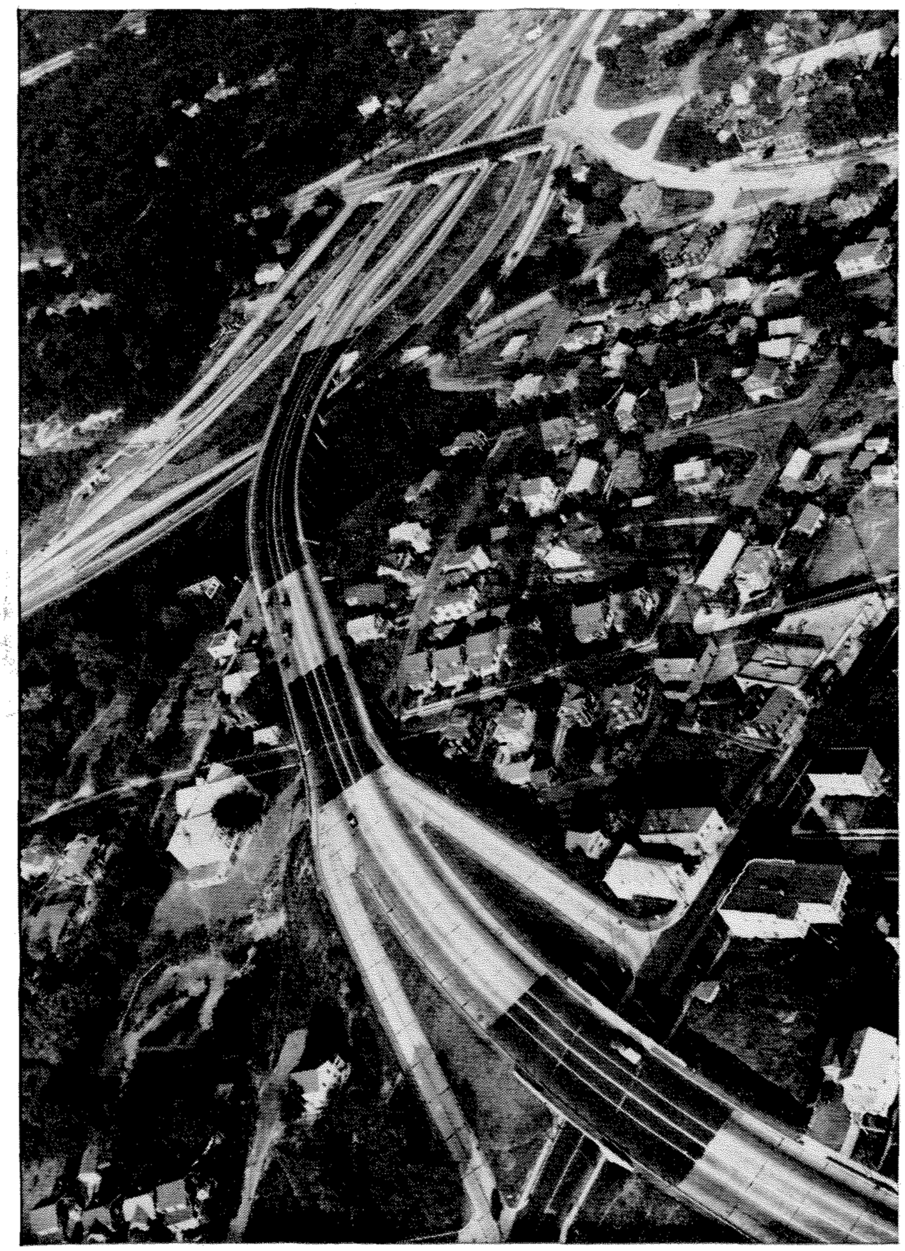
ENGINEERING AND SCIENCE

April 1950

Sunspots . . . Page 19

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

"... just drive straight ahead for 37,681 miles"



ALMOST everywhere you travel across this land of ours, you roll over beautiful wide, straight, smooth roads. A magnificent plan of interstate highways, the greatest road program in American history, is taking form at the rate of 700 million dollars worth of construction per year.

37,681 miles of swell driving . . . direct travel from any part of the country to any other part . . . routes north and south, east and west, and diagonal routes as well . . . big highways directly serving practically all cities of 50,000 population or more.

This is part of the better America that our generation is building. It's taking plenty of brains. Plenty of man power. Lots of cement. And lots of *Steel*.

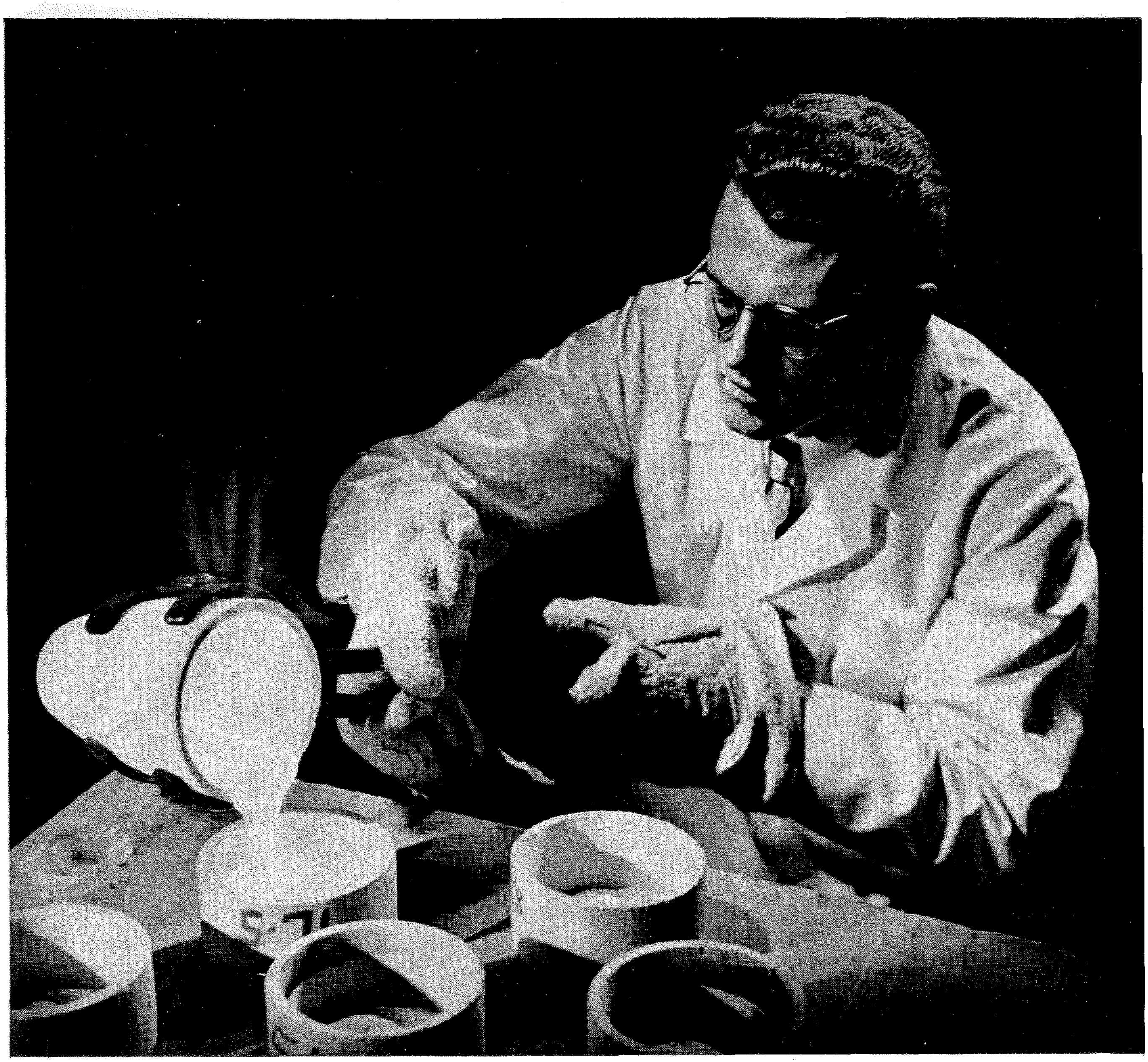
It's a job that's far from finished, though. And it's going to call for an even greater supply of each of these commodities. Trained engineers must plan and build the highways of the future. And the talents of countless other skilled men will go into the manufacture of the cement and steel for the job.

Knowing that progress depends on people, United States Steel is looking ahead. Promising young men, training for careers in the steel industry, are daily tackling problems and developing ideas which will create new steels and new uses of steel for better living. The achievements of these young men not only help keep United States Steel in the vanguard of the industry but provide opportunity for building fundamental qualifications for leadership.

AMERICAN BRIDGE COMPANY · AMERICAN STEEL & WIRE COMPANY · CARNEGIE-ILLINOIS STEEL CORPORATION · COLUMBIA STEEL COMPANY
H. C. FRICK COKE AND ASSOCIATED COMPANIES · GENEVA STEEL COMPANY · GERRARD STEEL STRAPPING COMPANY
MICHIGAN LIMESTONE & CHEMICAL COMPANY · NATIONAL TUBE COMPANY · OIL WELL SUPPLY COMPANY · OLIVER IRON MINING COMPANY
PITTSBURGH LIMESTONE CORPORATION · PITTSBURGH STEAMSHIP COMPANY · TENNESSEE COAL, IRON & RAILROAD COMPANY
UNITED STATES STEEL EXPORT COMPANY · UNITED STATES STEEL PRODUCTS COMPANY · UNITED STATES STEEL SUPPLY COMPANY
UNIVERSAL ATLAS CEMENT COMPANY · VIRGINIA BRIDGE COMPANY

USS

UNITED STATES STEEL



BOOKS

MAX PLANCK, Scientific Autobiography and Other Papers.

Philosophical Library, N.Y., $3.75

Reviewed by Paul S. Epstein
Professor of Theoretical Physics

THE FAMOUS GERMAN physicist Max Planck died in the fall of 1947 at the ripe age of 92. During the last two years of his life he wrote several papers intended for the general reader which are collected in the present volume.

Planck's scientific career was rather unusual. As early as 1892 he had been appointed professor of theoretical physics at the Berlin University and had thus attained the highest position in the German academic world open to men of his specialty. But he admits himself that his influence on the development of physics in his country was almost nil. Being of a lonely turn of mind, he devoted his interests to the out-of-the-way subject of thermodynamics and let slip past him the two great creations of nineteenth century physics: the electromagnetic and the kinetic theories of matter. He was, therefore, completely overshadowed by the exponents of these two problems, his great contemporaries Heinrich Hertz and Ludwig Baltzmann. To make matters worse, he had the mortification to discover that even his thermodynamical results were not new but had been anticipated, many years earlier and in greater generality, by the American Josiah W. Gibbs.

Nevertheless, Planck labored on undaunted, and about the turn of the century his work led to unexpected results. His investigation of the thermodynamics of heat radiation led him to the discovery of the *quantum of action*, which opened up never-dreamed-of new vistas of scientific insight. Thus, the man who had been considered a sound but backward physicist in the nineteenth century, became the founder and leader of the new physics of the twentieth century.

In the essay entitled "A Scientific Autobiography" Planck writes with quiet dignity about his frustrations and with modest restraint about his great achievement. The reader gets the impression of a noble personality dispassionately pursuing his lonely way. Only rarely a bitter remark reveals the depth of his early disappointments, as for instance: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

The other papers are mostly devoted to problems in which modern physics touches upon philosophy. They show that even in his very advanced age the author was fully abreast of the latest developments. Of particular interest are his views on "Religion and Natural Science." Planck grew up in a religious atmosphere, being the son and grandson of noted Protestant theologians. In his later life he lost the naive faith in miracles but retained the ethical outlook of religon: a strongly developed sense of duty and of moral purpose. He feels that mankind needs a great common ideology, a common belief through which men should become aware of their inherent brotherhood, and which should establish mutual love and peace on earth. It is doubtful, however, whether his own world view — a somewhat abstract pantheism—would be suitable to serve as this unifying ideal.

As an introduction the volume contains the memorial address read at Planck's funeral by Max von Laue, his pupil and life-long friend.

ROUTE SURVEYS
by Russell R. Skelton

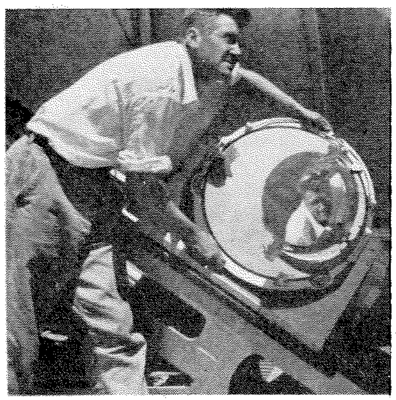
McGraw-Hill, N.Y. 531 pp., $4.50

Reviewed by William W. Michael
Associate Professor of
Civil Engineering

MR. SKELTON'S *Route Surveys* presents the subject in a comprehensive and informative manner.

The sample field notes on preliminary and location surveys are excellent examples of present day practice, and the text on curves—both simple and compound—with its illustrative problems covers this portion of the work in a satisfactory manner. The spiral curve has been presented in a way that is understandable and applicable on both railroads and highway location.

The chapter on construction surveys should be particularly useful to the student who has not had any practical experience on actual construction work. The tables are good, and the size and shape of the book lend to its usefulness in the field, making it fit snugly into the engineer's pocket or field bag. On the whole, the book should be well received both as a text and a reference for the party chief in the field.



In this issue

On the cover this month R. S. Richardson, Research Associate in Astronomy at the Mount Wilson Observatory, is adjusting the mirrors on top of Mount Wilson's 60-foot sun tower, in preparation for solar observations. Out of such experience Dr. Richardson has written the article on sunspots—certainly one of the most provocative, if not the most important solar studies—on page 19 of this issue.

The Process of Change

Elting E. Morison's article on page 5, "A Case Study of Innovation," was originally delivered as a lecture at the Institute—for members of the Athenaeum in March. Everyone who heard the talk then will, we are certain, be happy to have it in this comparatively permanent form. And those who missed it will now have an opportunity to discover what a stimulating and provocative talk it was—and article it is.

Professor Morison was graduated from Harvard in 1932, and received his M.S. there in 1937. During the recent war he was Director of the Historical Section in the Office of the Chief of Naval Operations, and, since 1946 he has been a consultant for the Research and Development Board in the Department of Defense. Author of *Admiral Sims and the Modern American Navy*, published in 1942, Professor Morison is now editing the *Letters of Theodore Roosevelt.* The first two of the projected eight volumes of these letters should be off the press next winter.

Mountain-Climber

In a sense, William Hainsworth's article "The Ascent of Mt. Vancouver,"

CONTINUED ON PAGE 4

ENGINEERING AND SCIENCE MONTHLY

VOL. XIII — CONTENTS FOR APRIL — NO. 7

ENGINEERING AND SCIENCE MONTHLY
Published at the California Institute of Technology

STAFF

Publisher.......Harry K. Farrar '27
Editor and Business Manager.......Edward Hutchings Jr.
Student News.......James Hendrickson '50
Staff Photographer.......Ralph Lovberg '50
Editorial Consultant.......Professor of English George R. MacMinn

PUBLICATIONS COMMITTEE

Chairman.......Harry K. Farrar '27
Members.......Richard H. Jahns '35, Martin H. Webster '37

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 $3.00, single copies 35 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 Main Line

APRIL, 1950

Lately almost everybody has been wiping away a nostalgic tear or two as the first half of the twentieth century drops from the calendar.

We caught the fever, too.

In rummaging through some old photographs, we ran across this one:

It was taken around 1900, and the setting is the observation platform of the *Overland Limited.* The caption read (rather superfluously) "Making Love In The Moonlight On The *Overland Ltd.*" or "Is That A Cinder In Your Eye?"

A lot of miles have slipped under the *Overland's* wheels since then (about eighty-two million of them, if you're statistically minded) and its official name has been changed from the *Overland Limited* to the *San Francisco Overland.* But it's still a good place to make love, moonlight or no moonlight.

High Sierra by Day

With the old giving way to the new, the open-air observation platform has been superseded by a streamlined parlor-observation car between Reno and San Francisco. It has huge picture windows for easy looking at the spectacular High Sierra, which the *Overland* crosses by day in both directions, as well as a swank "observation circle" at the rear.

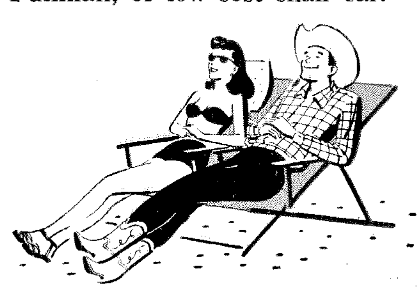
Incidentally, did you know that the *Overland* is the fastest non-extra fare train between San Francisco and Chicago? Just two nights en route. Only the extra fare *City of San Francisco* (swish!) gets you there any faster. Also, the *Overland* is getting lots of new cars. As fast as the car builders deliver them, we're putting them in service. Soon it will be another 100% streamliner. Keep it in mind for your next trip east. It's a wonderful, scenic way to go.

Take a Late One

If you feel as if winter cold and dampness have a long-term lease on your bones, here's a chance to break it.

Duck out now for a late season vacation in Southern Arizona or at Palm Springs. The desert's nice and warm this time of year, (but not *too* hot) and you'll have a little more elbow room than you would right at peak season.

We have some fine trains serving the southwest ranch and resort country. As a matter of fact, our *Golden State* streamliner, *Imperial, Sunset Limited* and *Argonaut* provide the only mainline train service direct to Palm Springs and Southern Arizona. Take your choice of luxurious Pullman, economical tourist-Pullman, or low-cost chair car.



Not Far

With the famous *Daylights* serving the Coast from Portland to Los Angeles, and the convenient overnight *Lark* and *Starlight* between San Francisco and Los Angeles, you can get to where the sun spends the winter in practically no time at all. So don't just sit there and brood about it. Visit your nearest S.P. office. You'll be surprised at how little it costs and how much fun a late winter vacation can be.

S•P The friendly Southern Pacific

In This Issue CONT'D.

is a companion piece to Robert P. Sharp's "Project Snow Cornice," which ran in E & S back in November, 1948. The ascent of Mt. Vancouver—the highest unclimbed mountain in North America—was made under the auspices of Project Snow Cornice.

The Project, in turn, is sponsored by the Arctic Institute of North America, a nonprofit, scientific organization founded in 1945 to study the problems common to Alaska, northern Canada and Greenland. Since national boundaries are largely artificial in the North American Arctic, most scientific problems are common to the entire region.

The Institute coordinates research interests pertaining to the North American Arctic and Subarctic, and works closely with government agencies, universities, scientific societies and other groups concerned with arctic problems.

In its first four years of operation the Institute assisted more than 50 separate field parties working in the North—including large-scale operations like Project Snow Cornice, in which for two consecutive years so far (1948 and 1949) 20 scientists and students, using a specially-equipped Institute aircraft, have landed on the Seward Ice Field on the Alaska-Yukon boundary to investigate the geology, glaciers, climate, plants and animals of this little known mountain region.

Bill Hainsworth, who received his M.S. from Caltech in 1918, is now vice-president of Servel, Inc., with offices in New York City. Most of the year he lives comfortably with his family in Scarsdale, a Westchester County suburb of New York. But when he makes a break from this routine, he goes all the way—as you can find out in his article an page 12.

