its way to market by the "man-made minerals" pioneered by CARBORUNDUM. Equally so wherever you find a process involving diffusion, filtration, resistance to heat, chemical attack, corrosion, abrasion.

The unique properties of these materials are opening new industrial frontiers. Your inquiry to CARBORUNDUM is invited—whether you are a potential customer of CARBORUNDUM or a potential member of our great engineering staff.

Keep your eye on

CARBORUNDUM

TRADE MARK

for significant developments based on "man-made minerals"

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

Products by CARBORUNDUM include Grinding and Cutting-Off Wheels, Discs and Sticks... Coated Abrasive Sheets and Belts... Waterproof Abrasive Paper... Abrasive Grain and Powders and other abrasive products... Electric Heating Elements and Ceramic Resistors... Grain and Briquettes for deoxidizing steel and iron... Super Refractory Bricks, Special Shapes and Cements... Porous Filter Media and Diffusers—and are marketed under the following trademarks: **CARBORUNDUM • ALOXITE • MX • RED-I-CUT • TEXALOX • GLOBAR FERROCARBO • CARBOFRAX • ALFRAX • MONOFRAX • MULLFRAX**

ALUMNI FUND

Report of the Fifth Year—1951-1952

YOUR CALTECH ALUMNI Fund reached $117,306.07 on June 1, 1952. Of this, $32,728.80 was the result of the fifth year's efforts. A total of 1,459 alumni contributed $27,422.67 during this year, which, together with special contribution and interest, reached the above figure.

The almuni can well be proud of this fund. It represents a sincere desire on the part of those who have contributed to be of material assistance to Caltech. It also represents a lot of hard work on the part of the Fund committee, which has organized and carried this effort along over the past five years. The Fund must also represent a welcome source of money to the Institute for those selected projects on which it is used.

It has been determined that the first use of this Fund will be for the construction of a swimming pool and locker rooms at Tournament Park. Plans are being drawn. The previously anticipated allocation of steel for the fourth quarter of 1952 has been postponed by the recent steel strike. Although the actual start of construction is indefinite at this time, it is reasonable to expect that ground will be broken within the coming year.

The Fund committee hopes that the coming year will see the Fund grow even more than it did during the past year, and that it will be looked upon by all of the alumni as their opportunity to make a lasting contribution to the Institute.

Undergraduate contributions received by the Fund during the last year are tabulated below. Class rankings are also shown. In the last two columns of the table below the 39 classes are ranked according to the size of their average gifts, and according to the percentage of each class that contributed. The names of all 1951-52 contributors are listed on the following pages.

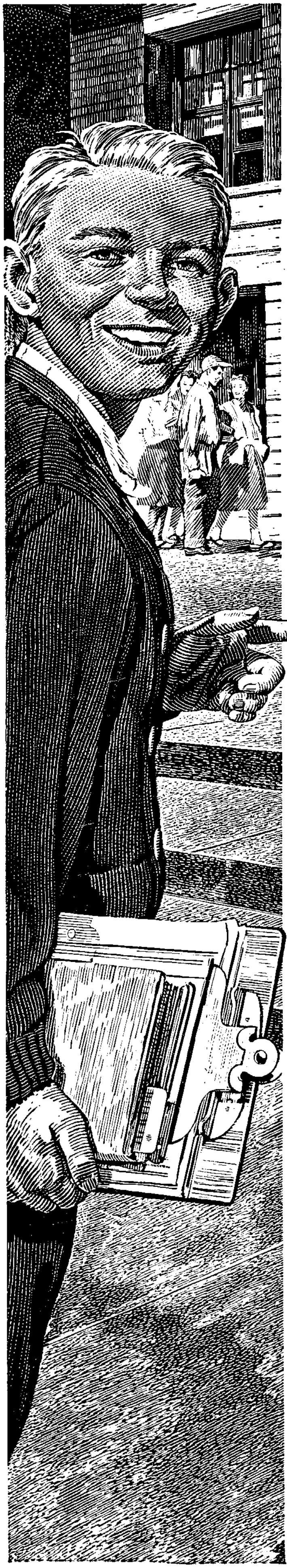
—K. E. Kingman
Director in charge of the Alumni Fund

FIFTH YEAR—1951-52
(As of June 30th, 1952)
Alumni Who Took Undergraduate Work at C.I.T.

