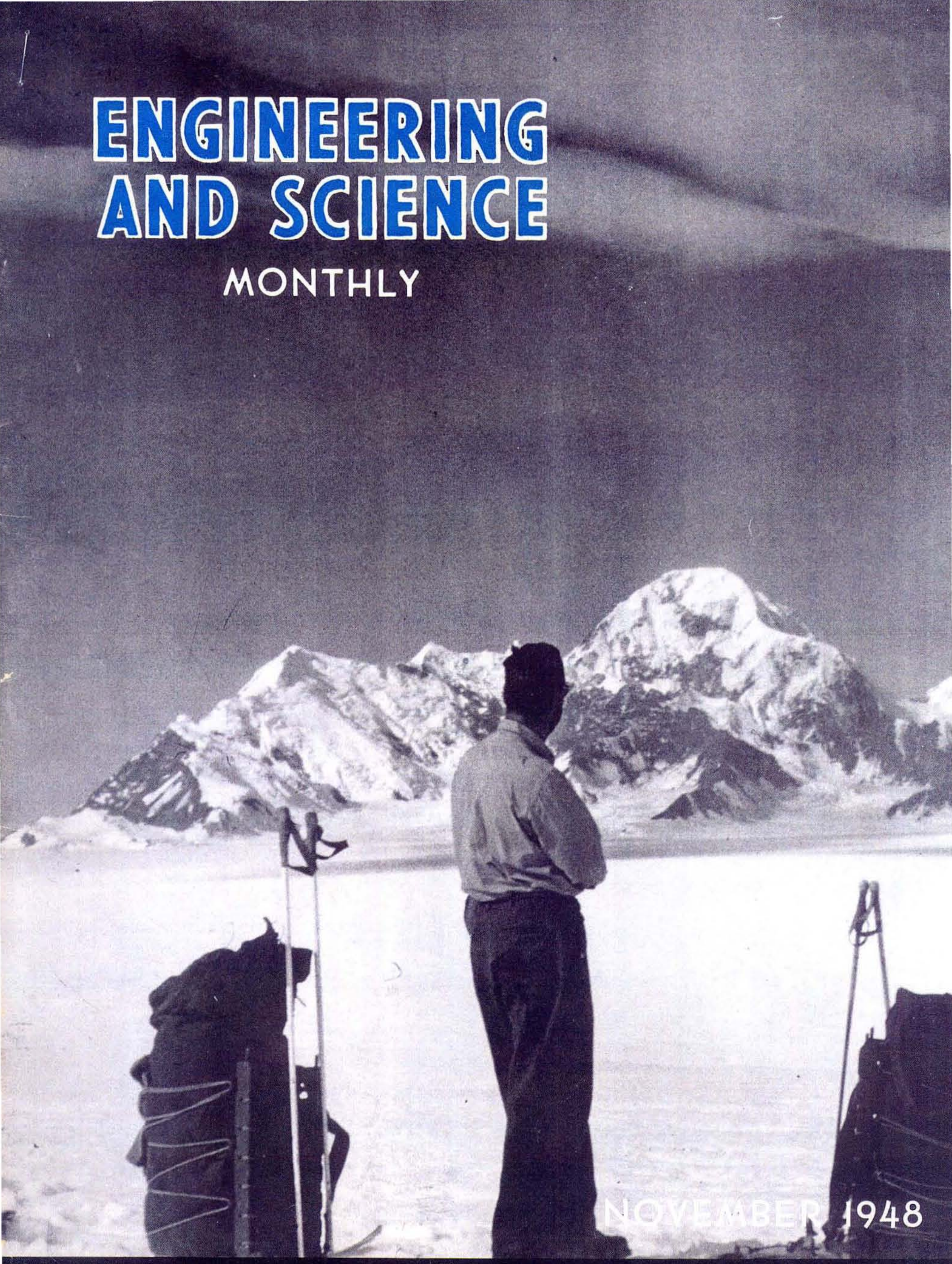
ENGINEERING AND SCIENCE

MONTHLY



NOVEMBER 1948

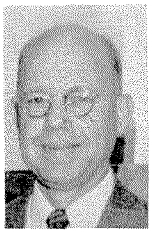
PUBLISHED BY CALIFORNIA INSTITUTE OF TECHNOLOGY ALUMNI ASSOCIATION

HAIL C. I. T.

Words and Music by
MANTON M. BARNES '21.

IN THIS ISSUE

A non-alumnus is responsible for the publication of Hail C.I.T. (across the page) in this issue of E & S. By some devious means this gentleman had crashed the gate at a recent alumni function and was quietly playing the piano when the crowd bore down on him and called for Hail C.I.T. The pianist was agreeable enough, but asked for a copy of the sheet music. This proved to be an impossible request, and, while the pianist learned to play the song by ear, the search he started went on for several days. Not only did it not turn up a copy of Hail C.I.T. on the premises; it revealed that there were precious few copies of the song in print. E & S herewith does its bit to put it back in circulation again.



Hail C.I.T. was written in the fall of 1919 by Manton Barnes, '21. "I was starting my junior year," says Barnes," after the war-time interruption of my education at Caltech—then still known as Throop College of Technology. The college hymn in use at that time had the melody of an eastern college hymn with words applicable to Throop. There were about four verses, as I recall, and the big punch lines went something like this:

'. . . and give a cheer for Throop
We will cheer our alma mater
With a vim and with a whoop!'

"It was impossible to feel anything but embarrassment or amusement as we sang those words. We needed a song that had dignity and one that was our own.

"To explain my temerity in thinking that perhaps I could fill that need, I may say that I had had a good deal of training in music throughout my childhood and youth, had played professionally for several years, and had been with a show troupe in France during part of my time in the army. In 1919, when this song was written, I was playing with Paul Whiteman's band as well as with others, to pay my college expenses.

(Continued on page 2)

ON THE COVER

That's George Rigsby, '48, one of the four-man Caltech glaciological team whose summer work in Alaska is described in **Project Snow Cornice** on page 6. Enroute from one camp to another, with skis and backpack, George is looking ahead to Mt. Augusta, one of the imposing markers of the Canadian-Alaskan border. Bob Sharp took the picture. He also took those on pages 6-10, except that at the top of page 7, which is Beach Leighton's. Other picture credits in this issue:

p. 3, 4 (top & center), 5, (top)—M. H. Montgomery
p.4 (bottom)—Ralph Lovberg
pps. 11-13—Ralph Ernst

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Monthly

The Truth Shall Make You Free

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ENGINEERING AND SCIENCE MONTHLY

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IN THIS ISSUE--cont.

"I had done a little original composition, but not much, and I was surprised at how quickly and easily the music came to me, once I felt the urgent desire to create it. I was then living in the one dormitory on the campus, in the middle of an orange grove, some 250 feet east of Throop Hall. All that I can remember is that I sat down in my room with my guitar and a pencil and paper and the melody came without any difficulty. The words also, except for one elusive line which would not come out right for a week or two longer.

"I limited the song to one verse because a college hymn is usually sung after an assembly or football game when people are eager to be on their way. A solemn mood I felt should not be sustained too long.

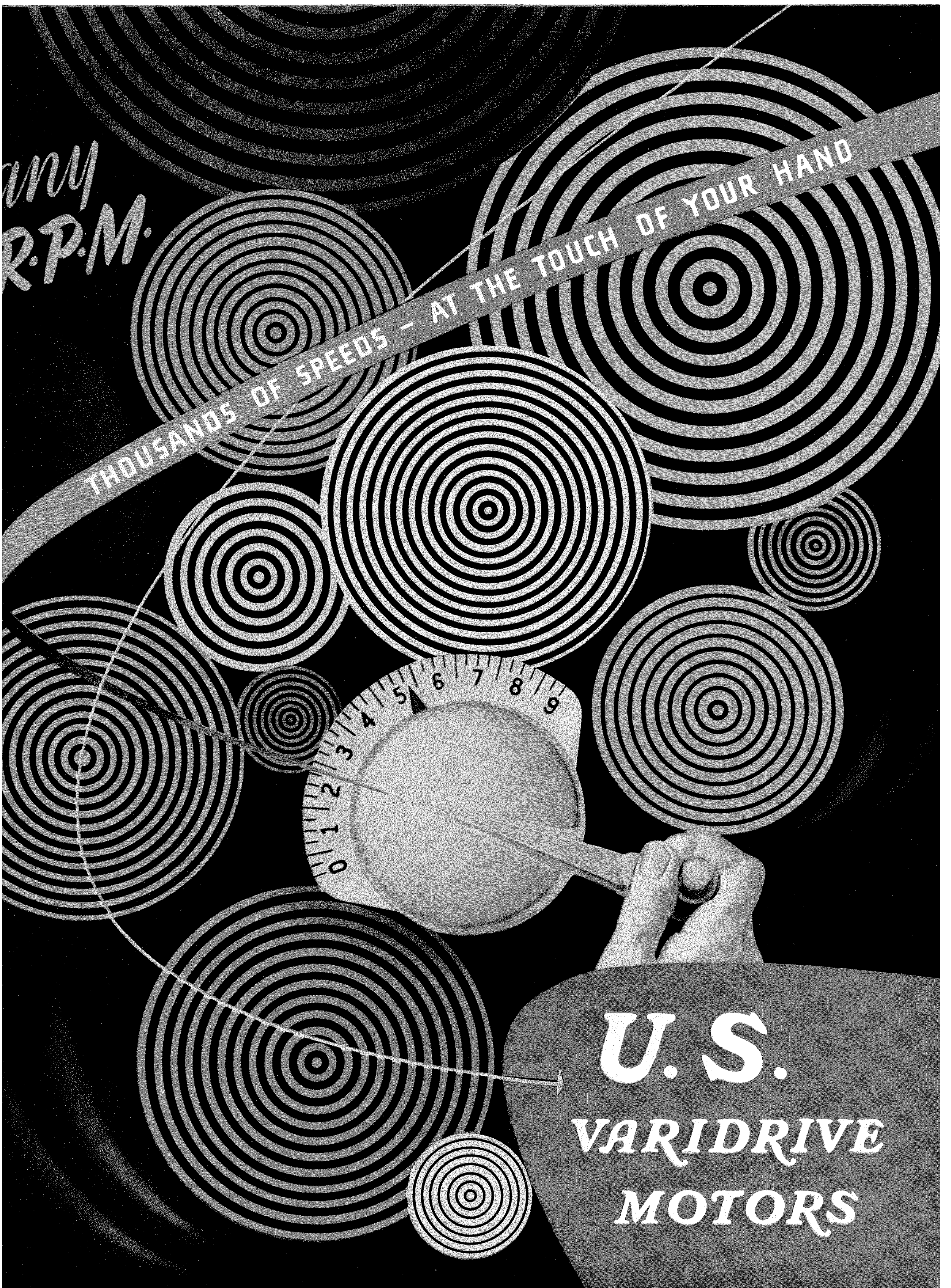
"After putting the song together I tried it out on several music-conscious friends. They liked it, and so I had it arranged and copies printed. It was then introduced to the student body at a banquet held after the last football game of the season. The glee club sang it beautifully and all present seemed to be enthusiastic about it, including Dr. Shearer who was then president.