PICTURE CREDITS

Cover—Mount Wilson Observatory
p. 10—Underwood-Stratton
pps. 12-16—William R. Hainsworth
p. 18—Bill Wright '51
p. 19—Mount Wilson
p. 22—Pasadena Star-News
pp. 24-26—William Muehlberger '49

A distinguished historian discusses the introduction of a single technological change in the United States Navy—and comes to some provocative conclusions about the process of change in general

A CASE STUDY OF INNOVATION

by ELTING E. MORISON

IN THE EARLY DAYS of the last war, when armaments of all kinds were in short supply, the British, I am told, made use of a venerable field piece that had come down to them from previous generations. The honorable past of this light artillery stretched back, in fact, to the Boer War. In the days of uncertainty after the fall of France, these guns, hitched to trucks, served as useful mobile units in the coast defense. But it was felt that the rapidity of fire could be increased. A time-motion expert was, therefore, called in to suggest ways to simplify the firing procedures. He watched one of the gun crews of five men at practice in the field for some time. Puzzled by certain aspects of the procedures, he took some slow-motion pictures of the soldiers performing the loading, aiming, and firing routines.

When he ran these pictures over once or twice, he noticed something that appeared odd to him. A moment before the firing two members of the gun crew ceased all activity and came to attention for a three-second interval, extending throughout the discharge of the gun. He summoned an old colonel of artillery, showed him the pictures, and pointed out this strange behaviour. What, he asked the colonel, did it mean? The colonel, too, was puzzled. He asked to see the pictures again. "Ah," he said when the performance was over, "I have it. They are holding the horses."

This story, true or not, and I am told it is true, suggests nicely the pain with which the human being accommodates himself to changing conditions. The tendency is apparently involuntary and immediate to protect oneself against the shock of change by continuing in the presence of altered situations the familiar habits, however incongruous, of the past.

Yet, if human beings are attached to the known, to the realm of things as they are, they also, regrettably for their peace of mind, are incessantly attracted to the unknown and to things as they might be. As Ecclesiastes glumly pointed out, men persist in disordering their settled ways and beliefs by seeking out many inventions.

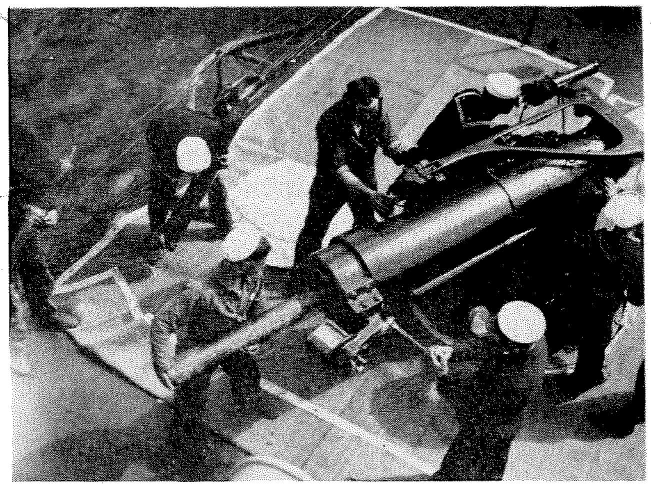
The point is obvious. Change has always been a constant in human affairs; today, indeed, it is one of the determining characteristics of our civilizaton. In our relatively shapeless social organization, the shifts from station to station are fast and easy. More important for our immediate purpose, America is fundamentally an industrial society in a time of tremendous technological development. We are thus constantly presented with new devices or new forms of power that, in their refinement and extension, continually bombard the fixed structure of our habits of mind and behaviour. Under such conditions, our salvation, or at least our peace of mind, appears to depend upon how successfully we can in the future become what has been called in an excellent phrase a completely "adaptive society."

It is interesting, in view of all this, that so little investigation, relatively, has been made of the process of change and human responses to it. Recently psychologists, sociologists and cultural anthropologists have addressed themselves to the subject with suggestive results. But we are still far from a full understanding of the process, and still farther from knowing how we can set about simplifying and assisting an individual's or a group's accommodation to new machines or new ideas.

With these things in mind, I thought it might be interesting and perhaps useful to examine historically a changing situation within a society; to see if from this examination we can discover how the new machines or ideas that introduced the changing situation developed; to see who introduces them, who resists them, what points of friction or tension in the social structure are produced by the innovation, and perhaps why they are produced and what, if anything, may be done about it. For this case study, the introduction of continuous-aim firing in the United States Navy has been selected. The system, first devised by an English officer in 1898, was introduced into our Navy in the years 1900-1902.

I have chosen to study this episode for two reasons. First, a navy is not unlike a society that has been placed under laboratory conditions. Its dimensions are severely limited; it is beautifully ordered and articulated; it is relatively isolated from random influences. For these reasons the impact of change can be clearly discerned, the resulting dislocations in the structure easily discovered and marked out. In the second place, the development of continuous-aim firing rests upon mechanical devices. It, therefore, presents for study a concrete, durable situation. It is not like many other innovating reagents—a Manichean heresy, or Marxism, or the views of Sigmund Freud—that can be shoved and hauled out of shape by contending forces or conflicting prejudices. At all times we know exactly what continuous-aim firing really is. It will be well now to describe, as briefly as possible, *what* it is.

The governing fact in gunfire at sea is that the gun is mounted on an unstable platform—a rolling ship. This constant motion obviously complicates the problem of holding a steady aim. Before 1898 this problem was solved in the following elementary fashion. A gun pointer estimated the range of the target—ordinarily about 2800 yards. He then raised the gun barrel to give



Continuous-aim firing on the Cruiser Birmingham, 1913

the gun the elevation to carry the shell to the target at the estimated range. This was accomplished by turning a small wheel on the gun mount that operated the elevating gears. With the gun thus fixed for range, the gun pointer peered through open sights, not unlike those on a small rifle, and waited until the roll of the ship brought the sights on the target. He then pressed the firing button that discharged the gun. There were, by 1898, on some naval guns, telescope sights which naturally enlarged the image of the target for the gun pointer. But these sights were rarely used by gun pointers. They were lashed securely to the gun barrel and, recoiling with the barrel, jammed back against the unwary pointer's eye. Therefore, when used at all, they were used only to take an initial sight for purposes of estimating the range before the gun was fired.

Notice now two things about the process. First of all, the rapidity of fire was controlled by the rolling period of the ship. Pointers had to wait for the one moment in the roll when the sights were brought on the target. Notice also this: There is in every pointer what is called a "firing interval"—the time lag between his impulse to fire the gun and the translation of this impulse into the act of pressing the firing button. A pointer, because of this reaction time, could not wait to fire the gun until the exact moment when the roll of the ship brought the sights onto the target; he had to will to fire a little before, while the sights were off the target. Since the firing interval was an individual matter, varying obviously from man to man, each poiner had to estimate, from long practice, his own interval and compensate for it accordingly.

These things, together with others we need not here investigate, conspired to make gunfire at sea relatively uncertain and ineffective. The pointer, on a moving platform, estimating range and firing interval, shooting while his sight was off the target, became in a sense an individual artist.

In 1898, many of the uncertainties were removed from the process, and the position of the gun pointer radically altered, by the introduction of continuous-aim firing. The major change was that which enabled the gun pointer to keep his sight and gun barrel on the target throughout the roll of the ship. This was accomplished by altering the gear ratio in the elevating gear to permit a pointer to compensate for the roll of the vessel by rapidly elevating and depressing the gun. From this change another followed. With the possibility of maintaining the gun always on the target, the desirability of improved sights became immediately apparent. The advantages of the telescope sight, as opposed to the open sight, were for the first time fully realized. But the existing telescope sight, it will be recalled, moved with the recoil of the gun and jammed back against the eye of the gunner. To correct this, the sight was mounted on a sleeve that permitted the gun barrel to recoil through it without moving the telescope.

These two improvements—in elevating gear and sighting—eliminated the major uncertainties in gunfire at sea and greatly increased the possibilities of both accurate and rapid fire.

You must take my word for it that this changed naval gunnery from an art to a science, and that gunnery accuracy in the British and our Navy increased about 3000 per cent in six years. This doesn't mean much except to suggest a great increase in accuracy. The following comparative figures may mean a little more. In 1899 five ships of the North Atlantic Squadron fired five minutes each at a lightship hulk at the conventional range of 1600 yards. After twenty-five minutes of banging away two hits had been made on the sails of the elderly vessel. Six years later one naval gunner made 15 hits in one minute at a target 75 x 25 feet at the same range; half of them hit in a bull's eye 50 inches square.

Now with the instruments (the gun, elevating gear, and telescope), the method, and the results of continuous-aim firing in mind, let us turn to the subject of major interest: how was the idea, obviously so simple an idea, of continuous-aim firing developed; who introduced it; and what was its reception?

Introduction of an idea

The idea was the product of the fertile mind of the English officer, Admiral Sir Percy Scott. He arrived at it in this way, while, in 1898, he was the captain of H. M. S. *Scylla*. For the previous two or three years he had given much thought, independently and almost alone in the British Navy, to means of improving gunnery. One rough day, when the ship, at target practice, was pitching and rolling violently, he walked up and down the gun deck watching his gun crews. Because of the heavy weather they were making very bad scores. Scott noticed, however, that one pointer was appreciably more accurate than the rest. He watched this man with care and saw, after a time, that he was unconsciously working his elevating gear back and forth in a partially successful effort to compensate for the roll of the vessel. It flashed through Scott's mind at that moment that here was the sovereign remedy for the problems of inaccurate fire. What one man could do partially and unconsciously, perhaps all men could be trained to do consciously and completely.

Acting on this assumption, he did three things. First, in all the guns of the *Scylla*, he changed the gear ratio in the elevating gear, previously used only to set the gun in fixed position for range, so that a gunner could easily elevate and depress the gun to follow a target throughout the roll. Second, he rerigged his telescopes so that they would not be influenced by the recoil of the gun. Third, he rigged a small target at the mouth of the gun, which was moved up and down by a crank to simulate a moving target. By following this target as it moved, and firing at it with a subcalibre rifle rigged in the breech of the gun, the pointer could practice every day. Thus equipped, the ship became a training ground for gunners. Where before the good pointer was an individual artist, pointers now became trained technicians, fairly uniform in their capacity to shoot. The effect was immediately felt. Within a year the *Scylla* established records that were remarkable.

At this point I should like to stop a minute to notice several things directly related to, and involved in, the process of innovation. First, the personality of the innovator. I wish there were space to say a good deal about Admiral Sir Percy Scott. He was a wonderful man. Three small bits of evidence must suffice, however. First, he had a certain mechanical ingenuity. Second, his personal life was shot through with frustration and bitterness. There was a divorce, and a quarrel with the ambitious Lord Charles Beresford—the sounds of which, Scott liked to recall, penetrated to the last outposts of empire. Finally, he possessed, like Swift, a savage indignation directed ordinarily at the inelastic intelligence of all constituted authority—especially the British Admiralty.

There are other points worth mention here. Notice first that Scott was not responsible for the invention of the basic instruments that made the reform in gunnery possible. This reform rested upon the gun itself, which as a rifle had been in existence on ships for at least forty years; the elevating gear, which had been, in the form Scott found it, a part of the rifled gun from the beginning; and the telescope sight, which had been on shipboard at least eight years. Scott's contribution was to bring these three elements, appropriately modified, into a combination that made continuous-aim firing possible for the first time. Notice also that he was allowed to bring these elements into combination by accident, by watching the unconscious action of a gun pointer endeavoring through the operation of his elevating gear to correct partially for the roll of his vessel.

The prepared mind is not enough

Scott, as we have seen, had been interested in gunnery; he had thought about ways to increase accuracy by practice and improvement of existing machinery; but able as he was, he had not been able to produce on his own initiative and by his own thinking the essential idea and modify instruments to fit his purpose. Notice here finally, the intricate interaction of chance, the intellectual climate, and Scott's mind. Fortune (in this case the unaware gun pointer) indeed favors the prepared mind, but even fortune and the prepared mind need a favorable environment before they can conspire to produce sudden change. No intelligence can proceed very far above the threshold of existing data or the binding combinations of existing data.

All these elements that enter into what may be called "original thinking" interest me as a teacher. Deeply rooted in the pedagogical mind often enough is a sterile infatuation with "inert ideas"; there is thus always present in the profession the tendency to be diverted from the *process* by which these ideas, or indeed any ideas, are really produced. I well remember with what contempt a class of mine, which was reading Leonardo da Vinci's *Notebooks*, dismissed the author because he appeared to know no more mechanics than, as one wit in the class observed, a Vermont Republican farmer of the present day. This is perhaps the result to be expected from a method of instruction that too frequently implies that the great generalizations were the result, on the one hand, of chance—an apple falling in an orchard or a teapot boiling on the hearth—or, on the other hand, of some towering intelligence proceeding in isolation inexorably toward some prefigured idea, like evolution, for example.

This process by which new concepts appear, the interaction of fortune, intellectual climate, and the prepared imaginative mind, is an interesting subject for examination offered by any case study of innovation. It was a subject that momentarily engaged the attention of Horace Walpole, whose lissome intelligence glided over the surface of so many ideas. In reflecting upon the part played by chance in the development of new concepts, he recalled the story of the three princes of Serendip who set out to find some interesting object on a journey through their realm. They did not find the particular object of their search, but along the way they discovered many new things simply because they were looking for *something*. Walpole believed this intellectual method ought to be given a name—in honor of the founders—Serendipity; and Serendipity certainly exerts a considerable influence in what we call original thinking. There is an element of Serendipity, for example, in Scott's chance discovery of continuous-aim firing in that he was, and had been, looking for some means to improve his target practice and stumbled upon a solution, by observation, that had never entered his head.

Educating the Navy

It was in 1900 that Percy Scott went out to the China Station as commanding officer of H.M.S. *Terrible*. In that ship he continued his training methods and his spectacular successes in naval gunnery. On the China Station he met up with an American junior officer, William S. Sims. Sims had little of the mechanical ingenuity of Percy Scott, but the two were drawn together by temperamental similarities that are worth noticing here. Sims had the same intolerance for what is called spit-and-polish and the same contempt for bureaucratic inertia as his British brother officer. He had for some years been concerned, as had Scott, with what he took to be the inefficiency of his own Navy. Just before he met Scott, for example, he had shipped out to China in the brand new pride of the fleet, the battleship *Kentucky*. After careful investigation and reflection he had informed his superiors in Washington she was not a battleship at all—"but a crime against the white race."

The spirit with which he pushed forward his efforts to reform the naval service can best be stated in his own words to a brother officer: "I am perfectly willing that those holding views different from mine should continue to live, but with every fibre of my being I loathe indirection and shiftiness, and where it occurs in high place, and is used to save face at the expense of the vital interests of our great service (in which silly people place such a childlike trust), I want that man's blood and I will have it no matter what it costs me personally."

From Scott in 1900 Sims learned all there was to know about continuous-aim firing. He modified, with the Englishman's active assistance, the gear on his own ship and tried out the new system. After a few months' training, his experimental batteries began making remarkable records at target practice. Sure of the usefulness of his gunnery methods, Sims then turned to the task of educating the Navy at large. In 13 great official reports he documented the case for continuous-aim firing, supporting his arguments at every turn with a mass of factual data. Over a period of two years, he reiterated three principal points: First, he continually cited the records established by Scott's ships, the *Scylla* and the *Terrible* and supported these with the accumulating data from his own tests on an American ship; second, he described the mechanisms used and the training procedures instituted by Scott and himself to obtain these records; third, he explained that our own mechanisms were not generally adequate without modification to meet the demands placed on them by continuous-aim firing. Our elevating gear, useful to raise or lower a gun slowly to fix it in position for the proper range, did not always work easily and rapidly enough to enable a gunner to follow a target with his gun throughout the roll of the ship. Sims also explained that such few telescope sights as there were on board our ships were useless. Their cross wires were so thick or coarse that they obscured the target, and the sights had been attached to the gun in such a way that the recoil system of the gun plunged the eyepiece against the eye of the gun pointer.

This was the substance not only of the first but of all the succeeding reports written on the subject of gunnery from the China Station. It will be interesting to see what response these met with in Washington. The response falls roughly into three easily indentifiable stages.

First stage: no response. Sims had directed his comments to the Bureau of Ordnance and the Bureau of Navigation; in both bureaus there was dead silence. The thing—claims and records of continuous-aim firing—was not credible. The reports were simply filed away and forgotten. Some indeed, it was later discovered to Sims' delight, were half eaten away by cockroaches.

Second stage: rebuttal. It is never pleasant for any man to have his best work left unnoticed by superiors, and it was an unpleasantness that Sims suffered extremely ill. In his later reports, beside the accumulating data he used to clinch his argument, he changed his tone. He used deliberately shocking language because, as he said, "They were furious at my first papers and stowed them away. I therefore made up my mind I would give these later papers such a form that they would be dangerous documents to leave neglected in the files." To another friend he added, "I want scalps or nothing and if I can't have 'em I won't play."

Sims gets attention

Besides altering his tone, he took another step to be sure his views would receive attention. He sent copies of his reports to other officers in the fleet. Aware, as a result, that Sims' gunnery claims were being circulated and talked about, the men in Washington were then stirred to action. They responded—notably through the Chief of the Bureau of Ordnance, who had general charge of the equipment used in gunnery practice—as follows: (1) Our equipment was in general as good as the British; (2) since our equipment was as good, the trouble must be with the men, but the gun pointer and the training of gun pointers were the responsibility of the officers on the ships; (3) and most significant—continuous-aim firing was impossible. Experiments had revealed that five men at work on the elevating gear of a six-inch gun could not produce the power necessary to compensate for a roll of five degrees in ten seconds. These experiments and calculations demonstrated beyond peradventure or doubt that Scott's system of gunfire was not possible.

Only one difficulty is discoverable in these arguments; they were wrong at important points. To begin with, while there was little difference between the standard British equipment and the standard U. S. equipment, the instruments on Scott's two ships, the *Scylla* and the *Terrible*, were far better than the standard equipment on our ships. Second, all the men could not be trained in continuous-aim firing until equipment was improved throughout the fleet. Third, the experiments with the elevating gear had been ingeniously contrived at the Washington Navy Yard—on solid ground. It had, therefore, been possible in the Bureau of Ordnance calculation, to dispense with Newton's first law of motion, which naturally operated at sea to assist the gunner in elevating or depressing a gun mounted on a moving ship. Another difficulty was of course that continuous-aim firing was in use on Scott's and some of our own ships at the time the Chief of the Bureau of Ordnance was writing that it was a mathematical impossibility. In every way I find this second stage, the apparent resort to reason, the most entertaining and instructive in our investigation of the responses to innovation.

Third stage: name calling. Sims, of course, by the high temperature he was running and by his calculated overstatement, invited this. He was told in official endorsements on his reports that there were others quite as sincere and loyal as he and far less difficult; he was dismissed as a crack-brain egotist; he was called a deliberate falsifier of evidence.

Sims gets action

The rising opposition and the character of the opposition was not calculated to discourage further efforts by Sims. It convinced him that he was being attacked by shifty, dishonest men who were the victims, as he said, of insufferable conceit and ignorance. He made up his mind, therefore, that he was prepared to go to any extent to obtain the "scalps" and the "blood" he was after. Accordingly he, a lieutenant, took the extraordinary step of writing the President of the United States, Theodore Roosevelt, to inform him of the remarkable records of Scott's ships, of the inadequacy of our own gunnery routines and records, and of the refusal of the Navy Department to act. Roosevelt, who always liked to respond to such appeals when he conveniently could, brought Sims back from China late in 1902 and installed him as Inspector of Target Practice, a post the naval officer held throughout the remaining six years of the Administration.