							Class Ranking	
Class	Amount	Number Giving	Number Eligible	Per Cent of Eligibles Giving	Average Gift	Median Gift	Average Gift	Per Cent of Eligibles Giving
Prior 1915	$ 65.00	8	25	32.0	$ 8.13	$ 7.50	32	12
1915	65.00	4	8	50.0	16.25	15.00	16	3
1916	30.00	2	7	28.6	15.00	15.00	18	22
1917	85.00	4	9	44.4	21.25	25.00	11	6
1918	258.99	5	30	16.7	51.80	10.00	7	36
1919	0	0	3	0	0	0	39	39
1920	100.00	9	30	30.0	11.11	10.00	24	16
1921	740.00	12	34	35.3	61.67	10.00	4	10
1922	2,740.00	28	61	45.9	97.86	20.00	2	4
1923	5,367.50	22	49	44.9	243.98	10.00	1	5
1924	705.00	12	74	16.2	58.75	10.00	5	37
1925	826.00	30	78	38.5	27.53	20.00	8	8
1926	135.00	15	101	14.9	9.00	5.00	29	38
1927	236.00	17	90	18.9	13.88	10.00	19	35
1928	342.50	19	60	31.7	18.03	10.00	14	14
1929	412.00	25	84	29.8	16.48	10.00	15	17
1930	579.99	25	102	24.5	23.20	10.00	10	28
1931	2,155.50	28	97	28.9	76.98	10.00	3	20
1932	1,429.00	27	94	28.7	52.93	10.00	6	21
1933	501.00	20	94	21.3	25.05	10.00	9	32
1934	596.50	38	102	37.3	15.70	11.75	17	9
1935	678.00	35	110	31.8	19.37	10.00	12	13
1936	539.00	29	116	25.0	18.59	10.00	13	27
1937	293.00	26	112	23.2	11.27	10.00	23	29
1938	356.00	28	127	22.0	12.71	10.00	20	31
1939	242.50	22	113	19.5	11.02	10.00	26	33
1940	542.00	43	140	30.7	12.60	10.00	21	15
1941	334.00	38	128	29.7	8.79	7.50	30	18
1942	497.50	58	149	38.9	8.58	5.00	31	7
1943	397.00	42	124	33.9	9.45	10.00	27	11
1944	623.00	54	208	26.0	11.54	10.00	22	25
1945	389.00	37	190	19.5	10.51	5.00	25	33
1946	246.22	37	163	22.7	6.65	5.00	34	30
1947	337.50	37	144	25.7	9.12	5.00	28	26
1948	316.00	53	193	27.5	5.96	5.00	36	23
1949	389.00	62	212	29.2	6.27	5.00	35	19
1950	380.50	48	183	26.2	7.93	5.00	33	24
1951	795.00	159	159	100.0	5.00	(5.00) ±	37	1
1952	307.67	126	126	100.0	2.44	15.00	38	1
TOTAL	$25,032.87	1284	3929	32.7	$ 19.50	....	....	....