"The song is copyrighted under the title 'Hail T.C.T.' Obviously it was a simple matter to substitute C.I.T. the following year when the name of the institution was changed. I wrote 'Fight Men of California Tech' after the change in name was made.

"I have been connected with the telephone business since graduating in 1921. At present I am a staff engineer in the Chief Engineer's group of the Pacific Telephone and Telegraph Company in San Francisco. I have two sons, one of whom is now a senior at Caltech. The other son's talents run toward music and he plans to follow it in some form after he graduates from college.

"Music is still my hobby and I enjoy the radio-phonographs I have made, which I try to keep up to the standard of the best as new developments are made in sound reproduction. In place of the more familiar stag sessions of poker, I play often with a group of men, who, like myself, find pleasure and relaxation in 'a little night music.' Lest anyone think we take ourselves seriously, playing our corny old popular songs, we call ourselves the Haywire Orchestra. For listening I rely chiefly upon my record collection and the best radio programs—symphony orchestra concerts being my favorites."

(Continued on page 19)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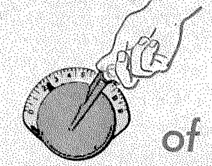
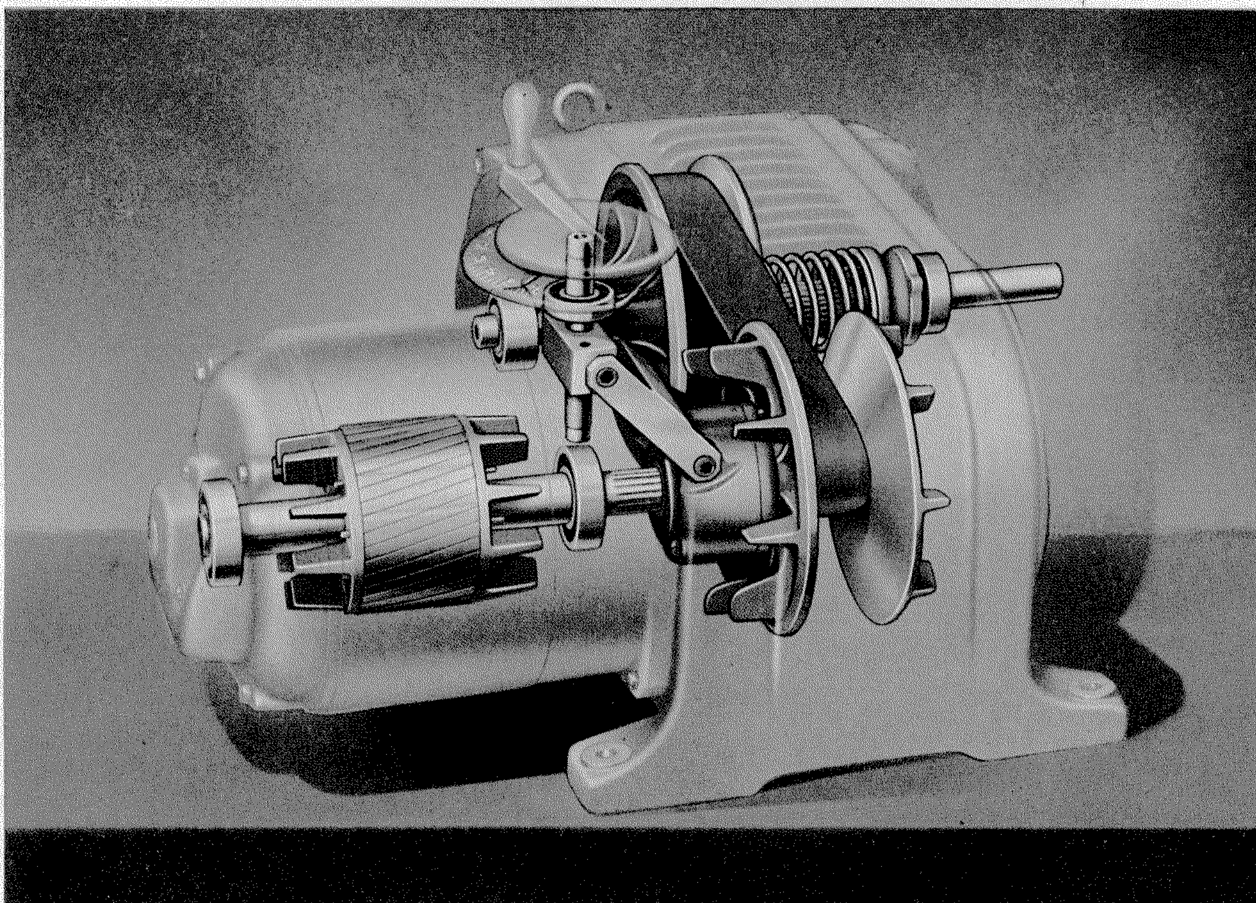
At the command  of your hand

ANY SPEED—ANY TIME—WITH ANY LOAD



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ENGINEERING AND SCIENCE
Monthly
Vol. XII, No. 2 November, 1948

"FOR OUTSTANDING SERVICES - - -"

ON OCTOBER 4, at a special Convocation of the Caltech faculty, student body, members of the Institute Board of Trustees, Associates, and friends, five Institute scientists received the Medal for Merit, the highest civilian award for outstanding contributions to the war effort.

Medals were presented to Dr. Lee A. DuBridge, Institute President; Dr. William A. Fowler, Professor of Physics; Dr. Max Mason, Research Associate; Dr. Linus Pauling, Chairman of the Division of Chemistry and Chemical Engineering, and president-elect of the American Chemical Society; and Dr. Bruce H. Sage, Professor of Chemical Engineering.

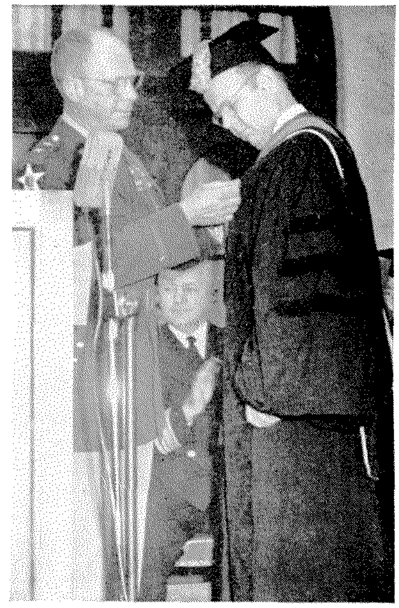
The ceremony was held in Dabney Garden with James R. Page, chairman of the Caltech Board of Trustees, presiding. The medals were presented jointly by Maj. Gen. W. M. Robertson, deputy commanding officer of the Sixth Army, and Rear Admiral Bernhard H. Bieri, USN, commandant, Eleventh Naval District.

The awards, and the individual citations:

DR. LEE ALVIN DUBRIDGE

For exceptionally meritorious conduct in the performance of outstanding services to the United States from November, 1940 to January, 1946, as Director of the Radiation Laboratory at the Massachusetts Institute of Technology, and as a member of Division 14 and of Division 15 of the National Defense Research Committee. As head of the small group of enthusiastic young scientists gathered together to form the Radiation Laboratory in the fall of 1940, his extraordinary ability to win the confidence and support of his colleagues and his far-sighted wisdom were responsible for the creation of a smoothly working team that grew to include almost four thousand persons. Under his capable guidance the Laboratory pushed the development of microwave radar forward with almost incredible speed, resulting in quantity production of a host of radar equipments used to telling advantage by our armed forces and those of our Allies. He encouraged the formation of civilian field agencies for direct assistance to the armed services in combat theaters, and gave effective support to their efforts by supplying Laboratory personnel and facilities. Through his unusual gifts as a scientist and as a leader of men, and his selfness devotion to the critical tasks at hand, Dr. DuBridge made a unique contribution to the war effort.