With this sequence of events (the chronological account of the innovation of continuous-aim firing) in mind, it is possible now to examine the evidence to see what light it may throw on our present interest—the origins of and responses to change in a society.

First, the origins. We have already analyzed briefly the origins of the idea. We have seen how Scott arrived at his notion. We must now ask ourselves, I think, why Sims so actively sought, almost alone among his brother officers, to introduce the idea into his service. It is particularly interesting here to notice again that neither Scott nor Sims invented the instruments on which the innovation rested. They did not urge their proposal because of pride in the instruments of their own design.

The Engineer and the Entrepreneur

The telescope sight had first been placed on shipboard in 1892 by Bradley Fiske, an officer of great inventive capacity. In that year Fiske had even sketched out on paper the vague possibility of continuous-aim firing, but his sight was condemned by his commanding officer, Robley D. Evans, as of no use. Instead of fighting for his telescope Fiske turned his attention to a range finder. But six years later Sims took over and became the engineer of the revolution.

I would suggest, with some reservations, this explanation: Fiske, as an inventor, took his pleasure in great part from the design of the device. He lacked, not so much the energy as the overriding sense of social necessity, that would have enabled him to *force* revolutionary ideas on the service. Sims possessed this sense. In Fiske we may here find the familiar plight of the engineer who often enough must watch the products of his ingenuity being organized and promoted by other men.

These other promotional men, when they appear in the world of commerce, are called entrepreneurs. In the world of ideas they are still entrepreneurs.

Sims was one, a middle-aged man caught in the periphery (as a lieutenant) of the intricate webbing of a precisely organized society. Rank, the exact definition and limitation of a man's capacity at any given moment in his own career, prevented Sims from discharging all his exploding energies into the purely routine channels of the peacetime Navy. At the height of his powers he was a junior officer standing watches on a ship cruising aimlessly in friendly foreign waters. The remarkable changes in systems of gunfire to which Scott introduced him gave him the opportunity to expend his energies quite legitimately against the encrusted hierarchy of his society. He was moved, it seems to me, in part by his genuine desire to improve his own profession but also in part by rebellion against tedium, against inefficiency from on high, and against the artificial limitations placed on his actions by the social structure, in his case junior rank.

Responding to change

Now having briefly investigated the origins of the change, let us examine the reasons for what must be considered the weird response we have observed to this proposed change. Here was a reform that greatly and demonstrably increased the fighting effectiveness of a service that maintains itself almost exclusively to fight. Why then this refusal to accept so carefully documented a case; a case proved incontestably by records and experience? Why should virtually all the rulers of a society so resolutely seek to reject a change that so markedly improved its chances for survival in any contest with competing societies?

There are the obvious reasons that will occur to everyone—he source of the proposed reform was an obscure junior officer 8000 miles away; he was, and this is a significant factor, criticizing gear and machinery designed by the very men in the bureaus to whom he was sending his criticisms. And furthermore, Sims was seeking to introduce what he claimed were improvements in a field where improvements appeared unnecessary. Superiority in war, as in other things, is a relative matter, and the Spanish-American War had been won by the old system of gunnery. Therefore, it was superior even though of the 9500 shots fired, at varying but close ranges, only 121 had found their mark.

A less obvious cause appears by far the most important one. It has to do with the fact that the Navy is not only an armed force; it is a society. In the forty years following the Civil War, this society had been forced to accommodate itself to a series of technological changes—the steam turbine, the electric motor, the rifled shell of great explosive power, case-hardened steel armor, and all the rest of it. These changes wrought extraordinary changes in ship design, and, therefore, in the concepts of how ships were to be used; that is, in fleet tactics, and even in naval strategy. The Navy of this period is a paradise for the historian or sociologist in search of evidence of a society's responses to change.

To these numerous innovations, producing as they did a spreading disorder throughout a service with heavy commitments to formal organization, the Navy responded with grudging pain. It is wrong to assume, as civilians frequently do, that this blind reaction to technological change springs exclusively from some causeless Bourbon distemper that invades the military mind. There is a sounder and more attractive base. The opposition, where it occurs, of the soldier and the sailor to such

William S. Sims as a four-star Admiral—1919

change springs from the normal human instinct to protect oneself and more especially one's way of life. Military organizations are societies built around and upon the prevailing weapon systems. Intuitively and quite correctly the military man feels that a change in weapon portends a change in the arrangements of his society.

Think of it this way. Since the time that the memory of man runneth not to the contrary, the naval society has been built upon the surface vessel. Daily routines, habits of mind, social organization, physical accommodations, conventions, rituals, spiritual allegiances have been conditioned by the essential fact of the ship. What then happens to your society if the ship is displaced as the principal element by such a radically different weapon as the plane? The mores and structure of the society are immediately placed in jeopardy. They may, in fact, be wholly destroyed. It was the witty cliché of the 20's that those naval officers who persisted in defending the battleship against the apparently superior claims of the carrier did so because the battleship was a more comfortable home. What, from one point of view, is a better argument?

This sentiment would appear to account in large part for the opposition to Sims; it was the product of an instinctive protective feeling, even if the reasons for this feeling were not overt or recognzed. The years after 1902 proved how right, in their terms, the opposition was. From changes in gunnery flowed an extraordinary complex of changes: in shipboard routines, ship design, and fleet tactics. There was, too, a social change. In the days when gunnery was taken lightly, the gunnery officer was taken lightly. After 1903, he became one of the most significant and powerful members of a ship's company, and this shift of emphasis naturally was shortly reflected in promotion lists. Each

Sims, characteristically choleric, and Theodore Roosevelt

one of these changes provoked a dislocation in the naval society, and with man's troubled foresight and natural indisposition to break up classic forms, the men in Washington withstood the Sims onslaught as long as they could. It is very significant that they withstood it until an agent from outside—outside and above—who was not clearly identified with the naval society, entered to force change.

This agent, the President of the United States, might reasonably and legitimately claim the credit for restoring our gunnery efficiency. But this restoration by *force majeure* was brought about at great cost to the service and men involved. Bitternesses, suspicions, wounds were caused that it was impossible to conceal or heal.

Now this entire episode may be summed up in five separate points:

(1) The essential idea for change occurred in part by chance, but in an environment that contained all the essential elements for change, and to a mind prepared to recognize the possibility of change.

(2) The basic elements—the gun, gear, and sight—were put in the environment by other men; men interested in designing machinery to serve different purposes, or simply interested in the instruments themselves.

(3) These elements were brought into successful combination by minds not interested in the instruments for themselves, but in what they could do with them. These minds were, to be sure, interested in good gunnery, overtly and consciously. They may also, not so consciously, have been interested in the implied revolt that is present in the support of all change. Their temperaments and careers indeed support this view. From gunnery, Sims went on to attack ship designs, existing fleet tactics, and methods of promotion. He lived and died, as the service said, a stormy petrel, a man always on the attack against higher authority, a rebellious spirit.

(4) He and his colleagues were opposed on this occasion by men who were apparently moved by three considerations: honest disbelief in the dramatic but substantiated claims of the new process; protection of the existing devices and instruments with which they identified themselves; and maintenance of the existing society with which they were identified.

(5) The deadlock between those who sought change and those who sought to retain things as they were was broken only by an appeal to superior force; a force removed from and unidentified with the mores, conventions, devices of the society. This seems to me a very important point. The naval society in 1900 broke down in its effort to accommodate itself to a new situation. The appeal to Roosevelt is documentation for Mahan's great generalization that no military service should or can undertake to reform itself. It must seek assistance from outside.

Now with these five summary points in mind, it may be possible to seek, as suggested at the outset, a few larger implications from this story. What, if anything, may it suggest about the general process by which any society attempts to meet changing conditions?

No society can reform itself?

There is, to begin with, a disturbing inference half concealed in Mahan's statement that no military organization can reform itself. Certainly civilians would agree with this. We all know now that war and the preparation of war is too important, as Clemenceau said, to be left to the generals. But military organizations are really societies—more rigidly structured, more highly integrated than most communities, but still societies. What then if we make this phrase to read, "No society can reform itself"? Is the process of adaptation to change, for example, too important to be left to human beings? This is a discouraging thought, and historically there is some cause to be discouraged.

This is a subject to which we may well address ourselves. Our society, especially, is built, as I have said, just as surely upon a changing technology as the Navy of the 90's was built upon changing weapon systems. How then can we find the means to accept with less pain to ourselves and less damage to our social organization the dislocations in our society that are produced by innovation? I cannot, of course, give any satisfying answer to these difficult questions. But in thinking about the case study before us, an idea occurred to me that at least might warrant further investigation by men far more qualified than I.

A primary source of conflict and tension in our case study appears to lie in this great word I have used so often in the summary—the word, *identification*. It cannot have escaped notice that some men identified themselves with their creations—sights, gun, gear, and so forth—and thus obtained a presumed satisfaction from the thing itself, a satisfaction that prevented them from thinking too closely on either the use or the defects of the thing; that others identified themselves with a settled way of life they had inherited or accepted with minor modification and thus found their satisfaction in attempting to maintain that way of life unchanged; and that still others identified themselves as rebellious spirits, men of the insurgent cast of mind, and thus obtained a satisfaction from the act of revolt itself.

This purely personal identification with a concept, a convention, or an attitude would appear to be a powerful barrier in the way of easily acceptable change. Here is an interesting primitive example. In the years from

1864-1871 ten steel companies in the country began making steel by the new Bessemer process. All but one of them at the outset imported from Great Britain English workmen familiar with the process. One, the Cambria Company, did not. In the first few years those companies with British labor established an initial superiority. But by the end of the 70's, Cambria had obtained a commanding lead over all competitors.

The Bessemer process, like any new technique, had been constantly improved and refined in this period from 1864-1871. The British laborers of Cambria's competitors, secure in the performance of their own original techniques, resisted and resented all change. The Pennsylvania farm boys, untrammeled by the rituals and traditions of their craft, happily and rapidly adapted themselves to the constantly changing process. They ended by creating an unassailable competitive position for their company.

How then can we modify the dangerous effects of this word *identification?* And how much can we tamper with this identifying process? Our security, much of it, after all, comes from giving our allegiance to something greater than ourselves. These are difficult questions to which only the most tentative and provisional answers may here be proposed for consideration.

The danger of limited identifications

If one looks closely at this little case history, one discovers that the men involved were the victims of *severely limited* identifications. They were presumably all part of a society dedicated to the process of national defense, yet they persisted in aligning themselves with separate parts of that process—with the existing instruments of defense, with the existing customs of the society, or with the act of rebellion against the customs of the society. Of them all, the insurgents had the best of it. They could, and did, say that the process of defense was improved by a gun that shot straighter and faster, and since they wanted such guns, they were unique among their fellows—patriots who sought only the larger object of improved defense. But this beguiling statement—even when coupled with the recognition that these men were right, and extremely valuable and deserving of respect and admiration—cannot conceal the fact that they were interested too in scalps and blood. They were so interested, in fact, that they made their case a militant one and thus created an atmosphere in which self-respecting men could not capitulate without appearing either weak or wrong or both. So these limited identifications brought men into conflict with each other, and the conflict prevented them from arriving at a common acceptance of a change that presumably, as men interested in our total national defense, they would all find desirable.

It appears, therefore, if I am correct in my assessment, that we might spend some time and thought on the possibility of enlarging the sphere of our identifications from the part to the whole. For example, those Pennsylvania farm boys at the Cambria Steel Company were, apparently, much more interested in the manufacture of steel than in the preservation of any particular way of making steel. So I would suggest that in studying innovation we look further into this possibility: the possibility that any group that exists for any purpose—the family, the factory, the educational institution—might begin by defining for itself its grand object, and see to it that that grand object is communicated to every member of the group. Thus defined and communicated, it might serve as a unifying agent against the disruptive local allegiances of the inevitable smaller elements that compose any group. It may also serve as a means to increase the acceptability of any change that would assist in the more efficient achievement of the grand object.

There appears also a second possible way to combat the untoward influence of limited identifications. We are, I may repeat, a society based on technology in a time of prodigious technological advance, and a civilization committed irrevocably to the theory of evolution. These things mean that we believe in change; they suggest that if we are to survive in good health we must become an "adaptive society." By the word "adaptive" is meant the ability to extract the fullest possible returns from the opportunities at hand; the ability of Sir Percy Scott to select judiciously from the ideas and material presented both by the past and present and to throw them into a new combination. "Adaptive," as here used, also means the kind of resilience that will enable us to accept fully and easily the best promises of changing circumstances without losing our sense of continuity or our essential integriy.

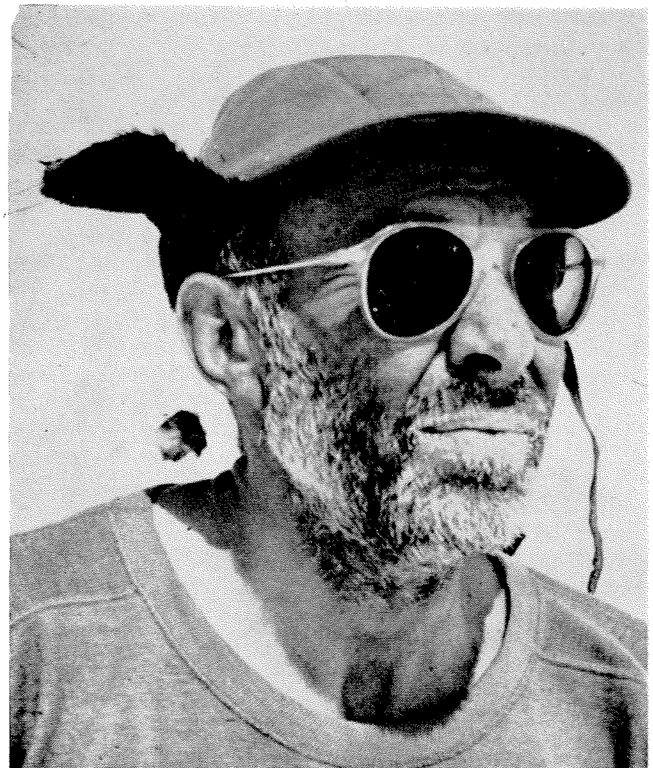
We are not yet emotionally an adaptive society, though we try systematically to develop forces that tend to make us one. We encourage the search for new inventions; we keep the mind stimulated, bright, and free to seek out fresh means of transport, communication, and energy; yet we remain, in part, appalled by the consequences of our ingenuity and, too frequently, try to find security through the shoring up of ancient and irrelevant conventions, the extension of purely physical safeguards, or the delivery of decisions we ourselves should make into the keeping of superior authority like the state. These solutions are not necessarily unnatural or wrong, but historically they have not been enough, and I suspect they never will be enough to give us the serenity and competence we seek.

A new view of ourselves

If the preceding statements are correct, they suggest that we might give some attention to the construction of a new view of ourselves as a society which in time of great change identified itself with and obtained security and satisfaction from the wise and creative accommodation to change itself. Such a view rests, I think, upon a relatively greater reverence for the mere *process* of living in a society than we possess today, and a relatively smaller respect for and attachment to any special *product* of a society—a product either as finite as a bathroom fixture or as conceptual as a fixed and final definition of our Constitution or our democracy.

Historically such an identification with *process* as opposed to *product*, with adventurous selection and adaptation as opposed to simple retention and posessiveness, has been difficult to achieve collectively. The Roman of the early republic, the Italian of the late fifteenth and early sixteenth century, or the Englishman of Elizabeth's time appear to have been most successful in seizing the new opportunities while conserving as much of the heritage of the past as they found relevant and useful to their purpose.

We seem to have fallen on times similar to theirs, when many of the existing forms and schemes have lost meaning in the face of dramatically altering circumstances. Like them we may find at least part of our salvation in identifying ourselves with the adaptive process and thus share with them some of the joy, exhuberance, satisfaction, and security with which they went out to meet their changing times.



The author on the spot

What it's like to climb the highest unclimbed mountain in the North American continent

by William R. Hainsworth '18

THE ASCENT OF MT. VANCOUVER

THE SEWARD GLACIER STORM was running true to form when Walter Wood suggested I take advantage of the "socked in" day to jot down a few notes on the ascent of Mount Vancouver while memories were fresh. Immediately my thoughts wandered through a maze of trifling things. The layer of ice and frost crystals inside our shoes in the morning—the socks and inner soles which were frozen in our shoes when we tried to remove them before getting into the sack—the bowl and spoon which served all courses, finally coming clean with the coffee, which was almost strong enough to dissolve the porcelain—gasoline-impregnated supplies—the snow crystals which formed inside the tent and turned to miniature rainstorms when the sun announced a good day—the debates between nature and the fact that it was cold outside—these and similar trifles were the important things. Even the whiskbroom, which had first impressed me as a foolish luxury, gained respect after failure to use it resulted in puddles of melted snow on, and in, my sleeping bag.

The really important thing, of course, was that, for the second summer, Mt. Vancouver was included in Project Snow Cornice plans. The expedition was under the able leadership of Colonel Walter A. Wood, Director of the New York Office of the Arctic Institute of North America and President of the American Alpine Club. His long climbing and expedition experience in Alaska was the primary factor in the success of the trip.