CONTRIBUTORS TO THE ALUMNI FUND 1951 - 1952

1896
Haynes, Miss Diantha M.
1900
Harris, Irving C.
1902
Bartlett, Louis A.
1906
Canterbury, H. H.
1907
Frey, Elmer E.
1913
Gerhart, Ray
Koch, Louis J., Jr.
Parkinson, Ralph W.
1915
Burt, Earle A.
Holmes, William M.
Holt, Herbert B.
Wilcox, Charles H.
1916
Allen, Robert N.
Rich, Kenneth W.
1917
Kemp, Archie R.
Kensey, Alexander
Richards, Roy T.
Youtz, J. Paul
1918
Andrews, Clark F.
Essick, L. F.
Hainsworth, Wm. R., M.S.
Heywood, Gene B.
Hoge, Edison R.
McDonald, G. R.
1920
Ehrenfeld, Day, M.S.
Hounsell, E. Victor
Hounsell, Theron C.
Lewis, John C.
Linhoff, Harold R.
Renshaw, Wm. C.
Sawyer, Mark A.
Smith, R. Carson
St. Clair, Harry P.
Whitworth, George K.
1921
Case, Henry R.
Champion, Edward L.
Craig, Robert W.
Honsaker, Horton H.
Male, Arthur N.
Morrison, Lloyd E.
Mullin, Wynne B.
Quirmbach, Charles F.
Raymond, Albert L.
Stamm, Alfred J.
Stenzel, Richard W.
1922
Ager, Raymond W.
Alles, Gordon A.
Ames, Paul R.
Bear, Ralston E.
Bozorth, Richard M.
Bulkley, Olcott R.
Catland, Alfred C.
Crissman, Robert J.
Darnell, Donald W.
DeVoe, Jay J.
Essick, Bryant
Fleming, Thomas J.
Hall, Albert D.
Honsaker, John
Hopper, Francis L.
Jasper, Walter
Keith, Clyde R.
Knight, Alfred W.
Kohtz, Russell H.
Learned, Kenneth A.
Marsh, Hallan N.
Morita, Jiro
Myers, Thomas G.
Ogden, Harold S.
Ritchie, Charles F.
Smith, George Kemper
Steffes, A. P. G.
Vesper, Howard G.
Wilson, W. F.
1923
Baier, Willard E.
Bangham, William L.
Barnett, Harold A.
Endicott, Harold S.
Fitch, Charles E.
Fowler, L. Dean
Gray, Robert M.
Heimberger, William L.
Lewis, Howard B.
Loughridge, Donald H.
Lynn, Forest L.
Nies, Henry T.
North, John R.
Puls, J. H.
Reeves, Hubert A.
Roth, Lawrence P.
Schonborn, Robert
South, Laurance G.
Stromsoe, Douglas A.
Walling, Lloyd A.
Walter, John P.
Woods, Robert E.
1924
Anderson, Kenneth B.
Campbell, Daniel M.
Clark, Rex S.
Forbes, C. Leonard
Goodhue, Howard W.
Hough, Frederick A.
Irwin, Emmett M.
Jenkins, Grant V.
Losey, Theodore C.
Miller, Roy
Stearns, Charles F.
Winegarden, Howard M.
1925
Alderman, Raymond E.
Atherton, Tracy L.
Brunner, Michael C.
Bryant, Walter L.
Burmister, LCdr. C. A.
Byrne, Hugh J. P.
Chapman, Albert
Clayton, Frank C. A.
Freeman, Henry R.
Fulwider, Robert W.
Hart, Edward W.
Heilbron, Carl H., Jr.
Henderson, Lawrence P.
Hertenstein, W.
Jones, Herbert J.
Jones, Walter B.
Karelitz, Michael B.
Maxstadt, F. W., M.S.
Newcomh, Leroy
Noll, Paul E.
Pauling, Linus C., Ph.D.
Prentice, Leland B.
Rivinius, Paul C.
Salsbury, Markham E.
Schlegel, Glenn M.
Sellers, W. D.
Sheffield, Lt. Col. H. C.
Simpson, Thomas P.
Stanton, Robert J.
Stewart, Earl D.
Thompson, Wilfred G.
1926
Burt, Robert C., Ph.D.
Dinsmore, Daniel G.
Edwards, Manley W.
Fahs, John L.
Fowle, Royal E.
Friauf, James B., Ph.D.
Graham, Glenn
Granger, Wayne E.
Halverson, Homer A.
Hardwick, Fray
Kirkeby, Eugene
Laws, Allen L.
Lewis, William A., Jr.
Pyle, M. Ivan
Richards, Harold F.
Schott, Hermann F.
Van den Akker, J. A.
Wise, Willis H., Ph.D.
Wulf, Oliver R., Ph.D.
1927
Bailly, Florent H.
Baldwin, Marshall A.
Baxter, Ellery R.
Bower, Maxwell M.
Bradley, Charles A., Jr.
Capon, Alan E.
Diamos, George K. S.
Farrar, Harry K.
Gardner, David Z., Jr.
Haserot, Clarence L.
Heilbron, Robert F.
Hoover, Vaino A.
Jaeger, Col. Vernon P.
Loxley, Benjamin R.
Mendenhall, H. E., Ph.D.
Peterson, Thurman S.
Rodgers, V. Wayne
Snyder, Leonard L.
Starke, Howard R.
Warner, Arthur H., Ph.D.
1928
Armstrong, Richard C.
Beckman, Arnold O., Ph.D.
Billig, H. E. Jr.,
Brighton, Thomas H.
Coulter, Robert I.
Cutler, Ralph W.
Duval, Richard H.
Evans, Robley D.
George, Wallace S.
Gewertz, Moe W.
Jacobs, W. Morton
Joujon-Roche, Jean E.
Kaneko, George S.
Kuhn, Jackson G.
Lash, Charles C.
Lindvall, Frederick C.
Lombard, Albert E., Jr.
McMillan, Edwin M.
Minkler, C. Gordon
Noel, Francis
Olsen, William L.
Renz, Carl F., M.S.
1929
Asquith, Harlan
Atwater, Eugene
Birge, Knowlton R.
Clark, Donald S.
Cline, Frederick R.
Dunham, James W.
Evans, Thomas H.
Findlay, Willard A.
Fredendall, Beverly F.
Grunder, Lawrence J.
Haeff, Andrew V., M.S.
Hincke, William B., Ph.D.
Hugg, Ernest B.
Huston, Harold M.
Kingman, Kenneth E.
Kircher, Reymond J.
Larrecq, Anthony J.
Lau, Hu Kam
Lufkin, George S.
Mohr, Col. William H.
Myers, Albert E.
Roberts, Bolivar
Russell, Kenneth F.
Scullin, James C.
Sperling, Milton H.
Weismann, George F.
Wheeler, Fred A.
1930
Arnquist, W. N., Ph.D.
Atkinson, R. B., Ph.D.
Bechtold, Ira C.
Blohm, Clyde L.
Bode, Francis D.
Boyle, J. R. Lester
Bungay, Robert H.
Butler, Albert
Carberry, Cdr. Deane E.
Crane, H. Richard
Giebler, Clyde
Hawes, Roland C.
Hopper, Rea E.
Johnson, Josef J.
Johnston, Norris, Ph.D.
Kinney, Edward E., M.S.
Levine, Ernest
MacDonald, James H.
Pearson, John M., Ph.D.
Pleasants, J. G.
Pritchett, Lt. Jack D.
Ross, George A.
Sawyer, H. G.
Sheffet, David
Stirton, Robert I.
Strong, Austin W.
Thayer, Eugene M.
Waite, Howard W.
Whitman, Nathan D.
Zipser, Sidney
1931
Amann, Jack H.
Arndt, Wm. Frederick
Arnold, William A.
Axline, Rea A.
Biddle, Russell L., Ph.D.
Boothe, Cdr. Perry M.
Bovee, John L., Jr.
Cogen, William M.
Detweiler, John S.
Eastman, Samuel C.
Gerschler, James M.
Green, E. F.
Johnson, Byron B.
Kinney, Edward S.
Kircher, Charles E., Jr.
Kuykendall, Charles E.
Langsner, George
Leeper, Laverne D.
Lehman, Robert M.
Lewis, George E.
McMillan, John R.
Morris, Ross E.
Neher, H. Victor, Ph.D.
Peer, Edward S.
Peterson, Raymond A.
Pratt, Leland D.
Sage, Bruce H., M.S.
Smits, Howard G.
Tarbet, Thomas
Terry, Paul M.
Wilmot, Charles A.
1932
Arnerich, Paul F.
Atwood, Albert W., Jr.
Barton, Millard V.
Batchelder, Dean S., M.S.
Behlow, Lewis B.
Bergren, William R.
Bowden, Frederick W.
Bradburn, James R.
Chambers, John V.
Claussen, William H.
Freeman, Robert B.
Hamlin, Charles F.
Hibbs, Frank J., Jr.
Kent, William L.
Leermakers, J. A., Ph.D.
Lyons, Patrick B.
McLaughlin, James P.
Pruden, Worrell F.
Roach, Harold
Rockefeller, William C.
Schuhart, Mervin A.
Schultz, William O.
Sheffet, Joseph
Shockley, William
Shull, George O.
St. Clair, Robert W.
Swart, Kenneth H.
Thomas, William J.
White, M. P., M.S.
Wilson, Chester E.
1933
Barlow, Wilson H.
Barton, Robert C., Ph.D.
Berkley, G. Merrill
Cromley, Raymond
Binder, Raymond C., M.S.
Czamanske, M. E., M.S.
Edwards, E. C., Ph.D.
Efromson, Philip C.
Gould, Laurence K.
Johnson, J. Stanley
Lewis, Wyatt H.
Libby, Alexander F.
Mendenhall, John D.
Mitchel, Ted S.
Morgan, Wendal A.
Omsted, Harald, M.S.
Palm, Bernhard N.
Perrine, Charles D., Jr.
Pickett, George H.
Prater, Arthur N.
Randall, John A.
Russell, Richard L.
Smith, Alvin J.
Spade, J. Clifton
Tillman, Charles E.
Widess, Moses B.
1934
Anderson, Robert C.
Bollay, William, M.S.
Boykin, Robert O.
Brown, Robert
Campbell, James R.
Childers, Milford C.
Cogen, Saul
Cortelyou, John T.
Dane, Col. Paul H.