DR. WILLIAM ALFRED FOWLER

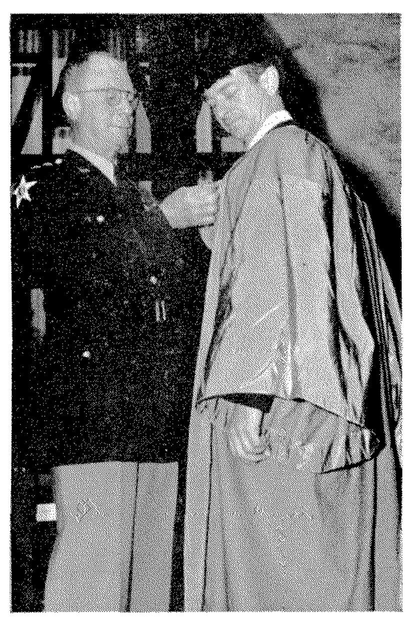


For exceptionally meritorious conduct in the performance of outstanding services to the United States from October, 1940 to December, 1945. Dr. Fowler served first as Consultant to the Division of Rocket Ordnance of the National Defense Research Committee, OSRD, and later as Assistant Director of Section L, the larger of the two sections of that Division. The Chief and members of the Division depended to a large extent upon his wise counsel in outlining their program of rocket research and development. As a leader of the large group of investigators on the Pacific Coast who were working closely with the Navy, he contributed materially to the development of anti-submarine rockets, barrage rockets for amphibious warfare, high velocity aircraft rockets, anti-aircraft rockets, as well as a number of other powerful weapons, all of which were produced in quantity in time to be put into effective use in practically every theater of operations. In the spring of 1944, he made a trip through the South and Southwestern Pacific Theaters, where he consulted at length with groups already using rockets. As a result of his talks he sent back to the group in California many suggestions for improvements and new developments which intensified the research on rocket problems, and wherever he went he was able to give valuable advice to the troops concerning the most effective use of rockets. . . . When the war ended and much of the responsibility for rocket development was transferred to the Naval Ordnance Test Station at Inyokern, California, Dr. Fowler . . . gave extremely valuable assistance to the Navy, helping to get the Research and Development Department in operation.

DR. MAX MASON

For exceptionally meritorious conduct in the performance of outstanding services to the United States from June, 1941 to December, 1945. Dr. Mason, as a member of the Division of Sub-Surface Warfare of the National Defense Research Committee, OSRD, from June, 1941 to May, 1944, played a most important role in the formation of the research program of that Division. Moreover, from September, 1941 to December, 1945, he was the directing head of a project devoted to a study of the underwater behavior of bombs, torpedoes and depth charges. This investigation, which was the subject of a contract between the OSRD and the California Institute of Technology, yielded a vast amount of information which was essential to the successful prosecution of the work of both the Division of Sub-Surface Warfare and the Division of Rocket Ordnance. Dr. Mason established facilities for this important study at Morris Dam, near Pasadena, and devised instrumentation which gave an accurate record of underwater trajectory and speed of descent of experimental rockets, bombs, and torpedoes, and also of the arming depth and impact functioning of the fuzes being tested. He also developed the devices for dropping or launching the various types of projectiles under study. His work led directly to improvements in the design of . . . antisubmarine weapons. Later he established a second laboratory at the Institute for a study of . . . small scale models of such weapons . . . and evolved a fundamental theory which brought the basic concepts of small-scale modeling into a more serviceable relationship with full-scale performance . . .

DR. LINUS CARL PAULING



For exceptionally meritorious conduct in the performance of outstanding services to the United States from October, 1940 to June, 1946. Professor Pauling, distinguished in chemistry and physics, as section and division member of the Explosives Division, consultant of the Divisions on Chemistry and on Rockets, member of the Consultant Panel of the Committee on Medical Research, and Chairman of an ad hoc Committee on Internal Ballistics of the National Defense Research Committee, turned his imaginative mind to research on military problems with brilliant success. His chromatographic method of analysis is used wherever investigations of rocket powder are under way. His studies of stability and surveillance methods were helpful in all powder developments. He led the way to an oxygen deficiency indicator for submarines and aircraft; and carried out important work on a substitute for human serum. His proposal for the use of rate control strands made the castable double base powder program more effective and widened the field of application. His contributions in the field of medical research and of explosives, among other contributions to the war effort, were brilliant. Professor Pauling's aid and advice made possible many of the war achievements in new materials and instruments required by the Armed Forces.

DR. BRUCE HORNBROOK SAGE

For exceptionally meritorious conduct in the performance of outstanding services to the United States from 1941 to 1946. Dr. Sage, as a Consultant to the Division of Rocket Ordnance of the National Defense Research Committee, OSRD, and later as a key investigator and supervisor of the Propellant and Interior Ballistics Section of the Pacific Coast rocket research group, played a most vital and important role in the development of rockets for military purposes. He contributed immeasurably to the solution of the basic problem on which all further development in the rocket program depended: that of devising apparatus and techniques for the dry extrusion of ballistite for rocket propellant grains. A satisfactory means of producing this rocket fuel in quantity was essential both to the continuance of the investigative program and to the production of rockets for use in combat. He and his staff designed a suitable press and pilot plant for the production of rocket propellant and supervised its construction, the procurement of equipment for it, and its operation through an adequate trial period. Mass production of the propellant was achieved in time to permit various types of rockets to become standard equipment with our fighting forces, and to contribute materially to the shortening of the war. When the transfer of much of the responsibility for rocket development was made to the Naval Ordnance Test Station, Inyokern, California, Dr. Sage continued to devote much of his time, through the summer of 1946, to the work there . . . to assist in establishing the program of investigations in the field of interior ballistics.

FURTHER HONORS FOR CALTECH

OF THE THOUSANDS of scientists who worked under the auspices of the Office of Scientific Research and Development during the war, only 65 throughout the country have been chosen to receive the Medal for Merit. The five medals presented at the Institute last month make a total of nine Medal for Merit awards to go to Caltech scientists. Those who received the award previously are Dr. Theodore von Karman, Professor of Aeronuatics, director of the Daniel Guggenheim Laboratory, and Scientific Advisor to the U. S. Air Forces; Dr. Charles C. Lauritsen, Professor of Physics and director of the war-time rocket project at Caltech; the late Dr. Richard Chace Tolman, member of the National Defense Research Committee, and advisor to the government on atomic energy; and Dr. H. P. Robertson, Professor of Mathematical Physics.

At another ceremony last month, at the University of California in Los Angeles, 26 scientists received the Presidential Certificate of Merit, while 48 were awarded the War-Navy Certificate of Appreciation.

The Caltech scientists who received these awards:

PRESIDENTIAL CERTIFICATE OF MERIT

Dr. Carl David Anderson, Professor of Physics
Dr. Ira Sprague Bowen, Director, Mt. Wilson Observatory
Dr. Leverett Davis, Jr., Asst. Professor of Physics
Dr. William Noble Lacey, Professor of Chemical Engineering; Dean of Graduate studies.
Dr. Thomas Lauritsen, Professor of Physics
Dr. Frederick Charles Lindvall, Professor of Electrical and Mechanical Engineering; Chairman, Div. Civil & Mech. Engineering & Aeronautics
Dr. Henry Victor Neher, Professor of Physics.
Dr. Carl C. Niemann, Professor of Organic Chemistry
Dr. Ernest Charles Watson, Professor of Physics; Dean of Faculty; Chairman, Div. Physics, Astrophysics, Math., and Electrical Engineering
Dr. Don M. Yost, Professor of Inorganic Chemistry