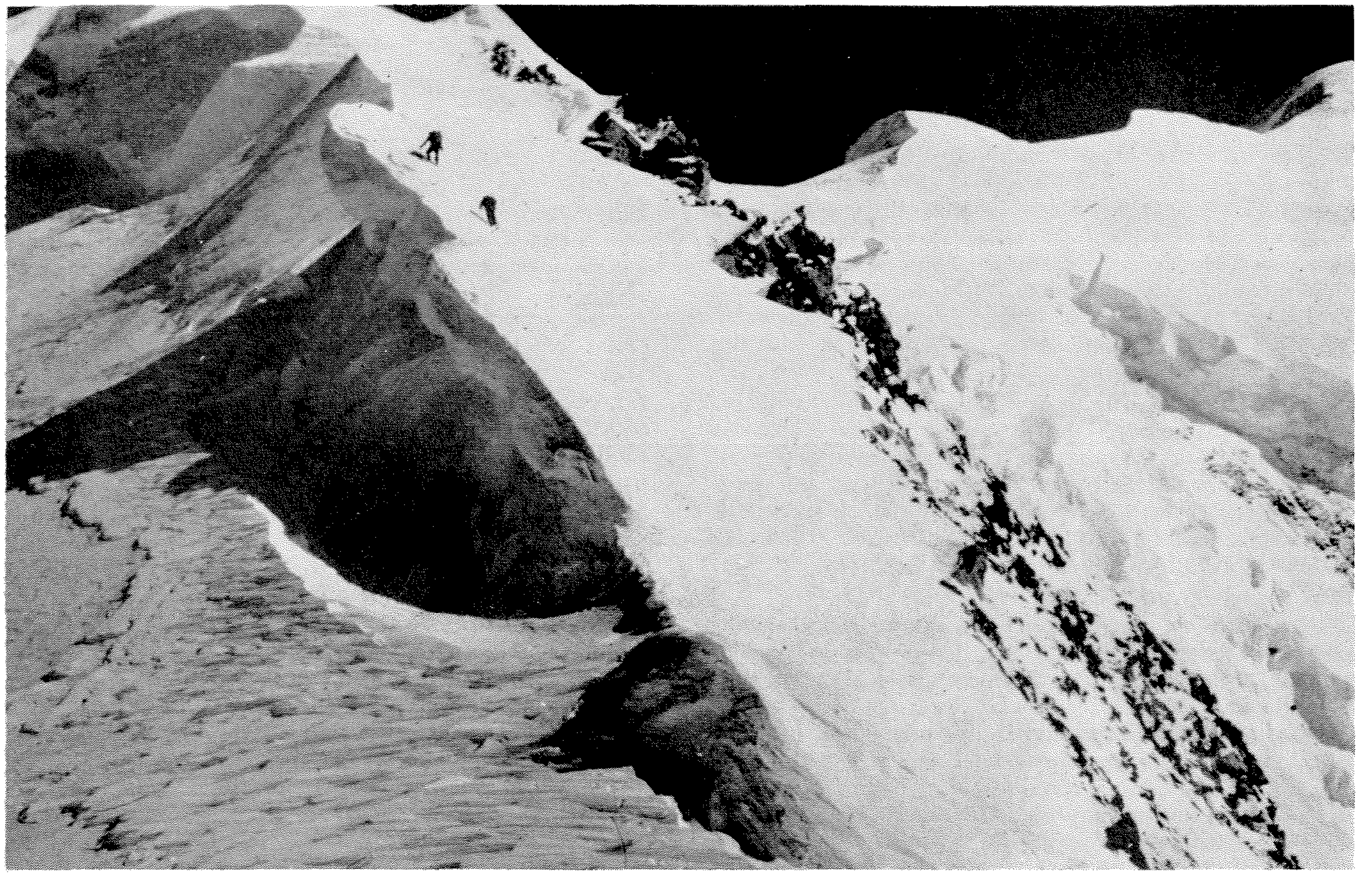
Vancouver had a special meaning for Walt. In the summer of 1948 he had, in effect, opened up the Seward Basin territory with modern expedition methods, using air supply. Vancouver, rising to 15,850 feet, was the highest unclimbed individual mountain mass in the region (although it should be noted that Mt. King, with its 17,000 feet, is also unclimbed, and a beautiful mountain in its own right—though it is sometimes considered a part of the Mt. Logan massive). As president of the American Alpine Club, Walt saw only one course to pursue—climb the mountain! But that was not so easily done. The expedition plane turned over on a glacier landing. Since Walt was responsible for the expedition he stayed on the job to work out some means of getting out of the Basin. In the meantime, a party attempted the North Ridge, but was turned back by the approach of a severe coastal storm and a shortage of supplies. This left Vancouver unconquered in 1948—and even more desirable than before.

Since the climb was integrated with the scientific activities of the 1949 expedition we were able to take full advantage of the Norseman ski-equipped airplane support, parachute and drop loads, the comfortable facilities of a Jamesway base camp hut on the Nunatak (a rock island in the Seward Glacier) adjacent to Mt. Vancouver, and excellent food and equipment; all the result of many hours of hard work and planning long before the expedition reached the Seward Glacier.

I left New York by commercial plane on June 12, spent a few days in Seattle, and landed on the excellent airfield of Yakutat, some 300 miles north of Juneau, on the afternoon of the 15th. On June 16 Maury King, the expedition pilot, flew us in to the Nunatak. On July 5, I arrived on top of Vancouver with three companions.

But I'm getting ahead of my story.

First let's pause for a better look at the St. Elias Mountains, to which range Vancouver belongs. It is a land of vast expanses and deceptive distances, and a land of extremes. At times the midday glare and heat on the Glacier is almost unbearable. Storms come and



The choice of routes was reduced to the North Ridge—though it included several long and steep icy pitches.

go in a matter of hours—or last for days. Winds are high and cold—or there is a dead calm. The snow is as hard as ice one day and the next you sink to your knees in it. It is spectacularly beautiful, and the delight and despair of the camera fan: delight—because there is a daily temptation to photograph everything in sight; and despair—because the light meter needle repeatedly jumps beyond the end of the scale in its effort to warn against overexposure.

The basin of the Seward Glacier to the west of Vancouver, in which the base camp was located, is rather inaccessible, to put it mildly. It lies only 25 miles from tidewater, but the circuitous approach—over the Malaspina Glacier, or along several alternate routes over the Hubbard Glacier to the east of Vancouver—would normally require a great deal of time and heartbreaking labor in relaying supplies over heavily crevassed areas.

The basin itself is roughly 750 square miles, and is surrounded by the enormous masses of Mt. Cook (13,760 feet), Mt. Augusta (14,070), Mt. St. Elias (18,808), Mt. Logan (19,850), Mt. McArthur (14,400), and Vancouver. The basin appears relatively flat, has large areas free from crevasses, and has excellent landing fields, especially in early summer.

We were all well supplied with Snow Cornice and personal equipment. U. S. Army double sleeping bags proved to be very practical in combination with air mattresses. At the hut the outer bag alone was satisfactory, with occasional temperatures of 15 at night. To conserve weight, the inner bag only was used on the climb, with the lowest night temperatures about zero and moderate but gusty winds. I listened to several discussions at the Nunatak base camp on the alleged advantages of crawling into one's sleeping bag without benefit of underwear, but decided to forego experimenting in this field. It seemed the better part of valor to retain some clothes and place the remainder between the air mattress and bag. Walt Wood's modified Mead tents, used in pairs, provided us with two bedrooms and a connecting vestibule. On two occasions the parachute loads dropped on the mountain provided a box which served as a storage cabinet and kitchen table when placed in the vestibule. Of much greater importance were the things which came to our door in the box. Perhaps it would be more accurate to say that the door came to the box, since two of our camps were established at the point where we found the parachute loads.

So it happened that we lived in comparative luxury on the mountain, thanks to the airplane and Walt's expedition philosophy. We had all the food supplies desired, and if anyone suffered for lack of equipment it was certainly not because it was unavailable. The 5 in 1 Army rations were supplemented with canned fruits, vegetables, and dehydrated foods. We were well supplied with raisins, dates, and figs. On the way up the mountain it was only necessary to back pack sleeping bags, air mattress, personal belongings, climbing equipment, camera and film, and daily food supplies. Coming down our loads became progressively heavier as we recovered essential equipment from each one of the three camps.

The mountain is a big mass, typical of those in the St. Elias range, and the selection of a route was not entirely obvious, even with the information gained on the 1948 experience. There are three minor summits on the mile-long summit ridge. An approach from either end seemed feasible, provided it did not involve a long summit traverse. This, of course, depended on the relative elevations of the summit peaks.

One purpose of the Arctic Institute studies was to determine accurately the elevations and positions of the peaks in the Seward Glacier area, and adequate equipment for the purpose was at hand. Walt established a 960-foot base line on the Seward Glacier and triangulated the summits with a theodolite which could be read accurately to five seconds. This corresponded to an error of 15 feet at the distance of the summit from the base, which is in the form of a symmetrically shaped pyramid. The North Peak was found to be 150 feet higher than the South Peak. A boundary survey had established the latter at 15,700 feet; therefore, Vancouver was found to have an elevation of 15,850 feet, with the North Peak the highest.

This reduced the choice of routes to the North Ridge, or a direct ascent up the glacier from the Northeast basin. It was agreed that the ridge would be best even though it included the prospect of several long and steep icy pitches. Actually, the snow conditions in July 1949 were considerably improved over August 1948, as observed by Bob McCarter, a graduate student at Stanford University, who was on both trips.

It was decided to establish three camps on the mountain; the first in a cirque just below the ridge, the second on the ridge, and the third on a slope behind Institute Peak, facing the final ridge. On June 27 the weather appeared promising, so Walt and Bob took off in the Norseman from the Glacier airstrip, with parachute loads containing tents, cooking equipment, food, some rope and other supplies. One load was dropped in the cirque below the North Ridge and another on the slope back of Institute Peak.

Our start up the mountain was a complicated affair, full of anticipation, weather uncertainties, and disappointments. On June 28, five of us got an early start on skis—Walter Wood, his son Peter, Noel Odell, a visiting professor of geology at the University of British Columbia, Bob McCarter, and I. Peter Wood had a badly cut finger. He had been nursing it for several days after a falling rock split it to the bone while we were looking for coneys (a species of rock rabbit) on Arctic Peak, just back of the Nunatak. Penicillin ointment proved very effective in preventing infection, but we had no sewing experience and the cut should have been stitched.

Our route lay up the comparatively flat glacial arm leading to the ice fall and cirque where we hoped to establish Camp I. By the time we parked our skis just below the ice fall, the weather had turned and we were confronted with low clouds and no sunshine. Nevertheless, it seemed best to go ahead and establish Camp I, which we did. Later that afternoon Bob McCarter and I went to the ridge above the camp and found the food cache which had been left there by the 1948 party. There was a high wind, with temperatures around 15 degrees and the cache was thoroughly frozen into the rocks. This part of our adventure ended with some extra food, a nipped finger, and a broken ice axe.

Since the weather was still uncertain the following morning Walt and I returned to the Nunatak to conserve supplies at Camp I and to get another axe. There we were pleasantly surprised to find that Alan Bruce-Robertson, a Canadian medical student and a veteran of the 1948 expedition, had arrived on the Glacier. He immediately packed to join the party. Right from the start it seemed to me that Bruce's pack consisted of about 50 per cent medical supplies and things which he insisted on carrying for other people. Now there were six planning to climb the mountain.

Air-Lift

Since there was a spare parachute load of tents and equipment at the airstrip it seemed a good idea to drop this at Camp I. This became a project for Maury King, our pilot, Bruce, and me. After receiving instructions we piled into the front of the plane to help lift the tail out of the snow, and took off. There was an oversized door-opening—equipped with no door—uncomfortably close to where we sat, so we tied ourselves in with ropes to keep from going along with the load when we pushed it out of the plane.

It was an exciting experience to observe the ridge from a few hundred feet above it and to push the load out on a split-second signal from Maury. And not the least of the excitement was the moment when Bruce grabbed my movie camera just as it was sliding out the door, trying to follow the load.

Walt, Bruce and I started from the Nunatak on the 30th to catch up with the climbing party. The snow was frozen so hard that we found it easier to tow our skis rather than wear them. Walt had in his pack a large can of gasoline for use in the Primus stoves, and on the way up he jokingly remarked several times about the "cloud cap" of gasoline vapors which seemed to be following him. Later this became serious and jokes turned into nausea. Nevertheless, we continued to Camp I. There, after examining Peter's cut finger, Bruce recommended that Pete return and agreed to accompany him back to the Nunatak the next day. Now there were four.

We continued to the ridge above Camp I, where it was cold and windy. We put on our parkas but unfortunately the fur on Walt's parka was saturated with gasoline. This was too much, and Walt became too ill with gasoline poisoning to go on. As leader of the party he overruled any plan to delay. It was a sad and difficult decision. I returned to Camp I with Walt, and arranged to join Noel and Bob later. They continued up the ridge to choose the site for Camp II.

At Camp I Walt asked Bruce to rejoin the climbing

GLOSSARY

At this point in Mr. Hainsworth's article, non-mountain-climbing readers may feel the need of further explanation of some of the terms used.

Here it is:

cirque—A theatre-like basin partly enclosed by steep rock walls and developed by glacial excavation—usually at the head of a canyon or valley.

ice fall—Like a waterfall, only ice; where an ice stream descends a steep grade and is badly crevassed and broken.

col—Low saddle in a ridge or divide.

seracs—Great blocks of ice developed on ice falls or by crevassing and breaking up by sliding or glacial flowage.

couloir—A more or less U-shaped chute extending down a steep mountain slope.

Mt. Vancouver—as it looks from the Seward Glacier, 35 miles away—showing route followed by the climbing party and location of the three camps.

party, whereupon he packed up his usual quota of medical supplies and took some of my pack, and we proceeded to Camp II. We met Noel and Bob patiently waiting at the top of a steep pitch, at which point they had placed 500 feet of fixed rope. It was impossible to pass each other on the pitch, so they could not return for loads which had been left at the col until we reached the top of the pitch. Finally, at the end of a long day, all four of us were established in Camp II, with several days' provisions and a parachute cache somewhere on the mountain above, near a place which we hoped would be Camp III.

July 1 in Camp II proved to be cold and foggy. Bob and Noel finally tired of looking at the top of the tent from the inside and decided on a reconnaissance up the ridge. A rocky band flanked by ice and seracs looked rather formidable, particularly as it faded away into the icy slopes just below the next higher step in the ridge. While Bob and Noel were up above, Bruce and I went down to get the rope we had left in a fixed position. It looked as if it would be much more useful higher up. After caching the rope some distance above the camp we all assembled again at Camp II for a "5 in 1" repast.

The trip to the Camp III site was a matter of weaving back and forth, as directed by cornices, from slightly below the ridge to the ridge itself. As expected, we encountered two steep pitches with a thin snow coating over ice. These were about 40 degrees in places and required considerable care. A plateau below Institute Peak provided a breathing spell, but we were still confronted with a long traverse along the east side of the peak to a point considerably above the saddle between Institute and the final ridge. This seemed to be the only access to the slope where we could hope to find the parachute load.

On rounding the shoulder it was disconcerting to see ahead a slide mark—which appeared to be about the width of our parachute load—ending in a large crevasse. My toes were frostbitten and visions of a camp without supplies, or a long pull back to Camp II, began to take realistic form. Luckily, after some searching, Bob and Noel spotted a corner of the box—almost buried—with the red parachute covered with snow, and with the marker flag still in a horizontal position. With characteristic forethought, Walt had tied a small shovel to the outside of the box. It was a pleasure to use this to clear a level platform for the tents on the 37-degree slope.

Following the usual pattern, the weather prevented an early start for the summit the next day, so we enjoyed an afternoon of wandering around on Institute Peak. Late in the day Walt and Maury King came up in the plane to look us over. The weather on the mountain, as observed from below, appeared excellent, and we learned later that it was puzzling to Walt to find we were not on the final ridge. Early morning fogs and cloud caps are deceiving unless you are in them.

July 5 seemed reasonably favorable, but not until the sun dispersed the morning fog. We started for the top at 7:00 A.M., Bob and I on one rope, Noel and Bruce on the other. The going was heavy and leads were switched often. Occasionally we placed willow wands but they were not needed on the return. There were a number of small cracks which were annoying to negotiate. Perhaps they were annoyed by our presence, to judge by the way they curled their upper lips at us.

We begrudged the loss of several hundred feet elevation while getting to the col between Institute and the final ridge, and again when we skirted a sizeable hump higher on the ridge which was decorated profusely with enormous seracs. About noon we built a small cairn on the flat rocky saddle between the hump and the final summit ridge.

We then came to the worst pitch encountered on the climb—ice covered with a film of snow. Estimated angles are always subject to impressions. The angle of this pitch permitted one to touch the snow with the fingertips while standing vertically in the step cut in the ice. One hundred and twenty steps and two hours of labor were left behind at this point.

Above the ice slope the fog closed in and it was difficult to stay on the ridge. This indeterminate area soon gave way to a sharp snow ridge, leading directly to the summit pyramid which we reached at 4:30 P.M. Frostbitten fingers and toes, and a community feeling that we ought to start back right away, reduced our stay on top to the bare minimum required for pictures of ourselves, since there was no other scenery around. The ceremony of raising the flag consisted of dropping a piece of red parachute cloth on the snow. Noel managed to find some rocks a few hundred feet below the summit and deposited our record in exchange for geological samples.

The return to Camp III was uneventful except for memories of the enormous chunks of lead that became attached to our feet on the uphill section just below Camp III. It does not sound reasonable, but I am sure I went to sleep for a minute or two while standing up contemplating that final slope. Although we were away from camp only 13 hours, it seemed a very long day.

Back to Camp II

On July 6 we started for Camp II. My diary reads: "We broke camp about 9:00 A. M. All was well to the lower pitch. The fixed rope area was easy. The final pitch was risky. A slip would have been bad because the belays were poor—ice only. Took two hours to descend 200 feet. Slipped twice but recovered without help of rope. Bob fell into several cracks but always managed to crawl out before I could get my camera out. In one place my boot went through on a slope and threw me forward. My head and shoulders broke through. It was quite a surprise to look along the under side of the bridge and see my foot hanging in space. No danger, but tough to get up with a pack on."

Bob and I reached Camp I at 8:30 P. M., having picked up some of the Camp II equipment. We could see Noel and Bruce moving slowly on the ridge above, but at 11:00 P. M. they were still above the col. We started back to help but they soon appeared above the camp. It turned out that Bruce had received a painful crampon spike in the ankle while jumping a crevasse and necessarily had to move very cautiously. At the top of the couloir above camp Noel removed his pack to adjust his crampons. In keeping with the spirit of the occasion the pack decided on a trip of its own and a few moments later stopped intact conveniently by the camp.

The hot sun not only had placed our camp on a pedestal during the time we were on the mountain, but managed to dish out the snow under the middle of the tent, much to our discomfort that night.

On July 7 we packed most of the gear into the drop box, attached ropes to it fore and aft, and started down, hoping to slide the box most of the way. After a minor struggle we reached the top of the couloir next to the ice fall. In spite of a 30-degree slope in the couloir the box bogged down in the wet snow. We would sink to our hips trying to start the box sliding. Twice, in my zeal, I found myself head down the slope, pack over my head, and my legs firmly implanted in the snow on the uphill side. It took a lot of energy to get out. Finally we abandoned the box, after belaying it at the end of a climbing rope. Later on, snowslides came down the couloir and batted our box over to the side like a big pendulum.

It was a great relief to get back on our skis and an even greater pleasure to get back to the Nunatak. On the way down, the plane buzzed us and we tried to signal success by shaking our hands over our heads, boxer fashion; however, Walt and Maury thought we were shaking our fists at them for coming too low and it wasn't until we were all together again at the Nunatak that they knew we had had a successful trip.

CK 6 W to WXD

One of the outstanding memories of the whole affair is that of Walt's radio conversations between CK 6 W on Seward Glacier, and the Army station in Yakutat. Here's a sample:

"CK 6 W on the Seward, CK 6 W, CK 6 W, calling WXD at Yakutat, WXD W-X-D, 54321 - 12345, are you tuned in? This is Wood calling. Do you hear me? Over!"