CONTRIBUTORS . . . CONTINUED

Dietrich, Robert A.
Doll, Edward B.
Donahue, Willis R., Jr.
Etter, L. Fort
Gregory, James N.
Gulick, Howard E.
Haskins, Ray W.
Howard, Ernest R.
Jaynes, Willis F.
Lien, Elvin B.
McCann, Gilbert
McClain, F. J.
McFadden, Wm. C.
McRae, James W., M.S.
Miller, Guy O.
Newton, Charles V.
O'Neil, Hugh M.
Parker, Richard T.
Pearne, John F.
Rooke, LCdr. Donald R.
Schaak, Frank A., Jr.
Sharp, Robert P.
Sherborne, John E.
Sluder, Darrell H.
Stevenson, Arthur L.
Switzer, Alfred L.
Thompson, A. E.
Ugrin, Nick
Van Osdol, George W.
von Huene, Rudolf
Weaver, Glenn W.

1935

Allardt, Frederick H.
Baldwin, Lawrence W.
Davenport, Horace W.
Davenport, Lind B.
Davies, James A.
Dawson, Charles A.
Dewees, Norman B.
Dunbar, Major Oliver C.
Etz, Arthur N.
Evans, M. H.
Fuhrmann, Hans H.
Fussell, Robert G.
Garner, Clifford S.
Gluckman, Howard P.
Higley, John B.
Hobson, Jesse E., Ph.D.
Jahns, Richard H.
Johnson, Wallace J. S.
Ketchum, M. C.
Keyes, William F., Jr.
Kramer, Robert L.
Leppert, Elmer L., Jr.
Lindsay, Chester W.
Maloney, Fred V.
Nies, Nelson P.
Pitzer, Kenneth S.
Rader, Louis T., M.S.
Ray, A. Allen
Ribner, Herbert S.
Roehm, Jack M., M.S.
Scherb, Ivan V.
Snow, Neil W.
Stanley, Robert M.
Stick, John C., Jr.
Stuppy, Lawrence J.
Taylor, Jay C.
Thomas, Charles F.