WAR-NAVY CERTIFICATE

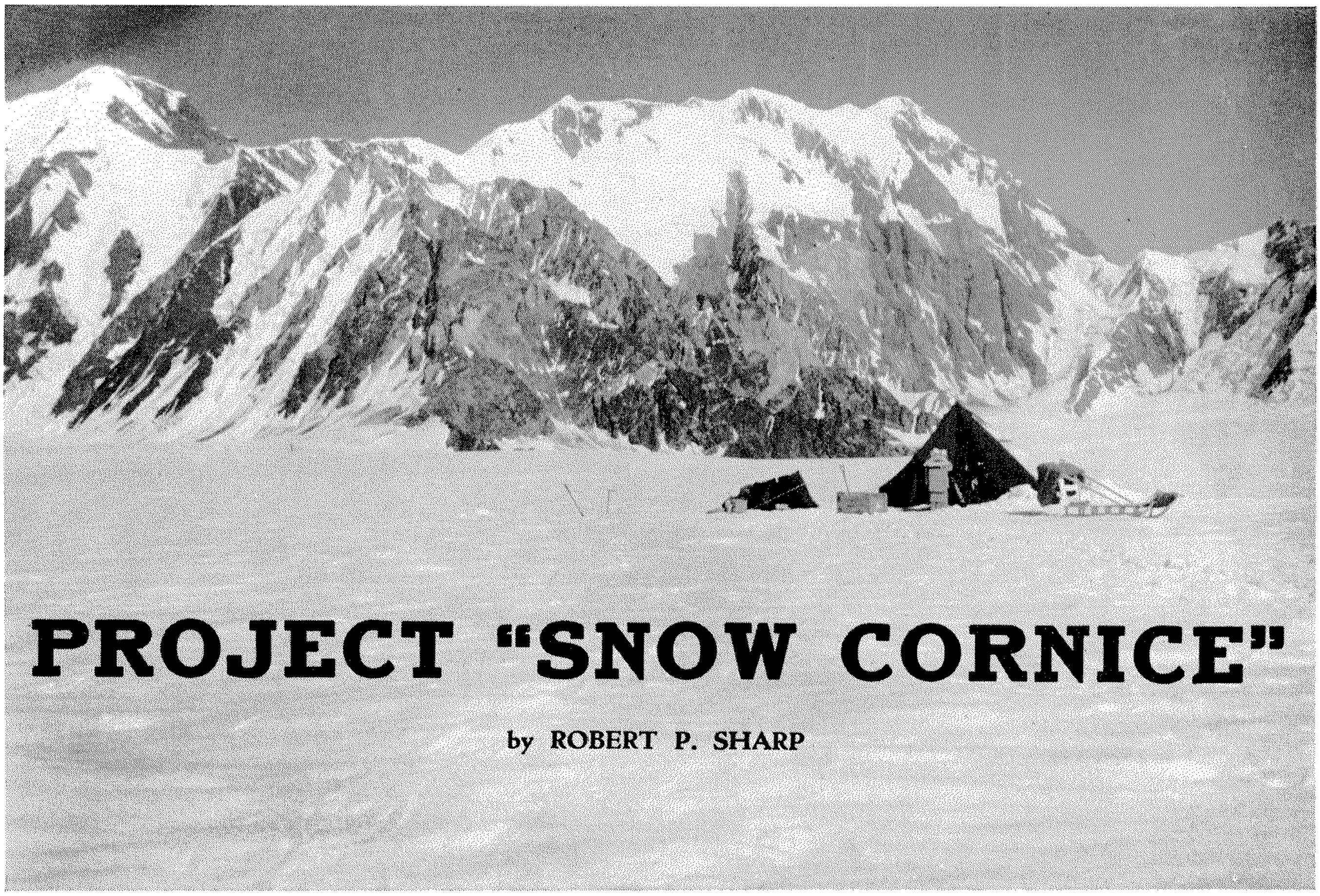
Dr. Horace W. Babcock, Research Associate, Mt. Wilson Observatory
Dr. Ralph E. Byrne, Jr., former Associate Professor of Applied Mechanics (Posthumous Award)
Dr. Robert B. Corey, Research Associate, Structural Chemistry
Dr. Robert T. Knapp, Associate Professor of Hydraulics Engineering; Director, Hydrodynamics Lab.
Dr. Joseph B. Koepfli, Research Associate in Chemistry
Dr. Paul E. Lloyd, Department of Physics
Dr. William R. Smythe, Professor of Physics
Dr. Royal W. Sorensen, Professor of Electrical Engineering
Dr. James H. Sturdivant, Professor of Chemistry
Mr. Charles H. Wilts, Asst. Prof. of Applied Mechanics.

Robertson

von Karman

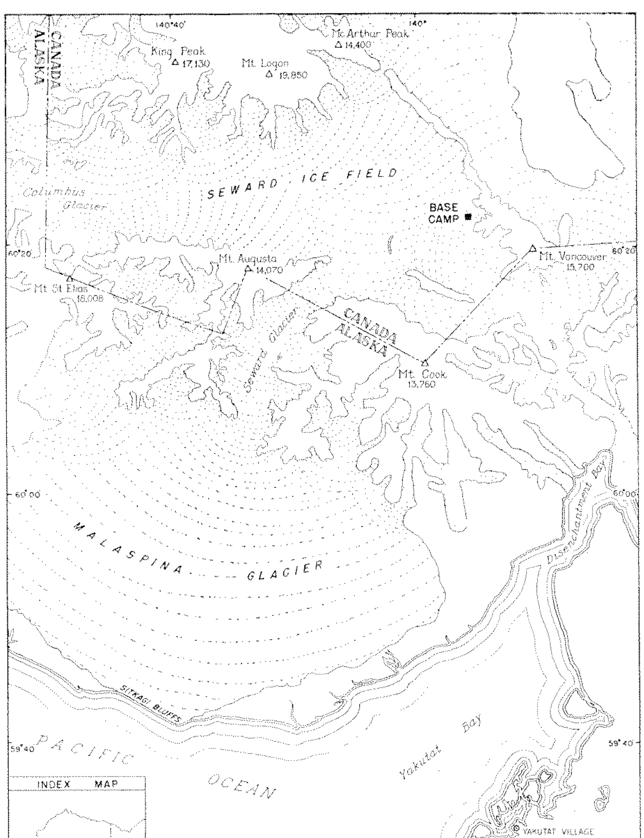
Tolman

Lauritsen



PROJECT "SNOW CORNICE"

by ROBERT P. SHARP



Caltech's four-man glaciological team cut a pretty wide swath.

Why study glaciers? Here's the answer

THE NEWS COMING IN through our small S P F radio transceiver as we cooked supper in a tent on the vast Seward Ice Field was not good. Definitely not good. It was the 15th of August. On the 27th, we had planned to fly 70 miles south to Yakutat, on the coast of Alaska, and thence 30 miles west to a beach near Sitkagi Bluffs, for further work on the Malaspina Glacier. But now the voice coming through the earphones reported in a jocular, almost light-hearted fashion, that the expedition plane, a red Noordyn Norseman, lay on its back in the middle of the Seward Ice Field—with its ski-wheels extended to the sky, its propeller bent, wing struts broken, and rudder crumpled.

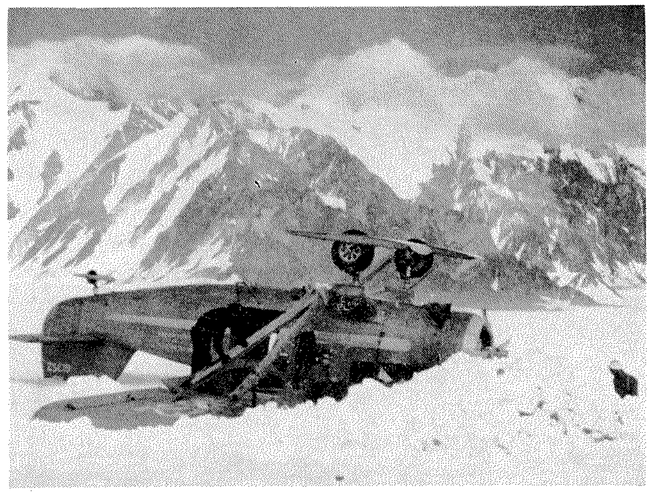
Fortunately, only minor injury, in the form of small cuts and bruises and a cracked rib, was suffered by personnel in the plane as it flipped over during a routine landing on soft snow. However, not only were possibilities of work on the Malaspina Glacier dimmed to the point of extinction; there was the immediate prospect of having to evacuate 15 men from the heart of the St. Elias Range by a tortuous, unexplored route over ice fields, snow-clad mountain ridges, and badly crevassed glaciers. As far as we knew, not another plane in all Alaska was equipped to take off from a regular airfield runway and land on a snowfield. At this particular moment we felt with firm conviction that this was a problem in logistics to which aircraft manufacturers and the armed forces should have devoted more time and effort.

Thus, the prospects were far from happy. But we underestimated the ingenuity and know-how of our pilot, Maury King, an experienced Alaskan bush flyer. With considerable help from eager expedition personnel, and by means of miscellaneous bits of equipment designed for other purposes, he righted the plane, straightened the prop, unfolded the rudder, substituted 4 x 4-inch timbers from our glaciological shaft for the broken struts, and flew the plane out to the airfield at Yakutat. Suitable repairs were made in about a week, and the entire expedition personnel was safely evacuated from the Seward Ice Field by the end of August.

The incident merely emphasizes a principle well known to anyone who has undertaken scientific work in remote regions. To be specific, about 60 to 70 per cent of one's time and energy goes into the day-to-day task of simply keeping body and soul together, and in moving supplies, equipment, and personnel from one place to another. Project "Snow Cornice" was no exception, but we feel that the 30 to 40 per cent of one's time devoted to scientific work in areas such as the Seward Ice Field pays off at a relatively high rate of interest.

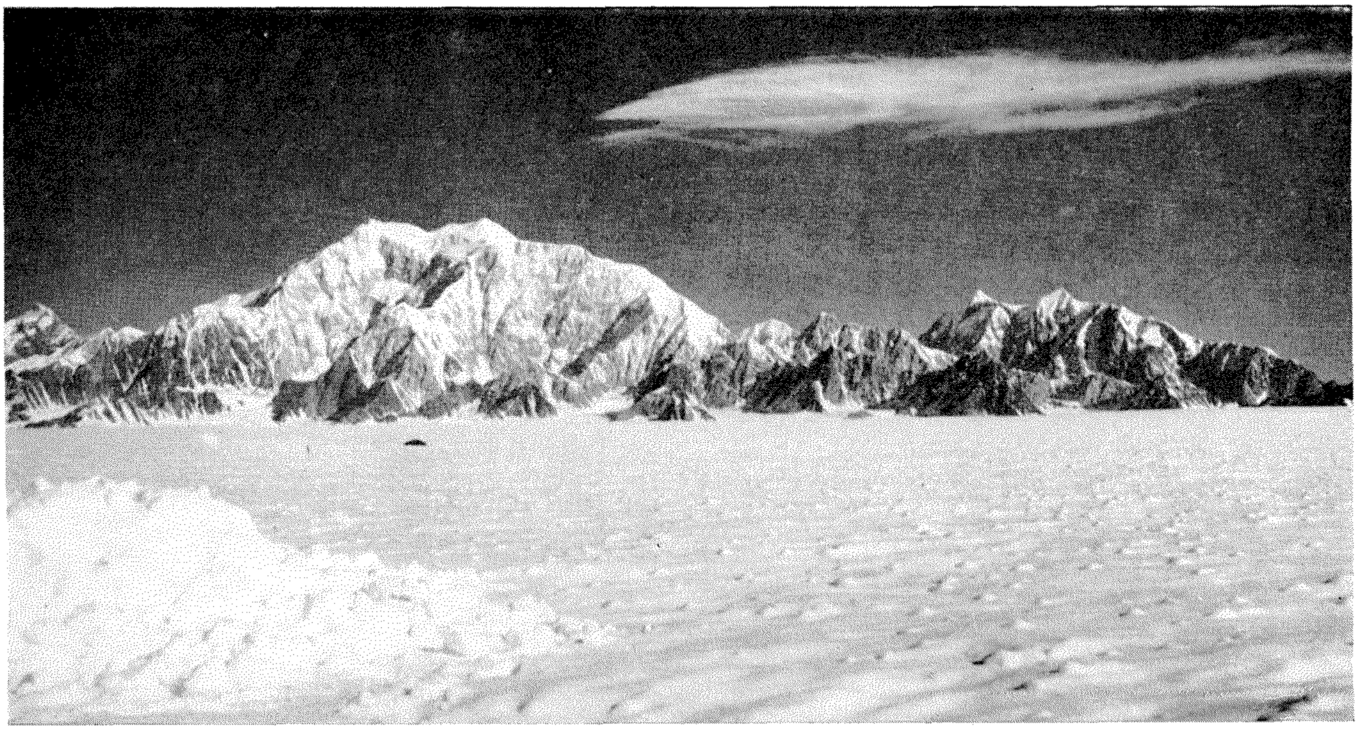
In this instance the "we" refers to three Caltech men, besides myself: Bernard O. Steenson, M.S. '48, graduate student in Electrical Engineering; and George P. Rigsby, '48, and F. Beach Leighton, graduate students in Geology. This group comprised the glaciological research team of a project set up and sponsored by the Arctic Institute of North America and led by Walter A. Wood, noted mountain explorer, photogrammetrist, and director of the New York office of the Arctic Institute.