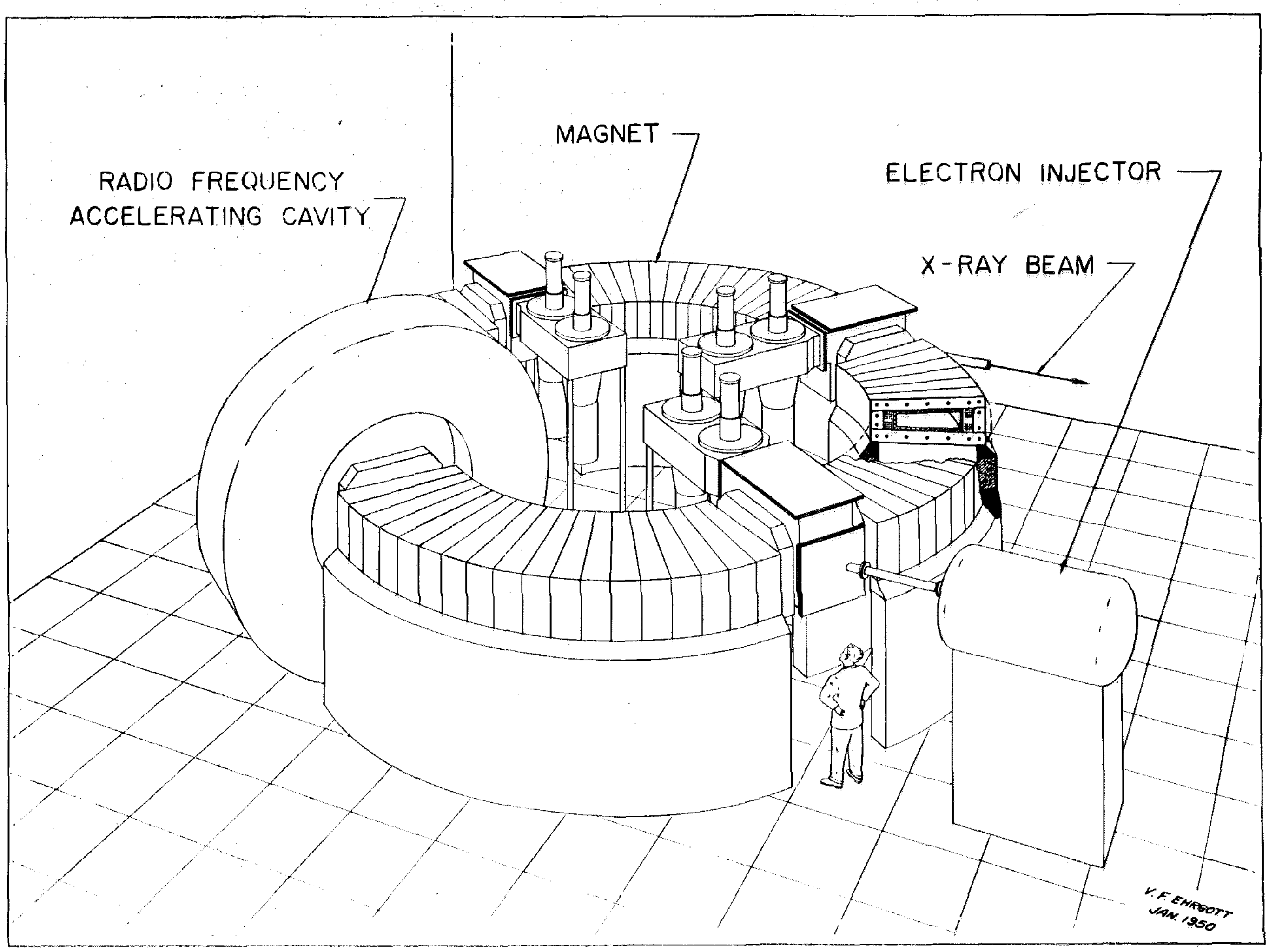
"CK 6 W, CK 6 W, CK 6 W, this is WXD. We hear you loud and clear. Do you have any message? Over to you!"

"Ah, yes, WXD. We are in the glorious sunshine of Seward Basin, feasting our eyes on the Alpine glow of Mt. Cook, the Parrish beauty of St. Elias, and the bold, stark rays cast heavenward from Mt. Logan as the sun goes to rest on its broad shoulders. We know you enjoy the palms and wide expanses of the beaches of the Yakutat summer resort—but take your mind off that for a moment. We have news for you! Four of our boys have just come in from the first ascent of Mt. Vancouver. They reached the top on July 5 and had a very successful trip. I know you'll be pleased with the news. Over!"

"Oh, yeah? What in hell did they want to go up there for? Anyhow, congratulations. Now, about that missing box of seismographic equipment you were looking for. We located it in Juneau and will have it in your hands in a couple of days—weather permitting. That is all, unless you have something else. WXD signing off. Over!"

Noel Odell and Bob McCarter at Camp II, which was established right where the parachute load was dropped.

The four members of the climbing party who reached the top—Bruce-Robertson, McCarter, Hainsworth, Odell.



The Billion-Volt Synchrotron

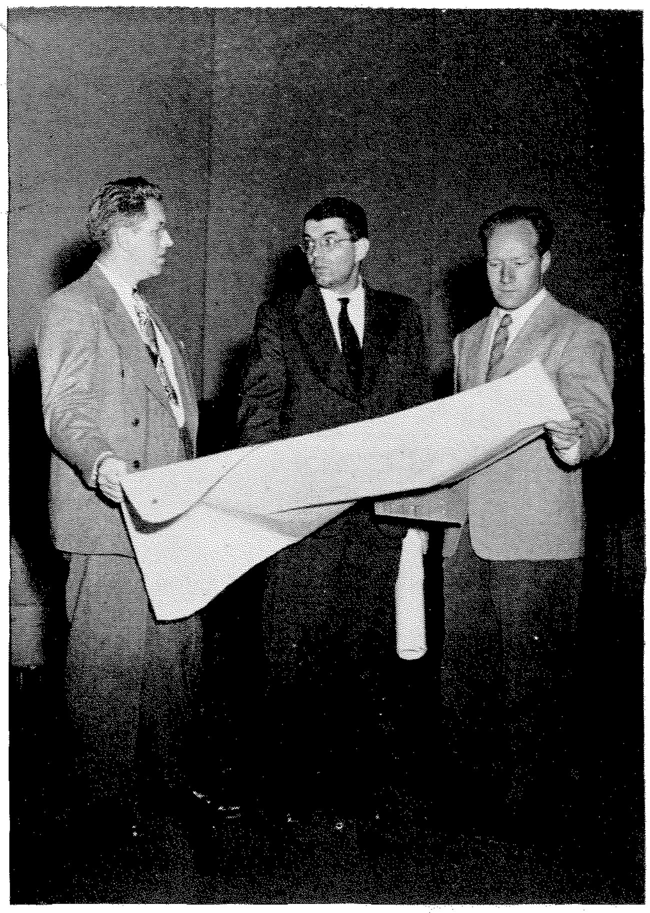
Caltech's new electron accelerator will be the most powerful machine of its type ever built

THE INSTITUTE HAS ANNOUNCED plans for a new high energy physics laboratory in which it will build a one-billion-volt electron acclerator, or "atom smasher" (E & S, July '49). The acclerator, an electron synchrotron, will be the most powerful machine of this type ever built. The electron synchrotron principle was first developed by Edwin M. McMillan (who graduated from Caltech in 1928, received his M.S. here in 1929, and his Ph.D. in 1932) of the University of California at Berkeley. A 300,000,000-volt unit is now in operation on the Berkeley campus, and there are similar units at Cornell University, and the Massachusetts Institute of Technology.

Final plans and designs for the Caltech synchrotron were developed during a year-long survey jointly financed by the Office of Naval Research and the Atomic Energy Commission. The conclusion of the survey—that research with electrons of a billion-volt energy was a highly important unexplored field—resulted in an Atomic Energy Commission contract to assist the Institute in building such a machine.

The synchrotron will be built in two stages. First, a magnet (to be obtained from the University of California, where it was used for a pilot model of the six-billion-volt proton acclerator now under construction there) will be used, with minor modifications, to speed up electrons until they have energies of 500,000,000 electron volts. After some experience has been obtained at this energy, the additional modifications will be made to bring the synchrotron to the billion-volt level. The first stage should be completed in about a year; the second in an additional year and a half.

The synchrotron will be housed in the present Optical Shop, where the 200-inch mirror for the Palomar tele-



The men in charge of getting the billion-volt electron accelerator built and in operation—Bruce Rule, Robert V. Langmuir, and Robert L. Walker

scope was ground and polished. Estimated cost of the completed installation, not including the building already available, is something over a million dollars. Annual operating costs of the experimental program to be undertaken after the billion-volt phase has been completed will be about $300,000 a year.

Three man team

Three men will be in charge of getting the accelerator built and in operation—Dr. Robert V. Langmuir, Senior Research Fellow in Physics; Bruce Rule, Director of Central Shop Facilities and Project Engineer in Astrophysics; and Dr. Robert L. Walker, Assistant Professor of Physics.

Dr. Langmuir, who received his Ph.D. from Caltech in 1943, was brought back to the Institute in 1948 from the General Electric Research Laboratories, where he worked on construction of the 70,000,000-volt GE synchrotron. Bruce Rule, who was project engineer for the Palomar Observatory, will handle the applied engineering in construction of the synchrotron. Dr. Walker, who came to Caltech last year from the Laboratory of Nuclear Studies at Cornell University, was connected with the Manhattan Project during the war, and worked at the Metallurgical Laboratory of the University of Chicago and at the Los Alamos laboratory where the atomic bomb was built. He is mainly responsible for the design of experimental equipment to be used in connection with synchrotron research projects.

While the fundamental principles in electron synchrotrons were first proposed simultaneously by E. M. McMillan of the University of California and Dr. V. Veksler of Russia, the actual design of the instrument to be built at Caltech is to be a modified version of a type first suggested by Dr. H. R. Crane, Professor of Physics at the University of Michigan. Dr. Crane, who received his B.S. from Caltech in 1930, and his Ph.D. in 1934, is now back here for a few months as visiting professor.

A race-track accelerator

The machine will be of the so-called "race track" type, in which the magnet is split into four quadrants with straight sections in between. As the electrons circulate around the race track at speeds very close to the velocity of light, a radio frequency oscillator will provide properly timed accelerations during each turn while the electrons are traversing one segment of the straight track. The outside diameter of the race track will be about 36 feet and the electrons will travel around it for a total distance of some 90,000 miles before reaching the maximum energy of a billion electron volts. Electrons will be fed into the machine at an initial energy of about 1,500,000 electron volts by the use of a pulse transformer. As each burst of electrons is introduced into the machine the magnetic field automatically rises steadily to keep the electrons in a proper orbit, while at the same time radio frequency acceleration goes into operation.

When they reach their full energy, the electrons may be used directly for the bombardment of atomic nuclei, or more frequently they will be used to produce billion-volt X-rays by impingement on a suitable target. At these energies the effects of electrons and of X-rays are expected to be more or less indistinguishable.

It has already been found that in cosmic-ray phenomena, as well as in the high-energy experiments at Berkeley, at the University of Rochester and other places, that the bombardment of nuclei with energies above 200,000,000 electron volts results in the copious production of mesons. These are the mysterious short-lived particles first predicted by the Japanese theoretical physicists Yukawa, and first discovered experimentally by Dr. Carl Anderson in the Caltech laboratories. This particle, intermediate in mass between the light electron and the heavier proton, seems to be important in nuclear binding forces, serving as a sort of glue to hold nuclei together.

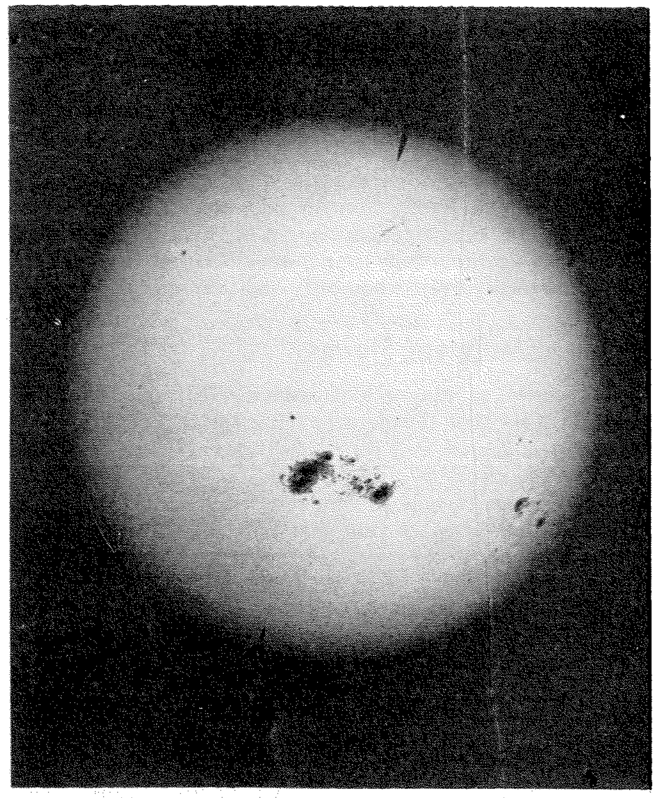
Increasing our knowledge of nuclear forces

"The purpose of this new accelerator," says Dr. R. F. Bacher, Chairman of the Division of Physics, "will be to seek additional knowledge about the nature of the forces that hold atomic nuclei together. Our knowledge of nuclear forces and their relation to the fundamental particles of nature is very incomplete. To obtain a better understanding of these forces is one of the most important goals of present-day physics. At the Berkeley Radiation Laboratory and at the Brookhaven National Laboratory, this problem will be studied with the accelerated protons (hydrogen nuclei) which they will obtain from the great machines now under construction. We shall attack the problem using the X-rays and electrons from the billion-volt electron synchrotron. We expect this work to yield additional important information."

"As in all basic research problems," President DuBridge points out, "the results obtained cannot be predicted. Much less can one predict what practical application, if any, will turn up. We do know, however, that nuclear energy is the main source of energy of the universe, and it is clearly important for us to understand more about the nature of this energy."

Blame it on Sunspots

by R. S. RICHARDSON



IN RECENT YEARS sunspots have been blamed for everything from depressions to headaches—including epidemics, radio static, the fecundity of rabbits and the weather. But slightly more than a century ago, when Heinrich Schwabe, an apothecary in the little town of Dessau, Germany, announced his discovery of the sunspot cycle—certainly one of the most important astronomical discoveries of the last century — it created scarcely a ripple. Apparently either nobody read it or else those who did failed to realize its significance. Not until six years later, when the announcement appeared again in the third volume of Humboldt's great work, *The Cosmos,* did recognition finally come. The trouble had been that whereas Schwabe spoke only to a handful of professional astronomers largely preoccupied with their own researches, Humboldt had a vast audience who read whatever he cared to write and accepted it as authoritative. Which demonstrates the value of having a publicity agent in science as well as other professions.

In 1849, six years after Schwabe's original announcement, Wolf of Zürich began a program of sunspot observations which has been continued by his successors to the present day without a break. Wolf's daily counts of individual sunspots and sunspot groups, when properly combined, constitute the famous Wolf relative sunspot numbers (see p. 20), the longest and most homogeneous index of solar activity that we possess. Wolf not only carried his observations forward in time, but by searching through the old records he was able to extend his relative numbers for each month as far back as 1749, and to estimate the times of maxima and minima clear to the invention of the telescope in 1610.

The average interval from one sunspot minimum to the next since 1749 is 11.1 years, although this interval has been as short as 9.0 years and as long as 13.6 years. It is probable that the sunspot cycle is only roughly periodic, like the eruptions of a geyser. A lot of people have spent a lot of time trying to predict the course of sunspot activity by superposing curves of different period and amplitude based upon the behavior of cycles in the past. So far, however, none has met with much success. The only way we seem to be able to predict sunspot activity with accuracy is backward.

Seventeen complete cycles have been observed since January 1749. The largest Wolf relative number for any one month was in May 1778, when the index reached 238.9. The third highest occurred during the cycle which is now in progress, in May 1947, when it attained a value of 201.6, being just nosed out for the place money by December 1836, with a count of 206.2.

Although the cycle from 1775 to 1784 is the highest on record, the present cycle which began late in 1943 has no rivals when it comes to the size of the spot groups involved. Previously the record for size was held by the great spot group of January 1926, with an area of 3700—meaning that it covered 3700 millionths or 0.37 of one per cent of the visible surface of the sun. (The size of sunspots is highly deceptive. They always appear to be much larger than they really are.) A sunspot group is considered "large" if it has an area greater than about 1000. Such groups can usually be seen through a very dark screen without the aid of a telescope.

When in February 1946 a spot group developed that had an area of 4900 we felt confident that it had set a record that would stand for many years. Our faith was somewhat shaken, however, when in July of the same year another group appeared with an area of 3700. Then in February 1947 a moderate-sized group passed across the disk that might be called a "sleeper," for at first it gave no hint of the rapid development it was to undergo. When the group reappeared on March 3, after a solar rotation of about a month, it had grown considerably and become more compact than in February. On its third return in April the group, although beginning to break up, had an area of 5400 and extended over 6.3 billion square miles of the solar surface. Thus this spot group (above) is the largest of which we have any record. Yet its place is still not too secure, as seen by the fact that in 1949 alone there were 59 spot groups large enough to be seen by the unaided eye.

In the last 50 years attempts have been made to correlate sunspot activity with practically every type of phenomenon imaginable: wars, earthquakes, the weather, the fecundity of furbearing animals in Canada, outbreaks of cerebrospinal meningitis and other diseases, the stock market, and I believe that even horse racing has come in for its share of attention. Of the many correlations that have been suspected, however, only a very few have withstood the test of time.

The oldest and best established correlation is that between the frequency of sunspots and terrestrial magnetic activity. Averages of terrestrial magnetic activity taken over a fairly long period, such as a year, follow the sunspot curve with remarkable fidelity. Occasionally magnetic records at stations all over the world will be subject to sudden and violent disturbances. These disturbances, which begin simultaneously to within about a minute and which last for about a day, are called magnetic storms. Great magnetic storms have been found to occur so often when a large spot group is near the center of the sun's disk that there seems little doubt the two must be connected in some way, although many large spot groups fail to produce storms, and a few storms have occurred when only small spots were visible.

Origin of Magnetic Storms

The cause of magnetic storms is still unknown, despite the fact that the data bearing upon them has been minutely analysed and much theoretical work has been done in an effort to interpret the results. At present two rival theories hold the field. One ascribes the origin of magnetic storms to charged particles ejected from active spot groups; the other to turbulent air motions in the ionosphere set off by bursts of ultra-violet radiation. Both theories have their loyal adherents who refuse to yield an inch to the opposition.

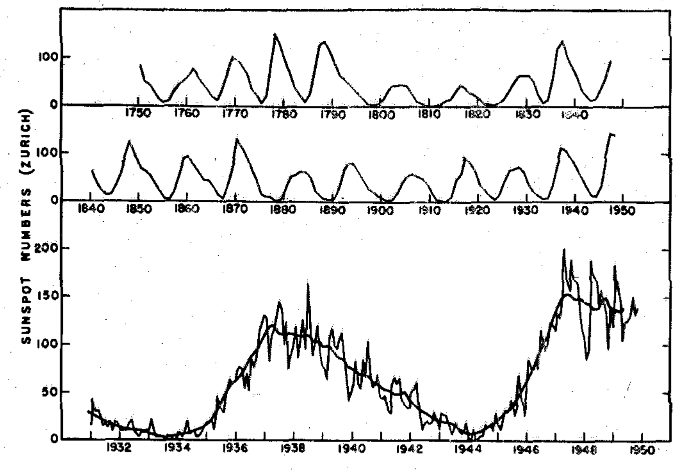
If the sun is viewed through some instrument such as the spectroheliosope, which shows the surface in the light of one element only as the red line of hydrogen, occasionally one will be startled to see bright patches break out near a spot group that certainly were not there a minute ago. The patches grow rapidly until within ten minutes the whole region in and around the spot group is ablaze with brilliant ribbons of flame. Soon the ribbons begin to fade and after perhaps an hour will have disappeared entirely, leaving the region essentially the same as before. This phenomenon is called a *flare.*

Flares and Fadeouts

Flares have been found to occur simultaneously with fadeouts in high frequency radio transmission over the daylight side of the earth. A fadeout occurs during a flare because the ionosphere suddenly ceases to reflect the waves back to the earth, somewhat as if reflections from a mirror were cut off by thrusting a screen in front of it. Apparently there is a burst of ultra-violet light emitted during a flare which is able to pass down through the atmosphere without hindrance until within about 50 miles of the surface. Here for the first time it meets certain molecules (possibly ozone) which absorb the ultra-violet light strongly and as a consequence become highly ionized. Radio waves from a station, upon encountering this low-lying level, set the ions in rapid motion, but the air is so dense that they are quickly brought to rest by jostling against other particles around them. Thus the energy of the radio waves, instead of being reflected, as in the high rarefied layers of the ionosphere, is dissipated away in random collisions.