1936

Boothe, Raymond H. F.
Bucknell, Wilson H.
Bush, Kenyon T.
Davis, Frank W.
Dickinson, Holley B.
Dilworth, Robert P.
Douglass, Malcolm E.
Folland, Donald F.
Graham, Ernest W.
Hammond, Paul H.
Heitz, Robert G.
Holland, E. Morton
Jensen, Ray
Johnson, F. L.
Jones, Paul S.
Jordan, Charles B.
Klocksiem, John P.
La Boyteaux, Ellsworth
McMahon, Michael M.
McRary, Willard L.
Meneghelli, Hugo A.
Milan, Leo J.
Morse, Charles A.
Muller, Conrad R.
Peugh, Verne L.
Ramo, Simon, Ph.D.
Smith, Apollo O.
Stitt, Fred B., Ph.D.
Swanson, Walfred E.
Thompson, Rev. Tyler
Unholtz, Karl
Whipp, LCdr. David M.
Wooldridge, D. E., Ph.D.
Young, Larry L., M.S.

1937

Benton, Ralph S., Jr.
Brice, Richard T., Ph.D.
Briggs, Stanford W.
Carrick, Harry H., Jr.
Cornwall, Ellsworth W.
Ellison, W. J., Jr., M.S.
Feuer, Stanley I.
Frost, Holloway H.
George, John W.
Harper, Thomas S.
Harris, Dale R., M.S.
Hyers, Donald H., Ph.D.
Johnson, Carl B.
Kinley, John C.
Lipson, Samuel L., M.S.
Lloyd, Paul E., Ph.D.
Lockwood, Robert B.
Mann, George E.
Miller, Harry H.
Miller, Nash H., M.S.
Miller, Wendell B.
Moore, Walter L.
Nichols, Dean
Nolte, Claude B.
Offeman, Richard E.
Poggi, Martin J.
Schaffner, Paul C.
Strong, Foster, M.S.
Sullwold, John
Summerfield, Martin, M.S.
Townsend, Robert D., Jr.
Walley, Bernard
Webster, Martin H.
Wickett, Walton A.
Wileman, Edward E.
Wiley, Harold F., M.S.

1938

Althouse, Wm. S.
Baker, John R.
Bertram, Sidney
Cardwell, W. T., Jr.
Bower, Clark D.
Claflin, Waldo M.
Clarke, Charles W.
Custer, Robert S.
Davis, Thomas V.
Dennis, Paul A.
Dixon, Blaine A., Jr.
Dowd, Munson W., Jr.
DuFresne, Armand F.
Evans, Henry K.
Farneman, John D.
Friend, Carl F.
Hopkins, Henry S.
Ives, Philip T., Ph.D.
Jewett, Frank B., Jr.
Jurs, Albert E., Jr.
Keller, Samuel H.
Kyropoulos, P. R., M.S.
McGraw, John T.
McLean, John G.
Merriam, John L.
Nagamatsu, H. T.
North, Harper Q.
Osborn, Elburt F., Ph.D.
Rosencranz, Richard, Jr.
Weinberger, Edward L.
Wilson, Gardner P.
Wood, Homer J.

1939

Battle, John A.
Beanfield, B. F., M.S.
Beck, Duane W.
Bonell, Wm. H., M.S.
Brown, Perry H.
Cabeen, Wm. R., M.S.
Carlson, Chester F.
Carstarphen, Chas F.
Connelly, Ronald B.
Crozier, George O.
Fischer, Richard A.
Flint, Delos E.
Goodell, Jack H.
Green, Major Wm. M.
Hance, Harold V.
Knoblock, F. D., Ph.D.
Lawson, William G.

8 ways up with Phillips Petroleum Company

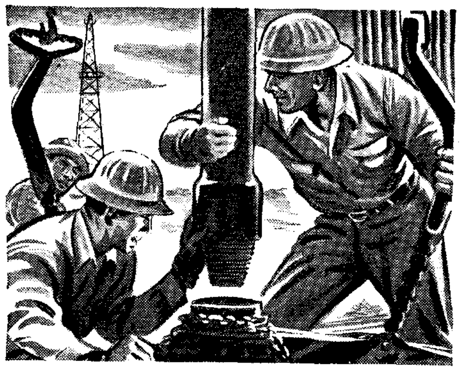
★

Scientific and technical graduates looking for a "career with a future" will find that Phillips offers many and varied opportunities for qualified men.

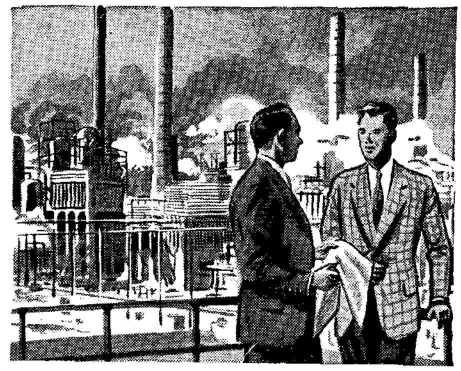
Petroleum is a young and progressive industry—and Phillips is a young and progressive company. In addition to our production of motor fuels and lubricants, Phillips is an important manufacturer of such diversified products as carbon black, chemical fertilizers, synthetic rubber, and many other compounds derived from petroleum hydrocarbons.