On July 10th our Caltech contingent took off from the airfield at Yakutat, Alaska. Slightly over an hour later we landed on the Seward Ice Field, in the midst of some of the wildest, most rugged mountain country on this continent. The scenery was superb, for this great ice field—some 38 miles long by 15 miles wide—is completely encircled by towering snow- and ice-clad mountains, except for one small gap to the south through which the Seward Glacier drains, and a second low saddle or col leading westward to the Columbus Glacier. To the east lay Mt. Vancouver (15,700), the highest unclimbed peak in North America; to the south rose Mt. Cook (13,760); to the southwest Mt. Augusta (14,070) and Mt. Elias (18,808), imposing markers of the Canadian-Alaskan-border; to the north-



A problem in logistics—the expedition plane turned turtle.

Intersecting crevasses at outlet from Seward Ice Field where Seward Glacier flows south to feed the great Malaspina ice sheet.



Mount Logan (19,850 feet), second highest peak in North America, dwarfs double-peaked Mount McArthur (14,400 feet).

west lay Mt. King (17,130), and grandest of all, Mt. Logan (19,850)—second in height only to Mt. McKinley on this continent.

Gradually, as we became satiated with the stark beauty and tremendous scale of this scene—and especially after our means of departure from the region became a matter of doubt—we began to wonder what type of insanity it was that had brought us to this never-never land in the first place.

The reader is probably asking the same question at this point.

There is an answer. An answer that, to us at least, is satisfactory. We were here to study glaciers, and in what better place can these great streams of ice be studied than where they roll off the production line? Glaciers have been extensively studied in the Alps, in areas bordering the North Atlantic—such as Norway, Iceland, Spitsbergen, and Greenland— and in many other regions of the world. Indeed, most of the fundamental contributions to glaciology, the study of existing glaciers, have come from those areas. But we are slowly coming to the realization that the nourishment and wastage, the constitution and structure, and even the mechanics of a glacier in the Alps may be considerably different from those of a glacier in Alaska. Hence our desire to study Alaskan glaciers. Furthermore, the finest display of mountain glaciers anywhere in the world is in the mountains of Alaska and Canada, bordering the Gulf of Alaska. Great moisture-laden storms sweeping inland from the Pacific leave a heavy blanket of snow on these lofty ranges, and this, of course, is the major cause of the extraordinary glacier development.

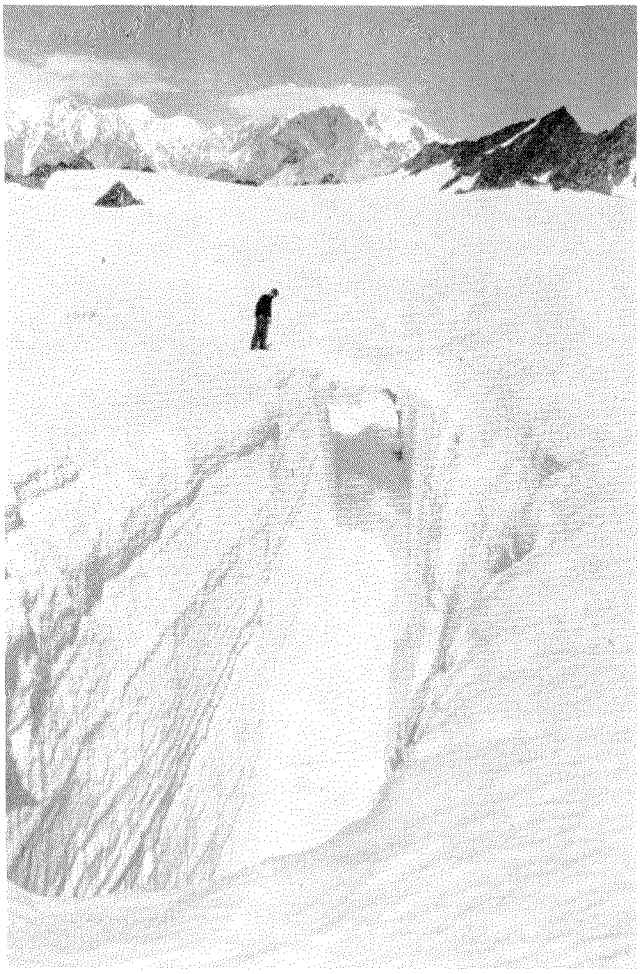
Alaskan glaciers have by no means been ignored during past decades. Excellent studies of their lower ends, where they approach or even reach the sea, are available. And they have been beautifully photographed from the air, chiefly by Bradford Washburn, Director of the Boston Museum of Science. However, the need for work on the upper reaches of these glaciers has become gradually more obvious—especially in the light of productive studies on glacier genesis, morphology, and behavior in the upper reaches of glaciers in other parts of the world, by British, Swedish, Norwegian, Danish, German, Dutch, French, Swiss, and a whole community of foreign scientists. It seems high time to us that a similar program should be launched in our own backyard, and we hope eventually to bring the California Institute to a prominent position in such endeavors. With the financial aid of the Office of Naval Research, the American Alpine Club, the Arctic Institute of North America, and the Division of Geological Sciences at Caltech, a start has been made.

Here we were then in early July, with a program of investigation and a wholly untouched area in which to exercise it.

This raises another question. "Why study glaciers anyway?"

We feel that the search for fundamental facts and information pertaining to any aspect of our natural environment is sufficient justification in itself for the type of work we were doing. It is not possible to demonstrate in terms of dollars and cents the present or even potential future value of knowing more about glaciers. But countless examples can be cited of advances in sciences which have been made possible by facts gathered solely for their own sake. Understanding and knowledge which lead to real scientific contribution can come only after the pertinent facts have been gathered, scrutinized, and interpreted. Genuine scientific advance seldom comes as a mystical bolt from the blue. In spite of such philosophical generalizations, let's be somewhat more specific with respect to our studies on the Seward Ice Field.

Perhaps some of you will recall being questioned by your elementary geology instructors as to the meaning of the uniformitarian principle. Chances are you booted the matter around for a while and then were much disgusted when the instructor expressed it very simply by saying, "The present is the key to the past."



Crevasses reveal the horizontal banded structure of the firn.

With limitations, one fertile method of deciphering past geologic events is through a study of processes currently active on the earth's crust. Many of the high mountain ranges of the western United States have been extensively glaciated in the not-far-distant past. It is our plan at Caltech to make an extensive study of this western mountain glaciation in years to come. What better way is there to approach an understanding of what has happened in the past in Yosemite, for instance, than to see great valley glaciers in action in Alaska? Thus our Alaskan glaciological studies are designed in part to help unravel the glacial history of the western United States and to train Caltech geologists for such work.

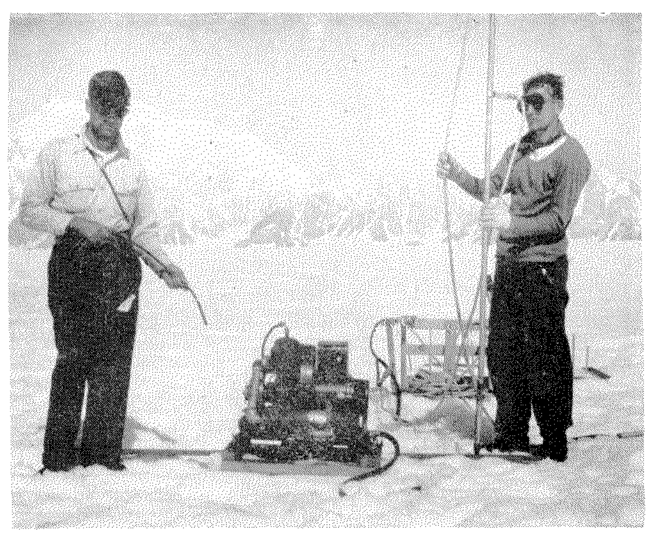
To some degree the uniformitarian principle is double-edged, and might be paraphrased as follows: "What has happened in the past and is happening now may be a key to the future." In other words, through our glaciological studies we hope to look forward as well as backward. Geologists, geographers, climatologists, and others are always searching for climatic indicators. Glaciers, being extremely sensitive to climatic variations, are an excellent climatic indicator. Imagine, if you can, anything more sensitive to temperature changes, in the proper range, than a block of ice. When we know and understand more about glacier nourishment and wastage, we may be in a position to aid meteorologists in long range predictions of climatological cycles. In a sense, glaciers are weather observers stationed in various remote parts of the world where normal weather stations are not, or cannot be, maintained. These glaciers know what has happened in the way of climatological changes if we can just wring the information from them. This is not always hard to do. For instance, a little digging near the center of the Greenland ice cap permits one to determine the relative amounts of precipitation in previous years in that remote area. It is conceivable that data from such remote regions may be essential to long-range climatological forecasts.