In February 1942, army radar stations in England experienced severe interference due to a high level of radio noise in their receivers. When bearings were taken on the source of interference they were found to point in a direction close to the sun. It was concluded that the noise was created by a large spot group then in transit across the disk. Here appeared to be a new method of exploring the solar atmosphere by means of waves short for radio but a million times longer than the longest infra-red rays we can photograph.

Although microwave technique has only been applied systematically to solar research since the war, already valuable results have been obtained. One of the most



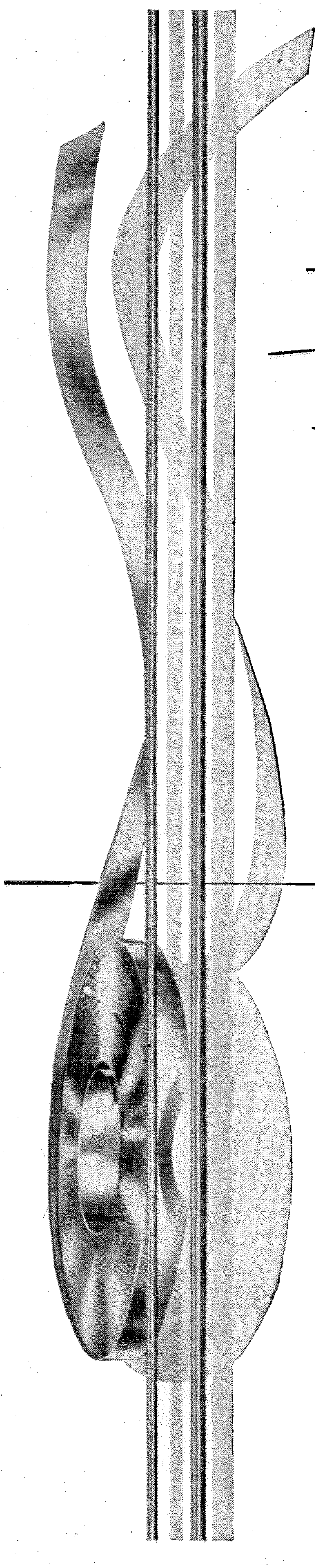
startling was the discovery that the fairly steady constant emission from the quiescent sun corresponds to a temperature of 1,000,000 degrees C! Since the surface of the sun that we see in the sky is known to have a temperature of only 5600 degrees C, such a figure might seem preposterous if we did not already have good reasons for believing that the temperature of the corona is around a million degrees. Hence the source of radio noise was tentatively identified with the corona, and later work has confirmed this view.

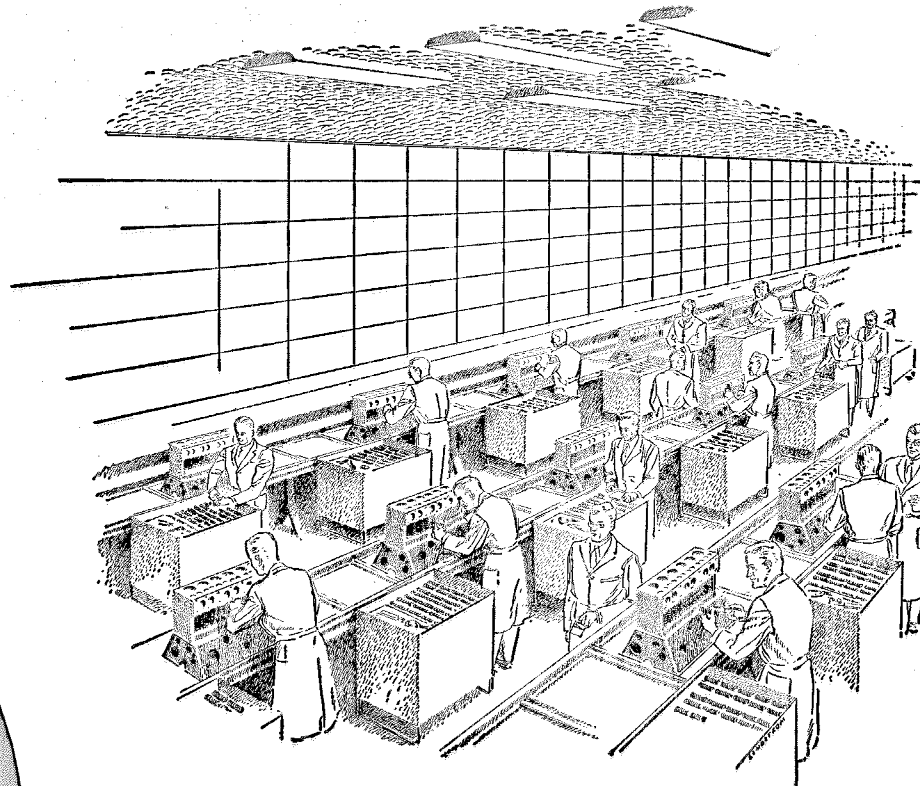
Radio noise usually rises sharply while a large spot group is crossing the solar meridian, and in addition there may be "bursts" when the intensity of emission increases by as much as a hundredfold in less than a minute. Enough bursts have been recorded almost in coincidence with flares to show that there is undoubtedly a connection between them, although all flares cannot be associated with bursts. As a general rule, the bigger flares are most likely to be associated with bursts, but the relationship is not a simple one.

Origin of Cosmic Rays

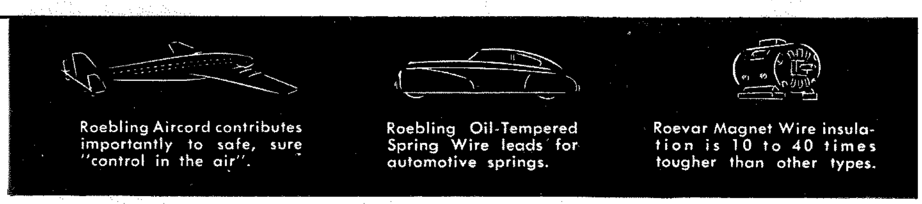
A recent theory advanced to account for cosmic rays assumes that they originate in flares in the sun or stars. Twenty years ago it was predicted that the changing magnetic field in a sunspot could accelerate charged particles up to cosmic ray energies. Three unusual increases in cosmic ray intensity have occurred, two soon after brilliant flares were observed, and a third after a radio fadeout indicating a flare. It seems scarcely credible that three such exceptional events could be the result of chance. The fact that many other brilliant flares failed to produce an increase in cosmic rays is attributed to the action of the sun's magnetic field, which prevents particles from escaping except near the poles. On very rare occasions, however, the magnetic fields of the sun and spot may combine temporarily to open up a long narrow "tunnel" through which charged particles can escape permanently from the solar surface. Calculations show that such tunnels actually existed during the three times in question. The theory still has many difficulties to meet, but it would appear that a promising lead has been obtained, at any rate.

Modern life has produced such a host of obscure and baffling ailments called neuroses, that the term has been taken over in other fields to such an extent that when an instrument performs in an erratic fashion we say jokingly that it must be "neurotic." Similarly, sunspots have been blamed for such a wide variety of disasters that befall us that they seem equally well suited as a universal scapegoat.





Better product . . . better production



WHEREVER HIGH CARBON WIRE can improve the quality of a manufactured product, Roebling wire can be adopted with complete confidence in results. Roebling is one of the world's largest producers of quality Oil-Tempered Spring Wires and Cold Rolled Spring Steels . . . furnishes wire with physical properties and finishes for almost every purpose under the sun.

But besides bettering your product, Roebling round, flat and shaped wires, bring you better production, too. Every inch of these wires is identical in gauge, grain and finish. Your machine preparation time is lowered; machine stoppages and rejects cut way down . . . Roebling research, special techniques and modern, precision equipment assure wires with definite *plus* values for every user.

THAT'S WHY...

Today it's Roebling!

JOHN A. ROEBLING'S SONS COMPANY, TRENTON 2, NEW JERSEY

Atlanta, 934 Avon Ave. ★ ***Boston,*** 51 Sleeper St. ★ ***Chicago,*** 5525 W. Roosevelt Road ★ ***Cincinnati,*** 3253 Fredonia Ave. ★ ***Cleveland,*** 701 St. Clair Ave., N. E. ★ ***Denver,*** 4801 Jackson St. ★ ***Houston,*** 6216 Navigation Blvd. ★ ***Los Angeles,*** 216 S. Alameda St. ★ ***New York,*** 19 Rector St. ★ ***Philadelphia,*** 12 S. Twelfth St. ★ ***Portland,*** 1032 N. W. 14th Ave. ★ ***San Francisco,*** 1740 Seventeenth St. ★ ***Seattle,*** 900 First Ave. S.

A CENTURY OF CONFIDENCE

THE MONTH AT CALTECH

Scholarship and the Citizen

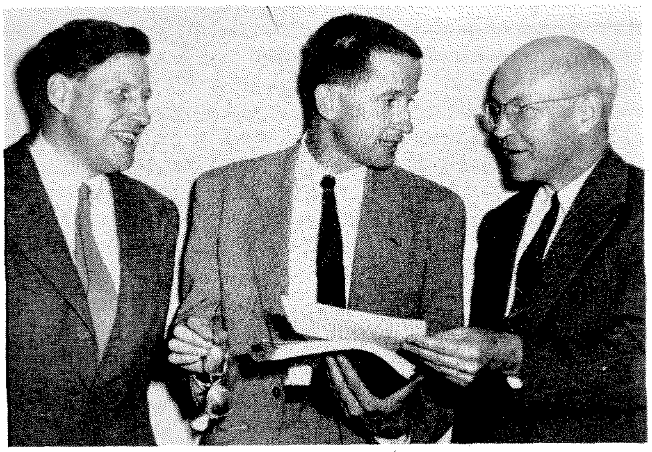
IN AN ADDRESS on "Scholarship and the Citizen," delivered at the Matriculation Day ceremonies of Pomona College in Claremont, Calif., last month President DuBridge had some pertinent and pointed remarks to make on the subjects of the hydrogen bomb and the National Science Foundation Bill. We quote:

"The atomic bomb, and now the proposed hydrogen bomb, have served to shock the American people into the realization that science and national affairs are no longer two separate and mutually exclusive fields of human endeavor. Each has its impact upon the other.

"Science affects national affairs because nuclear energy has now become the business of every American citizen. The responsibility of developing atomic energy for both peaceful and military purposes is the exclusive responsibility of the United States government—that is, of you and me. . . .

". . . When the President announced that he had issued orders to continue the development of this weapon (the hydrogen bomb), he did not provide for the release of information which would enable the public to understand something about the nature of the weapon or the reasons why it was necessary to develop it. As a result, the public press has been filled with the wildest sort of speculations, and it is impossible for the layman to determine which of the stories he reads has any resemblance to the truth. Obviously, informed public opinion cannot be built on the basis of misinformation. In a misguided attempt to keep information from potential enemies who already have it, we are keeping it from the American people who desperately need it in order to think and act clearly on urgent national and world problems.

"The second result of our secrecy hysteria has occurred more recently. For four years Congress has been considering various bills to establish a National Science Foundation to serve as an agency to stimulate the continued growth of basic science in this country. It is rather astonishing that there is no Federal agency authorized to give broad attention to the problems of basic science, and except for the important work of the Public Health Service, the attention of the Federal Government is devoted pretty largely to those areas of science having military potentialities.



At Caltech's virus conference—F. C. Bawden of England; Conference Leader Max Delbruck; Wendell M. Stanley of the University of California.

"Partly for this reason, and partly because of the great attention which has been given to the military weapons which modern science has made possible, there is apparently a feeling that all of the field of science must somehow be kept secret. As a result, when the National Science Foundation Bill finally passed the House of Representatives on March 1 there were attached to it three amendments having no relation to the purpose or function of the Foundation, and which might easily, indeed, kill the whole idea of the Foundation itself. These amendments parade under the euphonious name of "loyalty provisions" and purport to insure that all scientists connected with the Foundation are loyal citizens of the United States. Now everyone, of course, is in favor of loyalty, and consequently these amendments apparently pass without much opposition.

"The careful analysis of these amendments, however, shows that they actually stem from a misguided attempt to keep secret the work in nonsecret fields and the result of enforcing these provisions, as they are now stated, would be to impose qualifications concerning political beliefs and associations upon men working in the field of science.

"Now science has been built up on the theory that the political beliefs of the scientist have no relation to the value of his scientific work. To retain this policy is essential to the freedom of all American citizens.

"You, as students, will be especially interested in the provision that imposes political tests on students who wish to study science under a Foundation scholarship. You would normally expect that your qualifications for scholarship would depend only upon your intellectual competence and not upon the political organizations to which you belong, or to which you once belonged in the past. The original idea of the Science Foundation was that it was essential to national welfare to encourage competent young students to enter the field of science. But what student will be anxious to go into science if he knows that the first thing he must undergo is an FBI investigation, and that his opportunities for securing scholarships, and eventually a job, will depend upon, not his scientific ability, but his political beliefs and activities? Hitler excluded from the German universities those whose political beliefs were not liked. Stalin is doing the same thing. And now we in the United States of America propose to follow this same path.

"Scientists and educators throughout the country are organizing a concerted effort to have these amendments killed before the final bill is passed. They should have the united support of every thoughtful citizen."

First Virus Conference

TWENTY-TWO nationally prominent research scientists met at the Institute last month for a three-day conference covering the entire field of viruses. It was the first time scientists working on the three different groups of viruses —those which attack plants, those attacking men and animals, and those which attack bacteria (E & S, March '49; Feb. '50)—had ever formally gathered together. The conference was under the direction of Dr. Max Delbruck, Professor of Biology at the Institute, whose special field of interest is bacterial viruses.

In recent years man's bacterial diseases have been brought more and more under control by antibiotics like penicillin and streptomycin. As a result, virus diseases (like polio, influenza, Q fever, the common cold) are being pointed up; few of them are susceptible to treatment by the antibiotics.

The control of other diseases in plants has pointed up vi us diseases there too; most plants didn't use to live long enough to get them. Today the annual loss from plant and animal viruses in California alone runs to $100,000,000.

Viruses may, and do, differ enormously both physically and chemically, but—whether they attack plants, man, animals or bacteria—they have a good many features in common and show a remarkable similarity in their behavior. Thus, virus researchers—whether they work in the fields of agriculture, forestry, animal husbandry, medicine, or pure research—have a common problem. The Institute's virus conference, in recognizing this fact, is a heartening indication that we may someday find a way to launch a common attack on the virus.

Student Officers

■ THE NEWLY-ELECTED officers of the Associated Students for 1950-51 took office this month, at the start of the third term. The line-up: President, Ulrich Merten; Vice President, Oliver Gardner; Treasurer, Peter Mason; Secretary, Stanley Groner; First Representative, Robert Davis; Second Representative, Patrick Fazio Jr.; Publicity Manager, Robert Stanaway; Athletic Manager, David Hanna; Rally Commissioner, Frank Ludwig; Yell Leader, Charles Miller; Business Manager of the California TECH, Charles Steese; Editor of the California TECH, Robert Kurland; Business Manager of the BIG T, Charles Walker; and Co-Editors of the BIG T, John Boppart and Bernard Engholm.

Honors and Awards

■ DR. ALFRED H. JOY, Research Associate in Astronomy and retired Mount Wilson and Palomar Observatories astronomer, was presented the Catherine Wolfe Bruce Gold Medal for 1950 at a meeting last month of the Astronomical Society of the Pacific in San Francisco. Dr. Joy, who received the award for his outstanding work in the field of stellar spectroscopy, is the 43rd astronomer to receive the medal, and the sixth member of the Mount Wilson Staff to be so honored.

■ DR. ALFRED STERN, Lecturer in French, German and Philosophy, has been awarded the Academic Palm and the title of Officer of the Academy by the French government, for "his outstanding contributions to science, philosophy and especially to French culture."

Millikan's 82nd

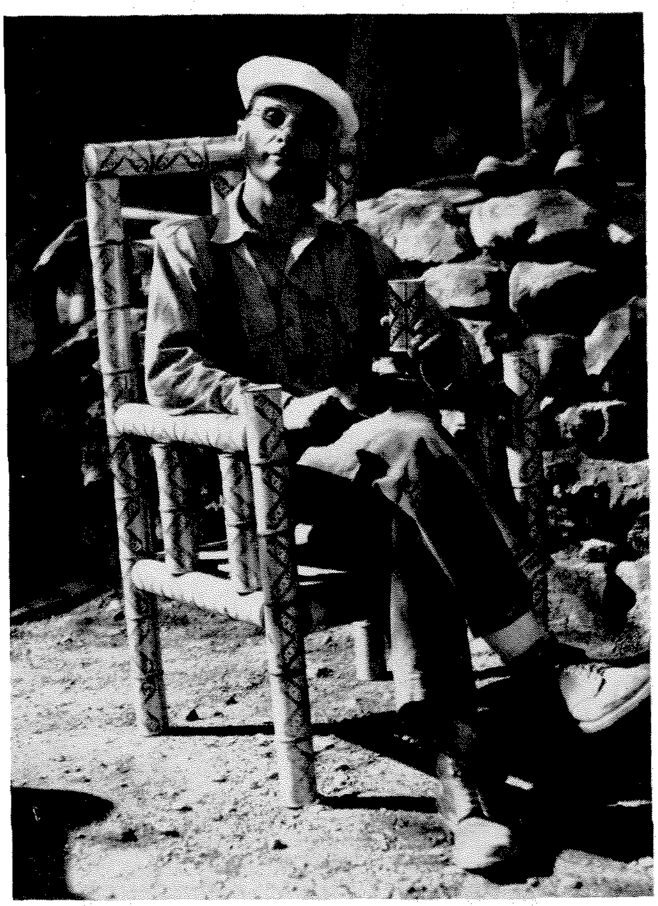
■ ON HIS 82ND birthday, March 22, Dr. R. A. Millikan, badgered by the press for his comments on the hydrogen bomb, complied with the succinct statement: "I am not yet convinced that it is at all certain we can build such a bomb." He was careful to add, however, that "we must be modest in skepticism concerning the hydrogen bomb, as the 'impossible' has been achieved before."

Dr. Millikan celebrated his birthday in typical fashion by delivering a speech before the faculty of Fresno State College—his fourth lecture in a three-day stay in Fresno—after which he flew back to Los Angeles and arrived home in time for a small birthday dinner party.

Searles Lake, one of world's great deposits of saline materials, invariably produces this reaction in geologists.

Geologists on the Ground

A report on Geology's regimented vacation known as the Annual Spring Field Trip



Dr. A. E. J. Engel, noted professor of Mineralogy, adding a much-needed air of distinction to the junket.

IF CALTECH'S HALLS of Geology seemed unaccountably silent during the recent week between the Winter and Spring terms, it was for a very good reason. No less than 64 of those souls who normally spend a large part of every day in Arms or Mudd (or in both buildings) sought relaxation from the ardors of the Winter term in the Annual Spring Field Trip, a mildly regimented vacation in the form of an excursion to points of geologic interest in California and adjacent western states. This year the group was treated to the scenic and geologic wonders of the desert country between the Sierra Nevada and Death Valley.