In most phases of the company's operations we offer supervised on-the-job training for new men to prepare them for assignments of responsibility and importance.

We invite qualified men to write to our Employee Relations Department for further information about opportunities with our company.

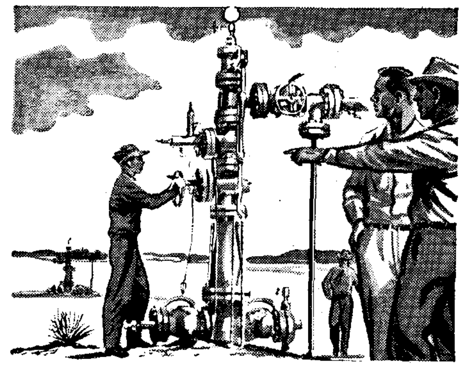


OIL PRODUCTION DEPARTMENT drills wells and produces crude oil. It is also the responsibility of this department to unitize oil fields for highest economic recovery.

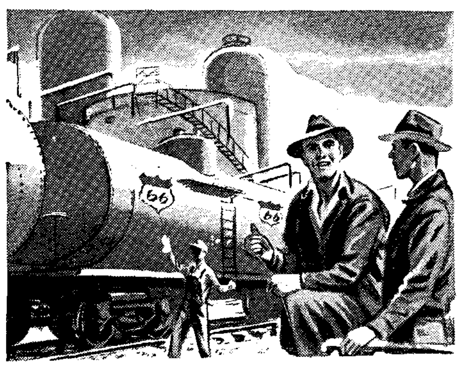


REFINING DEPARTMENT converts crude oil to finished marketable products. Utilizes advanced technology for maximum upgrading of raw petroleum.

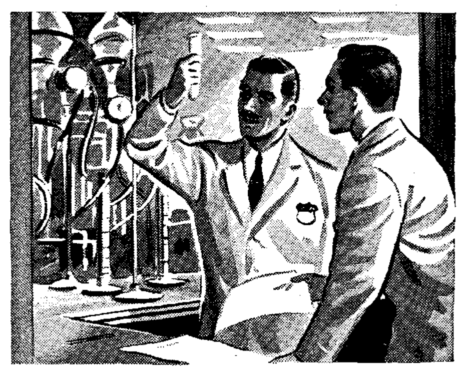
NATURAL GASOLINE DEPARTMENT extracts light hydrocarbons from natural gas. Phillips is the world's largest producer of natural gas.



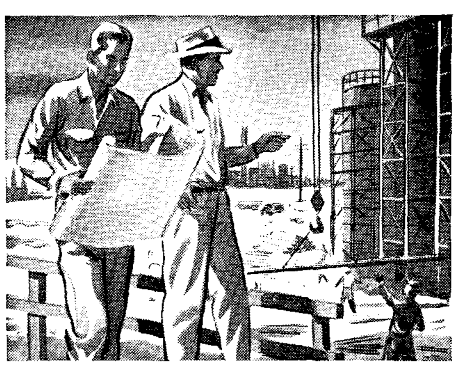
NATURAL GAS DEPARTMENT produces, gathers and sells natural gas in the development of one of the world's largest gas reserves.



SUPPLY AND TRANSPORTATION DEPARTMENT operates pipe lines, tank cars, barges and motor vehicles . . . purchases, sells and gathers crude oil.



PHILLIPS CHEMICAL COMPANY is a leader in fast-developing field of petrochemistry . . . manufactures and sells nitrogen fertilizers, carbon black, monomers and high polymers.



ENGINEERING DEPARTMENT designs, constructs and inspects new facilities, tests materials and operates the company's communication systems.

RESEARCH AND DEVELOPMENT DEPARTMENT conducts research, pilot plant and semi-commercial development, procures patents and surveys markets for new products.