The ultimate cause of an ice age is still a matter of speculation, and theories based on earthly or cosmic causes, or some combination of both, are numerous. If we can establish that glaciers all over the world are behaving synchronously—that is, growing or wasting, advancing or retreating all at about the same time and rate—then some of the leading theories of glaciation will have to be abandoned or modified. We shall have made a great step forward in demonstrating that at least one factor in the development of an ice age is extra-terrestrial, be it a variation in the constant of solar radiation or something else.

For this reason, it is necessary that glaciers in all parts of the world be studied, and especially along the north-south shore of the Pacific from Alaska to Tierra del Fuego, since this is the world's most continuous line of glacier-bearing mountains, extending through the northern and southern hemispheres. Part of our program on the Seward Ice Field, therefore, was to assess its state of health. This is most easily done by studying the glacier's budget, to see if it is in balance, running a surplus, or developing a deficit. Here it is necessary to find out if the Malaspina Glacier, fed chiefly by ice carried down from the Seward Ice Field by the Seward Glacier, is spending money faster than the Seward Ice Field is taking it in.

So far we have not gathered all the information necessary to strike a balance, but we do know something about the income of this glacier system for the year 1946-1947, and next summer we should be able to confirm preliminary estimates for 1947-1948.

Much information on the physical properties of ice and snow must be gathered before any worth-while interpretations concerning glacial mechanics and behavior are possible. A large part of our summer was devoted to gathering such basic physical data. We needed holes of different depths for determination



Equipment used for boring holes and measuring temperatures.

of temperatures in the ice field. For this purpose we bored ("melted" would be more descriptive) holes into the firn, a cover of granular snow on top of glacier ice, by means of electrically heated hot points designed in the Electrical Shop at Caltech.

This method succeeded beyond our expectations, and we "bored" several hundred feet of hole in all. The greatest depth attained was 204 feet, and we stopped there only for lack of more drill rod and cable. Thermohms, fundamentally resistance coils standardized to a specially calibrated Wheatstone bridge, were used to measure temperatures within these holes. This equipment, loaned by the National Bureau of Standards, had previously been used for similar work in the Antarctic. We found that by mid-July the Seward Ice Field to a depth of 204 feet was at the pressure-melting temperature.

We also dug a number of pits, one 50 feet deep, in the firn, to permit determination of firn and ice densities at various depths, and for study of firn structures. (This pit-digging program brought to mind the remark occasionally heard that some types of geology require a "strong back and a weak mind.") Crevasses also proved useful for penetrating the third dimension of our ice field, and we obtain some information on firn structures in such openings. However, the translucent darkness of a crevasse, particularly when the walls are dripping ice water down your neck, is hardly the most pleasant environment in which to make scientific observations. The amount and mode of circulation of melt-water through the firn layers were determined, and the preliminary data demonstrate that melt-water behavior is a significant aspect of the glacier regimen. In addition to temperature, density, and melt-water measurements, observations of ice flowage were taken at 15-minute intervals on a small valley glacier draining into the Seward Ice Field. The results of these observations were disappointing, as the glacier moved too slowly—about six inches a day—to permit the type of analysis we had hoped to make.

Bernard Steenson, our electrical engineer, made good progress in attempting to adapt radar to the determination of ice thickness in a glacier above its bedrock floor. He obtained a reasonable transverse profile of a valley glacier, and this method appears to have considerable promise. The radar results need to be checked independently by some other means, preferably by seismic reflections, and this is something we intend to do next summer. If the radar method of sounding through ice proves out, it will be valuable because of the lightness of the apparatus, and the ease and speed of operation, compared with other geophysical methods of determining ice thickness.

Toward the end of the summer we found time to make reconnaissance studies of the bedrock geology in so far as it was exposed around the edges of the ice field, and on small rocky peaks and ridges projecting through the ice—as in the picture below. Since this area is absolutely **terra incognita,** information of this type helps fill in great blanks on the geological maps of Canada and Alaska.

From the scientific standpoint our summer was not an unmitigated success. Our strategy mapped out in Pasadena, with the aid and advice of able and experienced men, failed to work on many occasions. Conditions were much different from those anticipated, and much of the equipment designed and fabricated for us with skill and ingenuity by Rudy Von Huene, '34, didn't do the job we hoped, simply because no one had been able to prognosticate correctly the conditions met on the Seward Ice Field.

Next summer we anticipate a higher degree of success, based on the knowledge and experience gained in 1948.

Rock outcrops like that in the foreground, and others projecting through the ice field, yielded information on bedrock geology.

XEROGRAPHY

A Newcomer to the Graphic Arts

by CHESTER F. CARLSON

IT WAS IN ABOUT 600 B. C. that Thales of Miletus discovered that if amber were rubbed with a piece of silk it strongly attracted bits of lint, straw and other materials. Today this phenomenon is being applied to the processes of printing, duplicating, copying, and photographing—with some surprising results.

Imagine, for instance, a printing plate consisting of a smooth metal sheet on which the image to be printed is formed of an insulating material affixed to its surface. If the image is given an electrostatic charge by frictionally rubbing the plate with a cloth or brush, or by passing the plate under a corona discharge electrode, it will electrostatically pick up an ink powder. The portion of the metal plate forming the background for the image will remain clean.

The powder electrostatically held on the insulating image can then be transferred to a sheet of paper held against the plate, by simply spraying an electric charge on the paper with the corona discharge electrode. The image can be permanently affixed to the paper with a solvent, or by heating to fuse the powder onto the sheet.

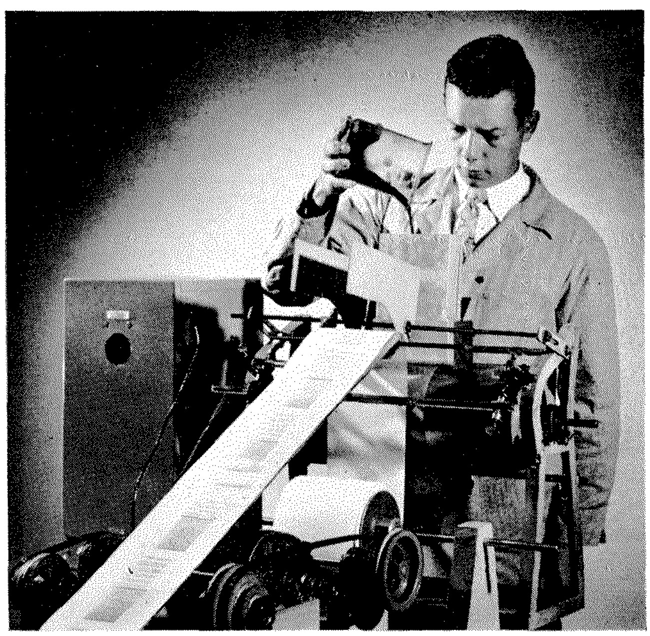
The steps can be repeated any number of times to produce a large number of copies, the same printing plate being used repeatedly. And since the steps are all mechanical in nature, they can be performed automatically by a suitably designed printing press.

This, in brief, is a description of Xeroprinting, one branch of a family of new graphic arts processes known collectively as Xerography (pronounced Zeer-aw'-graphy). Other members of the family are Xeroduplicating and Xerocopying.

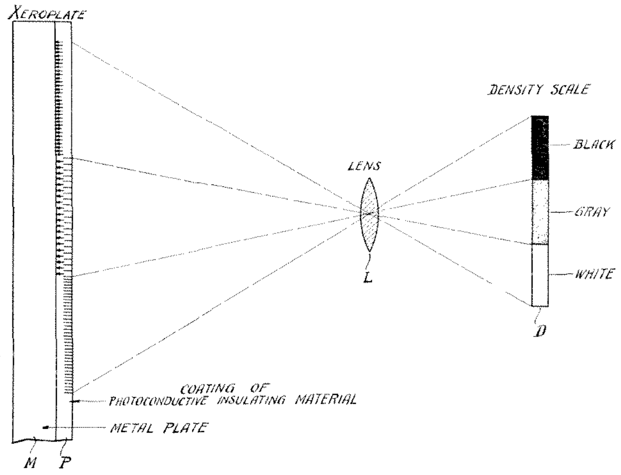
Xerography in all its phases is now the subject of an extensive research project at Battelle Memorial Institute, Columbus, Ohio and is commercially sponsored by The Haloid Company of Rochester, New York. The processes are based on patented inventions of the author.

The Xeroprinting process, like other printing procedures, is intended for the commercial printing field, to fill the need for rapid production of large numbers of identical copies. Where smaller runs are needed, with the minimum amount of equipment, the process can be adapted to office duplicating as a Xeroduplicating process.