Early Saturday morning, March 18, the caravan of 14 student-driven automobiles took off from Pasadena and headed over the San Gabriel Mountains to the edge of the Mojave Desert near Palmdale, where the famous San Andreas fault zone was examined at close range.

The first night was spent beside a small stream in Red Rock Canyon, amid scenic vistas that would set any red-blooded travel agent scurrying frantically for adjectives. As in past years, the men camped out during the entire trip, preparing nearly all of their own meals on the ground and sleeping beneath the stars after the fashion of desert travelers of long ago. The all-important first night's camp was made without untoward incident, although a large handful of blasting caps was spotted by an alert observer and whisked from behind a bush against which an eager camper was building a sizable bonfire! Evidently left on the sand by an absent-minded prospector, the caps were detonated in a controlled but noisy manner by explosives-wise members of the entourage.

The following day's fun began with a mapping problem in a small area near the mouth of Red Rock Canyon. Having thus polished up their techniques of observation and interpretation, the geologists moved on to the volcanic ash, or "seismotite," deposits of the Old Dutch Cleanser Corporation, and thence to the old mining district of Randsburg and Johannesburg.

Past Inyokern the caravan moved through the Little Lake volcanic area into the south end of Owens Valley. Major earthquake-fault features along the Alabama Hills and the east front of the Sierra Nevada were pointed out, and the history of Owens Valley was discussed as a brisk evening wind, increasing in velocity by the minute, began to worry the more experienced campers in the group. Still playing in luck, however, trip-leader Jahns found a good roosting spot in the lee of a high fill on the Friendly Southern Pacific, and a not unpleasant night was spent on the shores of almost-dry Owens Lake.

The third day was devoted to observations of faulting along the floor of Owens Valley and of the numerous formations so beautifully exposed along the bold west front of the Inyo Mountains.

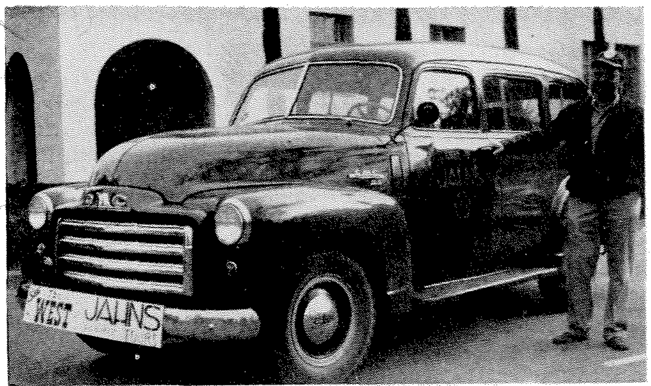
The highlight of the day, provided by the Anaconda Copper Mining Corporation, was a tour of the surface plant and some of the underground mine workings. The students were able to observe highly mineralized rock in place, alteration associated with the ore deposition, and several mining techniques in use. Many specimens were obtained from the high-grade stopes, and only dusk and the need for making camp in Darwin Wash, several miles east of the mine, stopped the more eager collectors from taking large bites from a tempting stockpile of tungsten ore.

Darwin Falls, one of the most famous watering spots of early desert days, was visited the next morning. Here a beautiful stream of water flows through a deep, nearly vertical-walled canyon and supports the growth of trees, grasses, and even ferns that are in refreshing contrast to the drab, scrawny brush on the Argus Range to the south and the Panamint Range to the east.

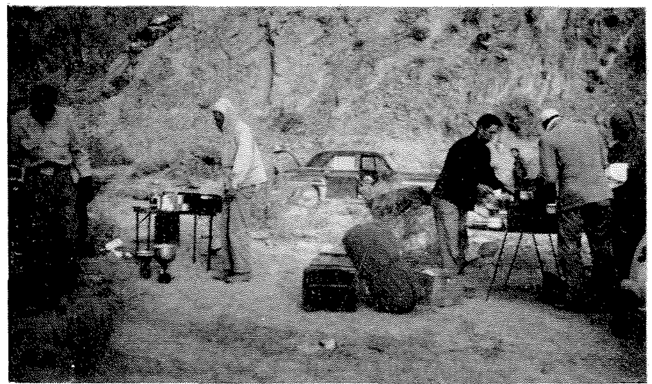
Following lunch and the customary baseball workout on the mirror-like surface of a small dry lake, or playa, the party arrived in Trona, a modern metropolis in the midst of desert wilderness. Here they were treated to a detailed tour of the gigantic $40,000,000 plant of the American Potash and Chemical Company. Later, their heads still spinning with chemical formulae and concepts of controlled fractional crystallization on a bulk production scale, all headed northward for the Valley Wells recreation center maintained by the company. A large swimming pool proved a most refreshing attraction, even for those men most likely to be classed as true desert lovers.* After a hearty meal in the company cafeteria and a pleasant evening in Trona, during the course of which a baseball game was played under the lights, the men spread their sleeping bags on the grass at Valley Wells, almost forgetting that they were "in the wilds." Whatever doubts they may have had on this score were dispelled in the morning, however, when a chummy black widow spider and several warmth-seeking scorpions were discovered in or beneath the bedrolls of certain fortunate individuals.

Several hours were spent in studying the geology of Searles Lake, a now almost dry mass of crystallized salts

*—For the benefit of the uninitiated semanticist, a desert lover is distinguished from a desert rat in that he is bathless but does not necessarily enjoy the situation.



This is Jahns, leader of the trip, at the take-off. His car, like the others, was fitted out with bumper banners urging one and all to "See the West with Jahns Scenic Tours."



This is the kind of thing Jahns led his 63 charges into—camping out "like the desert travelers of old." Above, an old-fashioned breakfast at sun-up, and thermometer-down.

and brine that is one of the world's great deposits of saline materials. Many specimens of rare evaporite minerals were collected by the happy rock hounds in the party, while others soberly discussed the probable mode of accumulation of these salts.

The caravan, now reinforced by Dr. A. E. J. Engel, Tech Professor of Mineralogy, retraced its path to the north, past Ballarat and the remnants of other once-great mining camps, to the mouth of Wildrose Canyon, where all paused to inspect the Panamint graben, a great block of ground that has been dropped many feet downward to form a broad trough along the east side of the valley. Soon the cars were on their way again, heating up steadily as they began the long pull up Wildrose Canyon.

Several vapor locks and one refreshment stop later the entire caravan was on the attractive, gently rolling upland surface of the Panamint Range. A short side trip was made to Augerreberry Point, from which 6500-foot eminence an almost unparalleled view of the Death Valley region can be obtained. Amid a crescendo of clicking camera shutters, Dr. Jahns attempted to point out the salient geologic features of this great valley area.

Following a stop in Emigrant Wash, where the students theorized on the origin of a rather strange rock formation, the party hurried down into Death Valley and pitched camp in the shelter of sand dunes and a volcanic crater. The good old wind soon sprang up, though, giving everyone a firsthand opportunity to observe the transport of solid materials by moving air. The following morning a pair of ancient spectacles, once carefully wrapped in an old newspaper, was found beside the remains of a shoe, the sole of which had been held to the uppers by means of long screws. These relics, evidently buried in the sand for many years, were not accompanied by remains of the owner.

A trip to the Corkscrew Canyon borate deposit in the Funeral Mountains followed a brief stop (for local color) at Furnace Creek Inn.

Dash for Shelter

That night, as the second sub-sea-level camp was made, a sand storm began to flex its muscles. The wind increased in velocity, and a rather difficult night was ultimately spent by all. A sandy breakfast fare was provided in the morning. Making additional stops from time to time, the caravan left Death Valley and crossed into the Amargosa Valley. As the afternoon progressed, storm clouds moved eastward and gradually spread over the entire sky. Believing completely in the intrinsic ability of all the men to stand up nicely under any adverse weather conditions, but at the same time not wishing to needlessly expose these hardy individuals to such meteorologic difficulties, Dr. Jahns decided to disband the trip half a day earlier than anticipated, and that night, amidst a torrential downpour, the students sought the shelter of their homes and dormitories back in the Pasadena area. They would not soon forget, however, the remarkable features seen, the many happy arguments of the week, and the numerous bits of good-natured horseplay that livened up the general proceedings. And, by no means least, many a man was brought once again face to face with that fundamental difference between text and diagrams in a book and the corresponding relations on the ground!

THE BEAVER

ONE SUNDAY AFTERNOON, when the Beaver had laid down the last of the Sunday funnies in the Lounge, he lit a pensive cigarette and thought dutifully about his roommate's stern admonitions to work on that eloquently tiresome report. It was very handy to have a roommate to keep you on the ball, the Beaver thought, as he meandered out into the sun-warm court. He moved on, out onto the olive walk and away from the Houses, until finally he stopped to look at a poster for the annual Drama Club play.

There were a lot of little organizations and clubs on campus that hardly ever obtruded on the attention of the majority of the undergraduates. Maybe once a year they rear their gopher heads and people hear about them — like the Drama Club.

Sometime during election week, smothered under campaign sparkle, the first poster for the Club's annual performance appeared on the advertising walk by the ME Building. But for a long time, behind the scenes, the eager stage-struck had been planning and rehearsing. Naturally curious, the Beaver went over to Culbertson to investigate. It seemed an excellent excuse not to study.

He poked his head into a strange ménage of his friends, dressed in stranger costumes—most of them disguised as the most atrocious females the Beaver had ever laid eyes on. Fascinated, he watched villain Fox twirl his insidious mustache and Malonoski fumble over a hopelessly complicated board of light switches. Shirley, the beautiful imported directress, yelled occasionally at on-stage actors; others wandered about the empty auditorium declaiming passionate speeches to silent balconies; somebody dabbled on the piano; people moved ladders around among the actors on stage; and the Beaver stood there and wondered how it was possible in less than a week to produce a play from this madness.

Still, as he sat in the audience Friday night, he saw a finished performance, and after it he stuck his head in on the cast party to hear post mortems and plans to do the play again for the public. Public acclaim is a fine intoxicant, the Beaver noted wisely.

Honors and Others

Another organization of occasional public attention was Tau Beta Pi. The Beaver saw the great gold "Bent" over Throop and knew initiations were on again. Somehow other things had played much hob with his callow freshman intentions to keep a high enough grade point for Tau Bate, and the Beaver had never been asked to join. In fact he secretly suspected he had never even been remotely considered. With a faint sigh expressive of dead ambitions, he entered his room, where his roommate greeted him with a huge smile, a pile of Tau Bate literature, and a Guess-Who-Got-Elected look in his eye. In the next couple of weeks he watched Roommate scuttle about into all the dark, basement laboratories to collect 140 signatures of members in a book touchingly entitled "Schoolday Memories"; he quietly watched him curse and sweat as he machined down and polished the rough brass casting of the Bent; he helped him memorize a lot of things and heard him muttering about secret rituals. As far as he could figure, the purpose of all this Herculean labor was simply to make Roommate appreciate the honor he had received.

The Beaver took up his blanket and sauntered out to generate vitamin D on the sun-lawn. His conception of the Tau Brains had changed: it seemed on close examination like an engineer's variety of the Masonic Order or the Elks. He darkly suspected them of possessing a secret handshake.

To the Victors

The Beaver was sure that house elections were always held a couple of weeks after ASCIT elections so the beaten candidates would still have a chance. Not as much campaigning went into them, but a lot more spirit. Election night he had put on old clothes and helped guard the Lounge doors so no candidates could leave. The air quivered with suspense and the candidates with misgivings before the evil leers of the waiting electorate. Then the results—and immediately pandemonium. The winners were overpowered in a short riot with the troops and were carted out, to the accompaniment of blood-curdling Indian yells, to a cold, wet demise across campus.

Meanwhile others went to work on their rooms. The Beaver remembered how last year the new Pope's room had been evacuated—completely; the doors, windows, sink, furniture, radiator, light fixtures, everything disappeared—and a stone bench was left in the vacant cell for the new Pope to perch on while contemplating the hard road of those who win popular favor. The Beaver smiled in diabolical remembrance, slipped the last screw out of the new V.P.'s medicine cabinet, and bore the thing off in triumph.

Prelude to Vacation

As he trudged off to his exam in the bright, hard 8:00 A.M. light, the Beaver tried to figure out how many exams he had written. He had decided this time that exams weren't worth cramming for. It was a delicious, fatalistic feeling. Anyway they frequently never tested you on what you had studied, and that just made you more bitter. There was certainly a minimum of bitterness in not studying hard the night before; so an impromptu mutual approbation society had formed over a pitcher of bock last night. Nonetheless, in the House there was a tangible air of tension, with lots of horseplay at dinner and in the Lounge. Sort of steam valve, probably. The Beaver spread his bluebook on the desk-arm in the exam room, wrote his name on it with infinite care, silently offered alms to Allah, and dreamed briefly of the sunny, beckoning beach for the vacation week.

—*Jim Hendrickson '50*

PERSONALS

1923

Donald H. Loughridge, Ph.D. '27, has been on a two-year leave of absence from the University of Washington in Seattle—where he was Professor of Physics—while serving as Scientific Advisor to the Secretary of the Army. Last month he resigned from the University, planning to stay with the Army as its Senior Scientific Advisor. He writes that he would enjoy having any Tech men look him up in the Pentagon Building—Room 3C-620.

1924

C. Harold Hopkins had an attack of coronary thrombosis in July, 1949, which caused him to resign from the Vortox Company in Claremont after 22 years. He has recently become associated with the Penn Mutual Life Insurance Company as District Representative in the Pomona Valley Territory.

1925

Masato Hirana visited the campus last month and brought us up to date on his activities. The first Japanese graduate from Caltech, he is living in Japan where he is an engineer with Nippon Hassoden, Japan, an electric generator and transmission company in Tokyo. During the war he was on General MacArthur's staff as liaison officer. He has a wife and eight children.

He came to the United States for three months this winter as a member of the Japanese power mission to the U.S.A.

1926

A. M. Ball is manager of explosives research at the Hercules Experiment Station in Wilmington, Delaware. During the war he was technical director of the Radford, Virginia, ordnance plant operated by Hercules, where he was engaged in developing rocket propellants. Now, in addition to his position with Hercules, he is consultant to the Alleghany Ballistics Laboratory.

Wayne B. Hales, Ph.D., is Professor of Physics at Brigham Young University in Provo, Utah, and was recently appointed general chairman of the Brigham Young University 75th Diamond Jubilee Anniversary Celebration for 1950-51.

He writes that when he received his Ph.D. in 1926 he had a wife and five children cheering at commencement. The five are now six—four boys and two girls. "About the boys—the oldest, Vern, is Professor of Meteorology at the University of Utah; the next, Wilson, is an M.D. at Sawtelle Hospital in Santa Monica; Richard is a third year graduate student in Physics at the University of California, Berkeley; and Robert is a sophomore at Brigham Young. The girls are happily married."

1930

J. B. Sturgess is working as a mechanical engineer with the Union Oil Co., and living in San Gabriel. Most recent addition to the Sturgess family is Jane, now 16 months old.

Roland Hodder is working for the Stanolind Oil and Gas Co. as District Geologist in the South Texas District, San Antonio. He has been in Texas since 1933, married a Texas girl, has two children (a daughter 12 and a son 8) and has "succumbed to all of the natural beauties of Texas."

O. F. Van Beveren is working in Bakersfield as Superintendent of Exploration for Standard Oil of California in the San Joaquin Valley, a position he has held since April 1949. He has worked for Standard and affiliated companies since 1933, going to Bakersfield in 1945 after foreign work in Mexico, Java, Sumatra, Arabia, and Egypt from 1937-1945. He married Miss

Agnes Toutonghi in Cairo, Egypt in 1944. They have three children—Charles Philip, 4½, Carol Ann, 3, and Jean Celeste, 1½.

1931

Lucas A. Alden, Ph.D. '35, has been named an Assistant Vice President of W. R. Grace & Co., New York, which perhaps is best known as owner of the Grace Line, but also is engaged in industrial operations and international commerce along the West Coast of South America. Mr. Alden has been with the firm since 1944 and previously was an Assistant Treasurer. He is living in Lake Success, New York, with his wife and five-year-old daughter. He returned recently from Peru, where he spent eight months in connection with W. R. Grace's extensive industrial interests.

1932

Ken Swart, M.S.'33, has lived in Whittier for the past 14 years and is now vice-president and chief engineer of the Security Engineering Co., Inc. He and his wife have two sons—one 14 and one 2.

John Leermakers is living in Rochester, New York, where he is Assistant Director of the Research Laboratory at Eastman Kodak Co. He is married and has three sons—ages 14, 12, and 6.

Fred B. Phleger, M.S., is Associate Professor of Marine Geology at Scripps Institution of Oceanography, University of California, in La Jolla.

Charles M. Harsh has been appointed Professor of Psychology at Pomona College, effective September 1. Since 1940 he has been on the staff of the Psychology Department of the University of Nebraska. He is married and has three children.

1934

Harold Holtom, M.S.'35, is Chief Engineer for Normac, Inc., Huntington Park, Calif., designers and builders of reinforced concrete houses. He recently returned from a job in northern Chile as construction engineer on a project for the Chile Exploration Co. (a subsidiary of Anaconda Copper).

1935

John Stick writes that he recently completed a three-week trip to Venezuela in connection with business (geophysics) and managed to sneak in three days on Barbados, B.W.I.—"the Riviera of the Caribbean, where the cost of living is still within-bounds."

Arthur Etz, Ex-'35, has been an engineering contractor since 1934. He is also a partner, and engineer, for an artificial lake and resort development near Los Angeles known as Munz Lakes Resort. During the next year he plans to divide his time between being engineer for a cattle ranch and continuing building development at the resort.

Lamar McMillan is still practicing medicine and surgery in Little Rock, Arkansas.

James N. Smith has lived in Laguna

Beach for the past three years, where he is a civil engineer working on subdivision work. He sent us news of *Neil M. Ruge*, Ex-'35, who visited him recently. After leaving Tech at the end of his second year, Neil went on to Stanford, U.C., and Harvard for law degrees. He served as a major in the Counter-Intelligence Corps of the Army, then joined the U.S. Foreign Service as Vice-Consul at Palermo, Italy. After a few weeks visiting around California he and his wife are leaving for his new post as Vice-Consul in Casablanca, Morocco.

1936

Robert A. McIntyre, M.S.'38, is the father of a daughter, Margot Gwen, born on February 12.

Charles Heath is Associate Professor of Engineering Materials in the Mechanical Engineering Department at Oregon State College, Corvallis. He has three children—twin girls, 6, and a boy, 4½.

John Waddell is head of the Northridge Development Co., a construction and architectural firm in the San Fernando Valley whose main activities are building-design of home and commercial structures.

Dean Wooldridge, Ph.D., has had his job title changed from Director of Electronics Research and Development to Co-Director, Research and Development Laboratories, Hughes Aircraft Co. The other Co-Director—*Simon Ramo*, also Caltech Ph.D. '36.

1937

Dean Nichols is practicing medicine in Helena, Montana. He writes that the latest job he has acquired is that of secretary-treasurer of the Lewis and Clark County Medical Society. He is also a delegate of the Society to the Montana State Medical Association. "The house of delegates of the latter body forms the policies and handles the business of the State Association, and is also a policy-making board of the Montana Physicians' Service, which is our state non-profit medical surgical insurance plan." He has a son, Peter Dean, 15 months old.