PHILLIPS PETROLEUM COMPANY

Bartlesville, Oklahoma

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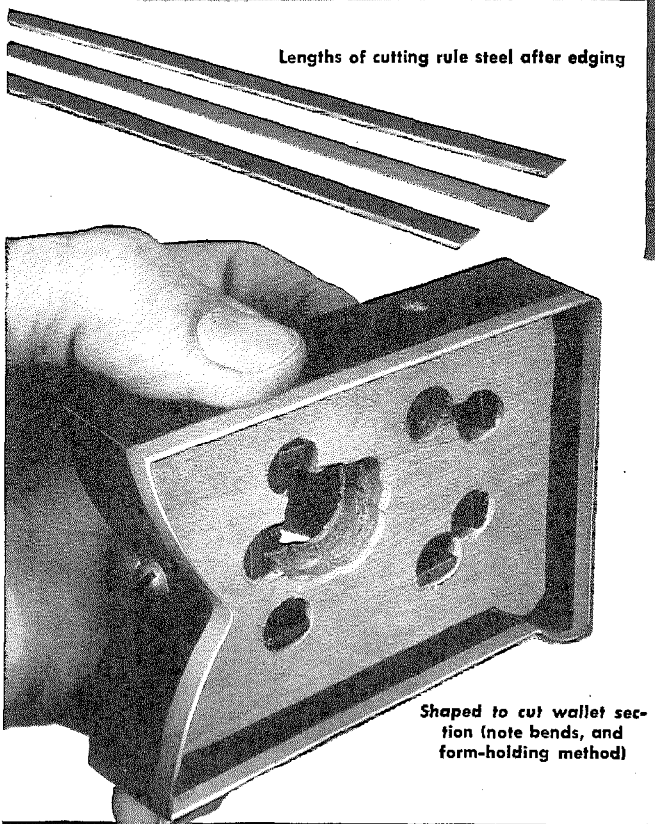
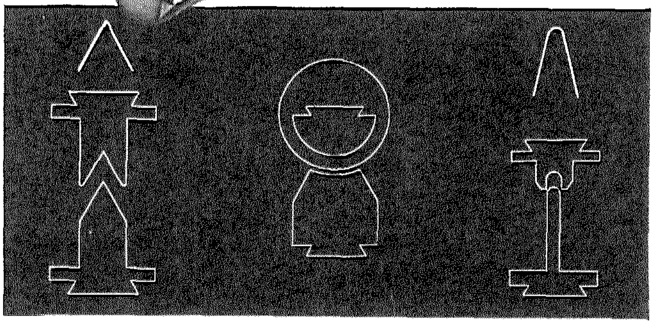
What's Happening at CRUCIBLE

about scoring and cutting rule steel



Lengths of cutting rule steel after edging

Shaped to cut wallet section (note bends, and form-holding method)



Some examples of the many shapes of bends needed

Scoring and cutting rule steel is a cold-rolled specialty steel for use in preparing dies for cutting paper, leather, rubber and other materials.

It is a pre-tempered product manufactured by skilled workmen, using precision rolling and hardening equipment, to close limits for chemistry, grain size and hardness. This product must also be capable of meeting intricate bend requirements in the hardened and tempered condition.

This specialty is furnished with round edges and in coil form to the rule manufacturer who grinds the edges — the one edge square and the other to a knife edge as well as cutting the material into desired lengths. This is sold to a die-maker who bends the rule to the required shape. This is then the nucleus of a pre-hardened die, which when properly brazed and supported is used to cut out material for display cards — aircraft parts — pocketbooks — wallets — gloves — gaskets — washers.

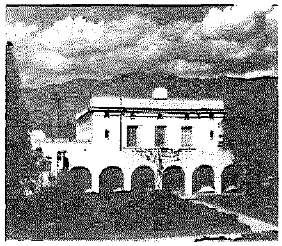
engineering service available

Since there is a great diversity of cold-rolled products, our staff of field metallurgists can help you apply what you require. Take full advantage of Crucible's more than 50 years experience as the first name in special purpose steels. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 *years of* *Fine* *steelmaking*

Midland Works, Midland, Pa. •• Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. •• Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio •• Sanderson-Halcomb Works, Syracuse, N. Y. •• Trent Tube Company, East Troy, Wisconsin



ALUMNI CALENDAR

October 15	Dinner Meeting Athenaeum
November 13	Oxy-Caltech Kickoff Luncheon
November 14	Open House Dabney Hall of Humanities
January	Dinner Meeting
February	Dinner Dance
March	Dinner Meeting
April	Annual Seminar
June	Annual Dinner Meeting
June	Annual Family Picnic

CALTECH ATHLETIC SCHEDULE

VARSITY FOOTBALL

Oct. 4, 8 p.m.
Redlands at the Rose Bowl

Oct. 10, 8 p.m.
Pomona at the Rose Bowl

Oct. 18, 8 p.m.
Arizona State at Flagstaff, Ariz.

Oct. 25, 8 p.m.
Whittier at Whittier

Nov. 1, 8 p.m.
LaVerne at Bonita High School

FROSH FOOTBALL

Oct. 18, 2 p.m.
Occidental at Caltech

Oct. 25, 2:30 p.m.
Pomona at Caltech

Nov. 1, 2:30 p.m.
Caltech at Pomona

CROSS COUNTRY

Oct. 17	Interhouse	1½ miles
Oct. 21	Interhouse	2 miles
Oct. 24	Interhouse	2½ miles
Oct. 31	Caltech at Oxy	4:15 p.m.
Nov. 7	Redlands at Caltech	4:15 p.m.