There are many situations, however, where the number of copies required is so small that the cost of preparing a printing plate, or a duplicating-machine master plate, would be prohibitive. How many times have you needed just one or two extra copies of a letter, specification, drawing or memorandum? You've probably had to get a photocopy, or a blueprint, or resort to a complete retyping of manuscript material. Xerocopying is intended to fill this need. It uses a



Dry printing is one of the potential uses of Xerography. With this experimental printing press, engineers at the Battelle Memorial Institute in Columbus, Ohio, have already achieved a press speed of 1200 feet a minute. Besides speed, chief advantages of Xeroprinting will be the light weight of printing machinery and simplicity of plate-making.



HOW XEROGRAPHY WORKS

A specially-coated metal plate is given an electric charge, and placed in a camera. An image—in this case a density-scale chart—is focused on the surface (P) of the plate by the camera lens. When light reaches the plate, the electric charge drains off the surface to the metal backing (M). Arrows show how the charge disappears completely from the white area, partly from the gray, not at all from the black.

dry electrostatic method, as in Xeroprinting, but with a light-sensitive photo-electric plate, known as a Xeroplate, intead of the Xeroprinting plate described.

A better understanding of the Xerographic process may be obtained by reference to the diagrams on this page. The Xeroplate comprises a metal backing sheet (plate M in the diagram above) carrying a thin layer (P) of a "photoconductive insulating material" a few ten thousandths of an inch thick. Sulphur is one suitable photoconductive insulating material. Anthracene is another. Vitreous selenium also falls in this class, but not the metallic form.

Most engineers are familiar with selenium photoelectric cells. The operation of one type of cell depends upon the increase in electrical conductivity of a layer of metallic selenium when it is illuminated. But even in the dark such cells have a substantial conductivity. The photo-conductive insulating materials used for Xerography are of much higher insulating value than metallic selenium—their resistance in the dark being comparable to that of other good insulators. Sulphur, in fact, is one of the best insulators known, having a resistivity in the order of 10^{17} ohm-cm.

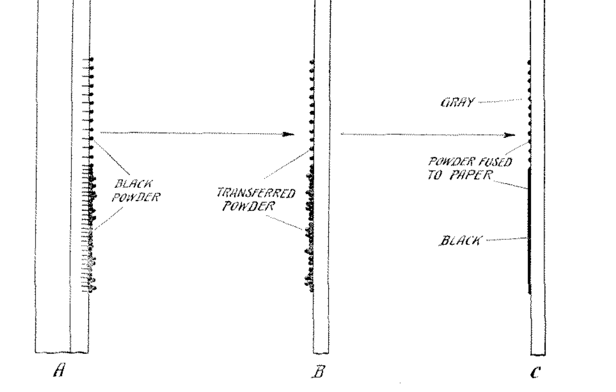
Thin layers of sulphur, anthracene, selenium, and other photoconductive insulating materials have the property of being rendered instantaneously more conductive upon exposure to light. Dr. A. L. Hughes and Caltech's Dr. L. A. DuBridge, in their excellent and very complete reference text **Photoelectric Phenomena,** mention that Joffé has reported that the conductivity of sulphur can be increased a million-fold by illumination. This would reduce its resistivity from 10^{17} to 10^{11} ohm-cm.—still a rather high resistance! Investigations so far indicate that the response to illumination of these photoconductive insulating materials is instantaneous, and is proportional to the intensity of the light for any given wave length. As soon as the illumination is cut off, the material instantaneously returns to its dark insulating value. The behavior differs in this respect from that of metallic selenium photoelectric cells, in which the conductivity builds up gradually after the light is turned on, and decays gradually after it is cut off.

A more complete explanation would be that the conductivities involved in Xerography are of a much lower order than those utilized in photo-cells, and while these instantaneous primary currents may also be present in photo-cells, they are masked by the superposed "secondary" currents arising from the primary currents in such cells.

Now, having indicated the nature of the Xeroplate, we can consider further the process of Xerography as applied to Xerocopying. If the coating of photoconductive insulating material of the Xeroplate is given a uniform electrostatic charge over its surface it is ready for exposure. This can be performed by placing it in a camera and focusing an image on the surface of the plate, as indicated in the diagram above.

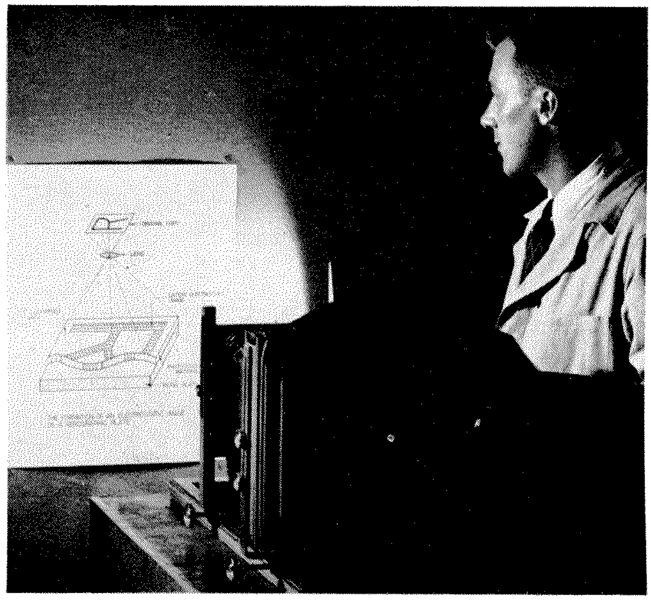
MAKING A XEROPRINT

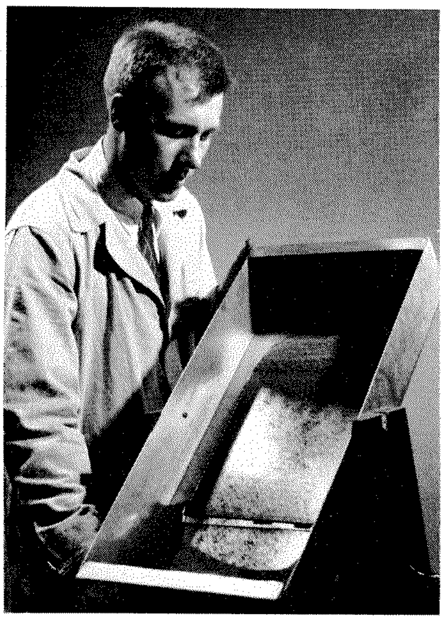
The exposed Xeroplate (A), which now bears a "latent" image of the density scale (see diagram at top of page) is coated with a dry, black powder. The powder adheres to the charged—black and gray—areas of the plate. Then, when a sheet of charged paper is held against the plate, the powder is transferred to it. Quick heating fuses the powder to the paper, and produces a permanent, fixed print.



For convenience of explanation let us assume that we are making a Xerocopy of the density scale (D). The scale may be simply a sheet of cardboard having three areas, the uppermost of which is black, the middle area being gray and the lower end of the strip being white. The image of the black area is focused by the lens (L) on the lower end of the Xeroplate. Since practically no light comes from this part of the density scale, the lower portion of the plate remains substantially in darkness, and the electric charge which is held on its surface is undisturbed—as indicated by the minus signs in layer P.

In the middle area, where the gray portion of the density scale is focused, sufficient light reaches the plate to render the insulating layer slightly conductive during exposure. This allows part of the electrostatic charge we have placed on its surface to drain off, through the photoconductive insulating layer, to the metal backing—as indicated by the small arrows. The result is that a reduced electrostatic charge is left on this area after exposure.





Above:

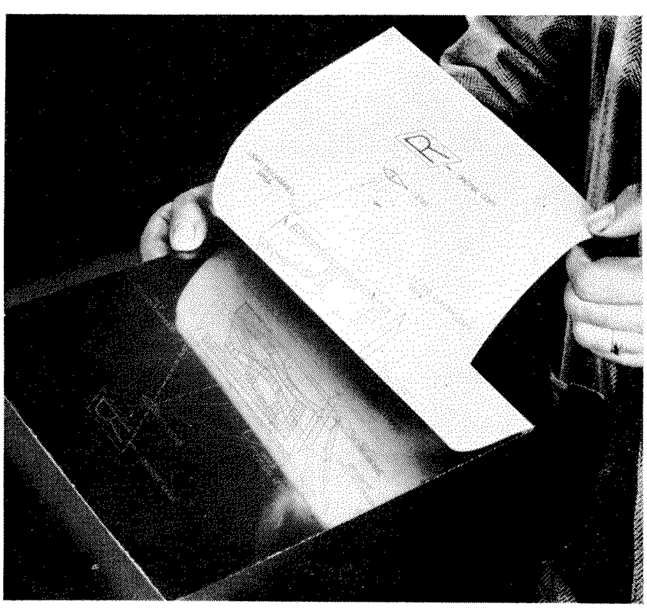
Exposing Xeroplate in camera.

Left:

Developing plate by cascading powder over surface.

Below:

Stripping transferred print from plate.



The upper part of the plate, on which the white area of the cardboard is focused, receives so much light that nearly all of the charge is conducted away, leaving this area almost completely discharged. We now have on the Xeroplate an "electrostatic latent image" of the cardboard density scale.

The plate is then removed from the camera in a closed plate holder and a fine black powder is applied to its surface in a covered tray. When the excess powder is removed, it will be found that powder adheres to the charged areas of the plate by electrostatic attraction, substantially in proportion to the "blackness" of the areas of the density scale. Thus, the part of the plate which received the image of the black area of the density scale will be completely covered with a layer of powder. The area corresponding to the gray part of the scale will be covered with a less-dense distribution of powder particles. And the area which received the image of the white part of the scale will retain practically no powder.