Walter L. Moore, M.S.'38, left Lockheed Aircraft Co. in 1947 to become Associate Professor of Civil Engineering in charge of hydraulics of Civil Engineering in charge of hydraulics at the University of Texas in Austin. In June he will take a leave of absence to attend the University of Iowa for a year of study toward a Ph.D. He and his wife have two daughters — ages 5 and 2½.

1938

John Farneman writes that he's still doing the same hitch, selling Weston instruments, sola transformers, Struthers-Dunn relays, "TAG" instruments and Biddle "Meggers," in continued association with Edward S. Sievers, and that he is "continually meeting Tech alumni who are invariably doing an even better job in the development of Southern California industry." The Farnemans live in Glendale, have two youngsters—8 and 4.

Robert Levit, M.S.'39, is Associate Professor of Mathematics at the University of Georgia, Athens. He was married in 1943 and has two children—Linda, 5, and Arthur, 2.

Edward Frisius writes that after more than four years on the industrial accident rolls due to "San Joaquin Valley fever" he is back at his old job with Standard Oil of Calif. as Civil Engineer in the Maintenance and Construction Division of the Producing Department—this time at the La Habra Headquarters instead of Taft.

1939

Paul Engelder, M.S.'40, is the father of three sons—the last one born on February 16. Paul is still doing research work for the Oil Well Water Locating Company of Long Beach, and spending his spare time chasing "wildcat" oil leases with the Major Play Leasing Syndicate.

Herb Strong is commanding officer of Volunteer Naval Research Reserve Unit 11-2, a group of Naval Reserve Officers who meet twice a month in Pasadena. This unit, being sponsored by the Office of Naval Research, follows basic and applied research programs of interest to the Navy.

Jack Goodell is working for the Bechtel Corp. as a mechanical engineer in their power division and doing work for the steam divisions of the Southern California Edison Co. He has three children—Bobby, 7; Johnny, 5; and Linda, 1½.

H. D. Bruce Wilson, M.S., Ph.D. '42, was associated with the International Nickel Co. from 1941 to 1946, then took up teaching, at the University of Manitoba. In a recent letter from Pretoria, South Africa, to his old cronies in the Geology Division at the Institute, he wrote: "The Wilsons have temporarily moved to a warmer climate, as I have two years leave of absence from the U. of M. to work in South Africa. I am back with International Nickel. Our stay here has been very enjoyable and Terry (3) and Wendy (9 months) are thriving in the African sunshine. My wife is also thriving with two native servants to help with the children and housework."

1940

Roswell J. Blackinton is chief chemist and a member of the board of directors of Western States Lacquer Corp. in Los

Angeles, where he has been employed since 1937.

Keith Anderson is leaving the Iowa Geological Survey some time in April to accept a position as engineering and groundwater geologist with the U. S. Bureau of Reclamation. He will start work in Salem, Oregon in the district planning office of the Bureau. His wife and two sons will join him on the west coast sometime this summer.

Robert A. Gewe is employed by the P. J. Walker Co. Builders as field engineer under *C. E. Larson* '37 superintendent, on the construction of a Research Laboratory for the Union Oil Co. at Brea, California. He has three children, Gerald, 5½, Anne, 2½, and Martha, 7 months.

Gilbert Van Dyke writes, "Now have a boy 7 years, a girl, 2½, 1 lady cat, 2 gold fish, and 1 lizard. To support this happy group, I work for Signal Oil and Gas Co. as a Production Engineer doing reservoir work."

Don Walter, M.S.'41, has written us a summary of what he's been doing since 1941. He worked at Douglas Aircraft in Power Plant Engineering until November, 1945. Then he joined Roy Marquardt at the newly formed Marquardt Aircraft, Van Nuys, and became Assistant Chief Engineer. In June 1947 he returned to Douglas, Santa Monica, to become Chief Engineer of the Testing Division (flight test of all Douglas airplanes and Research Lab at S.M.). He rejoined Marquardt Aircraft Co. in November 1948 as Chief Engineer and is now manager of engineering and manufacturing. Don was married in 1941 and has two daughters, 6 and 4.

1941

J. Vern Hales and his wife have a new son, Wayne, born November 28. He is named after Vern's father, *Wayne B. Hales*, Ph.D.'26. The Hales also have three daughters. Vern is still head of the Meteorology Dept. at the University of Utah.

Robert A. Dietrich recently became engaged to Miss Betty Mae Bradford of Los Angeles. They plan to be married in June.

1942

Paul Mader received a Ph.D. this February from the University of Illinois, having done his graduate work in Organic Chemistry. He is now working for Eastman Kodak in Rochester, N. Y., in the Color Process Development Dept.

Richard Kent, M.S., is engaged to Miss Marjorie Bevans of Washington, D. C. He is on duty in the Executive Department of the U. S. Naval Academy. The wedding is to be this month.

1943

Marcius C. Smith Jr. will be married on April 29 to Miss Ellen Frances Ellery of Monrovia.

David Elmer is a metallurgist in the Research Department of the C. F. Braun Co. in Alhambra. His first child, Douglas Alfred, was born September 26.

Donald Potts, Ph.D.'47, is an Assistant Professor of Mathematics at Northwestern University. He and his wife have one son, Richard, 15 months old, and are expecting another child in July. Don is also Associate Editor of *Track and Field News*, a monthly paper published at San Bruno, Calif.

Dwight Buettell became the father of a daughter, Christina Isabel, on October 1. The Buettells also have a son, Michael Dwight, aged 3½. Dwight is still with Douglas Aircraft in Santa Monica.

Al Grote is a structural designer with Johnson & Minasian, structural engineers, in Pasadena. He and his wife have two sons—the youngest 22 months.

Deane Morris reports the birth of his second son, Francisco Roberto (Pancho) on January 13. He is still working as an aerodynamicist at the Bell Aircraft Corp. in Niagara Falls, New York.

1944

John Gardner has been a petroleum engineer with the Arabian American Oil Co. in Saudi Arabia since November 1946. At present he's attending a reservoir engineering course given at Houston, Texas, by the Humble Oil & Refining Co. He will return to Arabia this month.

John Zivic was recently transferred from the Naval Ordnance Test Station, Pasadena Annex, to the N.O.T.S., China Lake, Calif. as head of the rocket design branch.

1945

Merle Waugh received his M.S. in Aeronautics from Stanford and since then has been working at Ames Aeronautical Laboratory, Moffett Field, in dynamic stability research in the Flight Research Section. He writes that he is still a bachelor and spends most of his free time skiing or at the beach.

Warren H. Parker Jr. and his wife are living in Billings, Montana, where he is working as an electrical engineer for the Bureau of Reclamation. He was transferred there from the Phoenix office of the Bureau of Reclamation on March 1.

Bob Scapple was graduated from Stanford last December with an Engineers degree in Metallurgy. He is now working in the laboratory at the Axelson Manufacturing Co. in Los Angeles where *Ed Green* '31 is Chief Metallurgist.

Melvin Wilson has been with the Southern Pacific Co. since August 1949 as a container engineer. He is living in Los Angeles but his work takes him over the southwest. He'd like to know if there are any other alumni working for the railroad.

1946

Robert A. Golding was married on March 3 to Miss Margaret Weiland in Long Beach. They will live in Long Beach at 414 Obispo Ave. Bob is finishing his graduate work at the University of Southern California.

Frederick Essig and his wife have a second son, Stephen Dana, born March 11. Fred has been working toward an M.S. in Physics at USC. This spring and summer he is working at USNAMTC, Point Mugu, Calif. in the Instrumentation Laboratory. In the fall he intends to enroll again at USC and finish up the requirements for the Masters degree.

Robert Frohman has had a busy time since graduation. He worked for six months at the Hughes Aircraft Co. in Culver City and then in Jan. 1947 left for Europe and matriculated at the University of Paris in March where he studied math., history, and literature. In March 1948 he worked for the U. S. government in the European area and traveled in Luxemburg and Belgium, and parts of France and Holland. In October 1948 he was released from his government job to matriculate at the University of Brussels to study philosophy. In November he married a Belgian girl and returned to the United States in May 1949. He has been a research assistant here at Tech since October.

Jay Stuart, M.S.'48, is also back on campus—working for his A.E. degree in Aeronautics on a Scholarship from Douglas Aircraft. He has been employed by Douglas, El Segundo, since 1946.

Howard Jessen is working for Ceco Steel Products Corp. in Omaha, Nebraska, in the structural design department. He has recently taken on duties in estimating and sales.

J. P. Calligeros completed two years with the Arabia-America Oil Co. last fall and went on a vacation through Iraq, Lebanon, Turkey, Greece, Italy, and France. Then he arrived in New York and drove to Los Angeles, where he was married on November 26 to Miss Jae Howard. At present they are living in Saudi Arabia where he is employed as a petroleum engineer with the same company.

George Meixner is a lecturer in Civil Engineering at the University of California, Berkeley. His first child, Sharon Lee, was born November 7.

1947

Charles B. Shaw, Jr., was married to Miss Marilyn Baron on March 19 at the Town House in Los Angeles. They will live in Chicago where Charles is taking his Ph.D. work at the University of Chicago.

Donald Granicher was married December 27 in Dalton, Ohio, to Miss Elizabeth Marker. He is working as a Process Engineer for the Stearns-Roger Manufacturing Company.

Graham Horine is an engineer for Sandberg-Serrell Corporation in Pasadena. He lives in Whittier.

David Opperman has been working as a meteorology instructor for the Air Force at Chanute Field, Illinois, since December, 1948. He recently became engaged to Miss Barbara Rowley of Manitowoc, Wisconsin.

1948

Tom Waters, M.S.'49, is working with Quinton Engineers, Ltd., Los Angeles. He writes that he is still single, "though trying to avoid being a hermit! Fortunately a number of my classmates in C.E. are in this area, and we get together quite often."

Niels Beck is the proud parent of a son, Paul Johannes, born January 24. Niels is employed as a research engineer by the General Motors Research Laboratories in Detroit.

R. L. Winchester is in his second year, "B" course, of the General Electric Advanced Engineering Program. He'll complete the third year before taking a permanent engineering assignment.

Thomas Stix is engaged to Miss Hazel Sherwin of New York City and plans to be married in June. He is studying for a Ph.D. in Physics at Princeton. In 1949 he was one of the six scientists on the U.S.S. Norton Sound in an experimental investigation of cosmic rays in the Pacific.

John Hedenberg is working at Hughes Aircraft Co. in the Department of Electronics and Guided Missiles. He and his wife and their two boys (one 4 years old, one 20 months), are living in Van Nuys.

Thomas Hamilton is a chemical engineer with the Texas Co. in Wilmington, Calif. He and his wife have a daughter, Sally Louise, who was born last July.

Martin Hybertsen is employed as Production Engineer for the California Portland Cement Co. His second child, Eric, was born last September.

1949

Jarvin Heiman is a Graduate Teaching Assistant in the Physics Dept. at Washington University in St. Louis, where he is working for his Masters Degree.

Robert Willard, M.S., at the beginning of this year formed the Willard Engineering Co. at 1206 South Maple Avenue, Los Angeles. The company was organized to provide mechancial engineering service and sell technical equipment.

CALTECH ALUMNI

You, Your Family and Your Guests are cordially invited—by 34 Tech alumni at Inyokern—to attend a field day at the Inyokern Naval Ordnance Test Station on Armed Services Day,

Saturday, May 20

THE PROGRAM

In the morning—Rocket-Firing
Air Parade

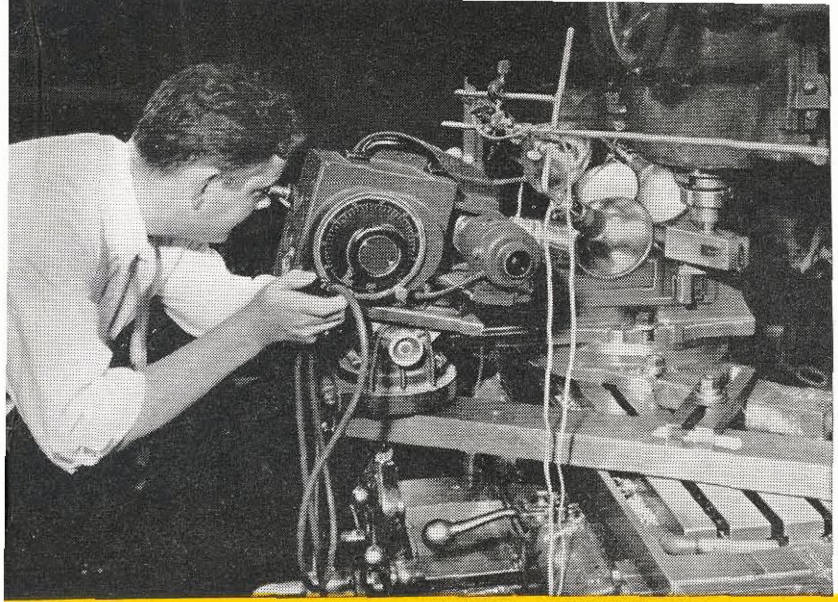
After lunch—Laboratory Exhibits
Rocket Movies

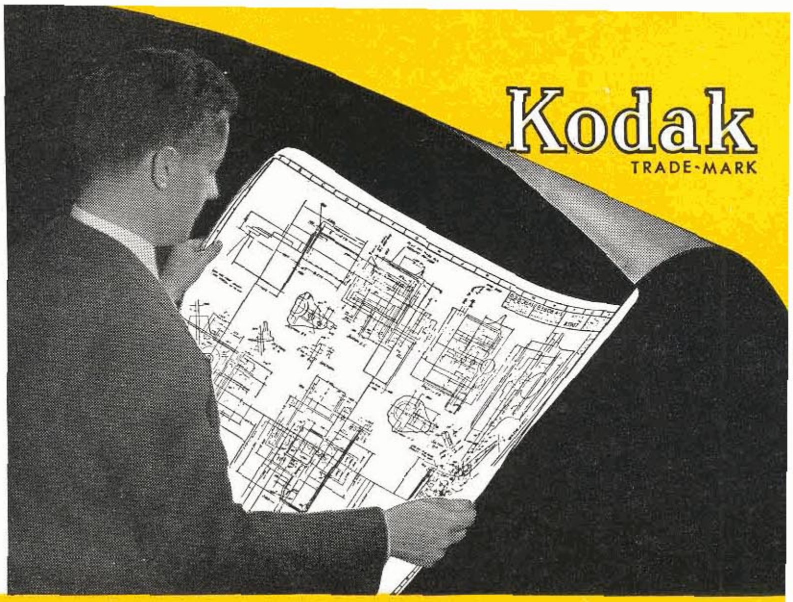
At 4 P.M.—Picnic at Sandquist Spa with music, coffee, beer and pop

(Note: Bring your own picnic)

Remember the Day—May 20

The Alumni Association will mail you, later this month, detailed information concerning reservations, routes, etc.





IT HELPS IMPROVE PRODUCTS—High speed movies provide a record of motion far too fast to see. With the Kodak High Speed Camera, a second becomes three minutes, so you can see and analyze rapid movement—spot faulty action and points of excessive wear—see ways to make a better product.

IT COPIES DATA IN SECONDS—Engineering drawings, shop orders, specifications, records, and letters of all kinds can be copied fast, and with utmost accuracy. Photocopying with Kodagraph Papers, Cloths, and Film saves time, protects originals from wear and tear—even permits producing clean, legible copies from faded or worn material.

How photography's *Lightning Speed* works for business

HERE YOU SEE a few examples of how the speed of photography serves industry. In addition, its accuracy is used in copying drawings, documents, and data of all kinds. Its ability to reduce can put records on microfilm and save 98% of filing space.

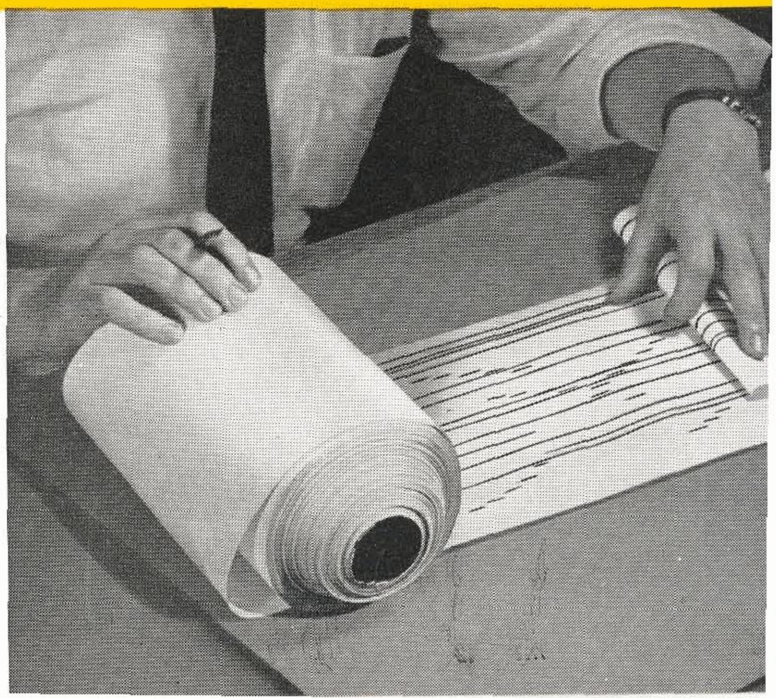
These and the other unique qualities of photography are helping cut costs, improve products, speed production, and stimulate sales. If you would like to know more about how it could serve you, write for literature or for specific information which may be helpful to you. Eastman Kodak Company, Rochester 4, N. Y.

FUNCTIONAL PHOTOGRAPHY

—serves industrial, commercial, scientific progress

IT ANALYZES CHEMICALS IN A FLASH—Spectrography with Kodak Spectrum Analysis Film and Plates quickly determines the composition of almost all materials. It provides a means to make frequent production-line analyses. It can maintain a check on specifications and speed up output.

IT RECORDS THE FLICK OF INSTRUMENTS—*The swift swing of the* galvanometer mirror or cathode-ray tube beam is not too fast for photography. Readings of these instruments are quickly recorded on Kodak Linagraph Films and Papers so that they can be studied and full advantage taken of the facts that they reveal.



Public Opinion—
NOTHING IS STRONGER
...given the facts
NOTHING IS WISER

POSTMASTER: Return postage guaranteed.

Mr. Thomas V. Davis
9107 Fortuna Drive
Mercer Island, Washingt

A

On the Owners of Business

A "community" estimated at some 14,000,000 people owns American business. The Bell Telephone system is owned by 940,000 stockholders. General Motors is owned by 436,000. Pennsylvania Railroad by more than 202,000.

* * *

There are more stockholders in the U. S. than there are farmers. More than the membership of the CIO. More than the membership of the A.F.L. Certainly stockholders are no "privileged few."

* * *

67,000 more stockholders now have a share in General Electric's ownership than 15 years ago. There are 80,000 more owners of General Electric than there are employees. Today's total of stockholders is over 250,000. Of these, more than 215,000 are individuals.

65,000 General Electric employees are participating in a plan which encourages savings. Investment in U. S. Savings Bonds gives them a bonus of G-E stock for bonds held five years.

* * *

Compared with the boom year of 1929, American businesses have collectively increased their payments to their stockholders by 45%, and their tax payments to government by 678%.

* * *

Anything that injures the owners of business directly injures 14 million people. It destroys the provisions that they have tried to make through their own efforts for security. Anything that injures the security of these 14 million people also injures the security of those who rely on invested capital for the tools and jobs they need to make a living.

You can put your confidence in—

GENERAL ELECTRIC