ALUMNI ASSOCIATION

CALIFORNIA INSTITUTE OF TECHNOLOGY

BALANCE SHEET

As of June 30, 1952

ASSETS

Demand deposit in bank		$ 7,424.26
Accounts receivable		14.15
Postage deposit		99.64
Investments, at cost:		
Share in Consolidated Portfolio of C.I.T.	$28,729.79	
U. S. Treasury bonds	222.00	28,951.79
Furniture and fixtures, at nominal amount		1.00
		$36,490.84

LIABILITIES

Accounts payable		$ 268.25
1952-1953 membership dues paid in advance		4,704.50
		4,972.75

SURPLUS

Life membership reserve:			
Fully paid memberships		$27,650.00	
Payments on life memberships under the installment payment plan		1,053.50	
		28,703.50	
Unappropriated income:			
Balance June 30, 1951	$1,708.10		
Transferred from life membership reserve	70.00		
Excess of income over expense, year ended June 30, 1952	1,036.49	2,814.59	31,518.09
			$36,490.84

STATEMENT OF INCOME

For the year ended June 30, 1952

INCOME

Dues		$8,602.00
Less subscriptions to Engineering and Science Monthly for Association Members		6,622.50
		1,979.50
Income from Consolidated Portfolio of C.I.T.:		
Normal income	$1,394.38	
Gain upon sale of investments	212.31	1,606.69
Annual seminar:		
Income	1,494.00	
Less expense	1,428.68	65.32
Five Social functions:		
Income	2,092.25	
Less expense	1,856.82	235.43
Miscellaneous		7.25
		3,894.19

EXPENSE

Administration:		
Directors' expense	131.18	
Postage	518.42	
Supplies and printing	673.92	
Miscellaneous	111.44	
	1,434.96	
Alumni Fund solicitation	969.15	
Alumni membership solicitation	353.59	
Assistance to student publications	100.00	2,857.70
NET INCOME		$1,036.49

AUDITOR'S REPORT

Alumni Association
California Institute of Technology
Pasadena, California

I have examined the balance sheet of Alumni Association California Institute of Technology as of June 30, 1952 and the related statement of income for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as were considered necessary in the circumstances.

In my opinion, the accompanying balance sheet and statement of income present fairly the financial position of Alumni Association California Institute of Technology at June 30, 1952 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Howard W. Finney
Certified Public Accountant

September 5, 1952

"Can I be sure I'll be an individual at G.E.?"

. . . asks John Dillingham, Union College 1952

What's it like to work for a large company? In this and subsequent ads, the questions of college students on this subject will be answered by G-E men of varying degrees of experience. What's your question? Send it to College Editor, Dept. 221-6, General Electric Co., Schenectady 5, N. Y.

JOHN G. HUTTON, *General Engineering Laboratory* . . . It is largely the enterprise of the individual which makes him outstanding. In his own thinking he becomes a cog in a machine, not realizing that every such cog is a chosen piece, performing functions for what it is best characterized as a vital member of a team operation. So it is with the individual in General Electric. Just as in the community an individual is free to "be himself," but for his own and the community's sake he must be part of that community. General Electric's success lies in its unique ability to instill in its employees great team spirit yet at the same time to recognize the employee's inalienable right to be himself.

H. A. WINNE, *vice-president, Engineering Services* . . . An important point which many young people overlook is that, by and large, individuals work in groups of reasonable size in either large or small companies. In the large company these groups may be called units or sections, and a number of these may constitute a department; a number of departments may make up a division; and the company may comprise several divisions. In each component the "manager" has a comparatively small number of people reporting to him, and consequently any outstanding performer quickly comes to his attention.

Furthermore, in General Electric we have a number of courses which train for advancement and we are constantly combing the organization to recruit people for these courses, so by this separate means management keeps in touch with individuals.

On the basis of forty-two years' experience in the Company I can assure you it is difficult for the college graduate to lose himself in the organization. There are too many people watching him, although he may not realize it for some time after entering the Company.

J. L. MICHAELSON, *manager, Employee Relations, General Engineering Laboratory*. . . The Company system for periodic employee evaluation furnishes a valuable guide to the individual with respect to his progress and ability. It also imposes on supervisory personnel the requirement that they study carefully the characteristics of all their employees. The system is so arranged that ability and good performance cannot remain unnoticed. Far from remaining obscure, each individual's characteristics are evaluated in order to provide him with the greatest opportunity to make use of his talents and abilities.

J. A. SPENCER, *manager, Employee Relations, Apparatus Sales* . . . The day I began work with G.E. twenty-odd years ago, and entered the plant with thousands of other Company employees, I felt small and insignificant and much inclined to climb on the first train returning to Montana. In a short time, however, I realized that I would be considered as an individual at General Electric.

I learned that the Company was operated in units of manageable size and that each person received individual consideration. My supervisors discussed my progress with me at regular intervals. I also learned that every employee's salary is reviewed individually at regular intervals.

Through this I learned that the individual cannot become lost in General Electric—neither can he hide!

You can put your confidence in—

GENERAL ELECTRIC