The developed Xeroplate is indicated at A in the diagram at the bottom of page 12. If a sheet of paper is now placed against the surface of the plate carrying the powder image and the assembly passed under a corona discharge wire, the powder will be transferred to the paper as indicated at B.

Suitable black or colored powders can be used for development, but for convenience in obtaining a permanent copy it is desirable to use a powder which can be permanently affixed to the paper. A satisfactory developing powder can be formed from certain fusible resins which are naturally black or colored, or which have been dyed or pigmented to provide any desired color. After transfer to the paper the sheet is heated momentarily to fuse the powder onto the surface of the paper, thus completing the Xerocopy as indicated at C.

Instead of using a camera, the plate can be exposed in a contact printing frame by placing a transparent original—a film, a sheet of tracing paper carrying a drawing, or a typewritten letter—directly against the surface and exposing to an incandescent lamp or other light source. Exposure can also be effected by projecting an image onto the plate with a projector or enlarger.

Either a negative or a positive electric charge may be applied to the plate prior to exposure. With frictional charging the sign of the charge is dependent

Camera portraits of live subjects, like that at left, can be taken by the Xerographic process. Finished prints are ready within 45 seconds after exposure. Though quality of photographs is not too satisfactory yet, the Haloid Co. of Rochester, N. Y., plans eventually to develop a good Xerocamera.

upon the triboelectric properties of the material which is rubbed against the surface of the plate. With corona charging the sign is dependent upon the polarity of the corona electrode. A dusting powder is selected so as to give the best results with the polarity of the charge used.

Black areas of the original are reproduced as black (or colored) areas on the copies. Hence a direct positive is obtained from the original without the necessity of first making a negative. Positives from negatives are also possible. With camera exposure, or contact printing in which the face of the original is placed against the plate, the right-hand edge of the original comes out as the right-hand edge of the copy, so that the copy reads the right way, rather than as a mirror reverse.

For the Xerographic portrait above the subject sat in front of a camera containing a Xeroplate. An exposure was made, the plate developed with black powder, and the powder image then transferred to, and affixed on, a sheet of paper.

Of course the picture you see here, like the other illustrations in this magazine, was prepared for printing in ENGINEERING AND SCIENCE by conventional methods. Briefly, these involve exposing a layer of bichromated gelatin, or similar photosensitive covering, on a metal plate to form a hardened gelatin image. After washing away the hardened gelatin to leave a resist image, the plate is chemically etched to remove part of the metal and leave raised printing surfaces.

Xerography may some day supplant these involved procedures and make practicable the direct production of printing plates for conventional printing processes, as well as for Xeroprinting, by a method requiring only a single exposure step. One way in which this can be done is to transfer the resin powder image obtained on the Xeroplate to a clean metal plate, and then fuse the powder onto the metal to produce the resist image for etching to make a printing plate.

Another method of making printing plates, which requires no transfer of the powder, is made possible by the properties of certain of the coatings used for Xeroplates. One of these photoconductive coatings is anthracene, a waxlike insulating material derived from coal tar. It can be evaporated or sublimed readily by moderate heating. Hence, when the powder image has been deposited on the anthracene coating after exposuse of the plate, it is only necessary to heat the plate to evaporate the anthracene, and then raise the temperature sufficiently to fuse the resin powder onto the metal backing layer. The metal can then be etched in acid to produce a printing plate. Lithographic plates can be prepared by quite similar procedures, using grained zinc or aluminum plates.

Several other applications of Xerography are being developed. An office copying machine has been designed which will turn out copies of letters, drawings, and other documents in a few seconds—from the start of operations until the finished copy is obtained.

The stenographer of the future may not be concerned with carbon paper. She can simply type the original letter, slip it into a Xerocopying machine, set a dial for the number of copies desired, push a button, and the required number of clean permanent copies will issue from the machine in a few seconds.

The color possibilities of Xerography are intriguing. Since there is no limitation on the colors of the dusting powders which may be used, it is possible to obtain a copy of any color desired. By using a colored paper sheet to receive the image a two-color print may be produced. Multiple color prints and natural color photographs have been obtained by a series of independent exposures for each color. The powder images of each color are all transferred to a single sheet of paper, where they are superimposed in correct register to form the multi-color image.

Many fields of application for the various phases of Xerography remain to be further explored. They range from the purely pictorial applications, through the various copying and office duplicating processes, to the commercial printing field. A few of its potential applications include the making of murals, billboards, and wallpaper—economically. Its versatility may even make it a valuable tool in many new fields not adequately served by present known procedures.

THE MONTH AT CALTECH

VITAL STATISTICS

A TOTAL OF 1272 students registered for the 1948-49 school year at Caltech on September 27. There are 754 undergraduates, and 518 graduate students. The freshman class numbers 172, about 22 per cent being veterans. Of the 200 new students registering this year, six are from outside the United States—Costa Rica, Hawaii, England, Canada, Dutch East India, and Pakistan. And in the entire student body there are 76 men from 28 foreign countries.

TROUBLE IN THE TUNNEL

THE SOUTHERN CALIFORNIA Cooperative Wind Tunnel, at 950 South Raymond Avenue, is temporarily shut down as the result of an accident on September 13 which caused some $350,000 worth of damage. The tunnel—which handles an annual $800,000 worth of aeronautics research experiments for the airplane industry—was in full operation when one of the 16 fan blades in the upstream propeller hub broke out of its socket. The loose blade smashed into the others and debris roared down the tunnel.

Because the entire structure was subjected to a severe racking, it will require careful inspection of critical areas before operation can be resumed—December 1, at the earliest. In the meantime, arrangements have been made for the Cornell Tunnel, identical with that at Caltech, to take over the most urgent tests. Availability of spare blades and other parts from the Cornell Tunnel will also speed up the repair work at Caltech.

ANTI-THOMAS COMMITTEE

ON SEPTEMBER 6, eight leading atomic scientists sent telegrams to President Truman and Governor Dewey, urging an investigation of the "smear tactics" of the House Un-American Activities Committee. The scientists, all of whom had participated in the development of the government's atomic energy program, included Caltech's Professor of Physics Charles C. Lauritsen; Dr. Karl Compton, president of the Massachusetts Institute of Technology; Dr. Harold C. Urey of the University of Chicago; Dr. George B. Pegram, Columbia University; Dr. Philip M. Morse, M. I. T.; Dr. Thorfin R. Hogness, University of Chicago; Dr. John C. Warner, Carnegie Institute of Technology; Prof. Harrison Brown, University of Chicago.

The tactics of the Thomas Committee, said the telegrams, had caused many topnotch scientists to resign from government service because "they found it increasingly difficult to reconcile themselves to government employment on secret projects where they are looked upon by groups such as the Un-American Activities Committee as men not to be trusted, where they must subject themselves to the possibility of irresponsible smears that may ruin them professionally for life. In many cases the men prefer to work elsewhere for considerably lower salaries on research programs completely unconnected with our atomic endeavors." Of the 150 senior American scientists mentioned in the wartime Smyth Report, "fewer than 10% are now devoting their full energies to the various government atomic programs."

"No nation with adequate scientific resources can hope for any degree of security in the event of another war," the scientists stated. "In the face of this fact, it is important that the leaders of our nation attempt to understand the conditions under which scientific research can be and cannot be done. In particular, if our nation is to have a vigorous government research program, the unhealthy atmosphere that has been created by the Un-American Activities Committee must be removed."

EYE AND EAR

EARLY IN 1949 is the best estimate that can be made at this time as to when the 200-inch Hale telescope on Palomar Mountain will go into operation, according to Dr. Ira S. Bowen, director of the Mt. Wilson and Palomar Observatories. There is no possibility that it will be in operation on any research program this year, he said.

One auxiliary mirror, the 36-inch Counde, remains to be completed and installed. A small modification of the 36 support mechanisms which hold the big mirror has been completed. Final adjustment of the support mechanisms—a long, tedious job—is yet to be made, along with periodic test photographs to determine how the telescope is functioning. This work will require at least the remainder of 1948.

In the meantime, the big 48-inch Schmidt camera is also being readied for operation and put through its first tests. First job of the Big Schmidt will be mapping of the skies of the northern hemisphere, a project that will require from two to three years. Much of the work to be done later by the 200-inch will be determined by results obtained with the Schmidt, which places it in the position of serving as a scout for the Hale.

While the scientists on Palomar Mountain are looking into space, others in Ithaca, New York, are listening to it. Cornell University now has a $30,000 "Ear" which complements Caltech's $6,000,000 "Eye". Made possible by radar devices developed during the war, the radio telescope is able to tune in on the radio waves which are transmitted from celestial bodies. Its "mirror" is a 204-inch saucer-shaped radio reflector—which means that, by stretching, the ear is just four inches bigger than the eye.

HONORS AND AWARDS

ON OCTOBER 20, Dr. Theodore von Karman, director of the Guggenheim Laboratory of Aeronautics at Caltech and chairman of the Scientific Advisory Board of the U. S. Air Force, received the 1948

THE MONTH AT CALTECH--cont.

Franklin Gold Medal, highest honor of the Franklin Institute of Pennsylvania.

Dr. von Karman was awarded the medal "in recognition of his outstanding engineering and mathematical achievements, particularly those relating to the development of advanced aerodynamic conceptions which have directly influenced the progress of aeronautical design, and for his unusual leadership whereby some measure of his own genius is constantly instilled in those who work for him."

Dr. von Karman has also received the Presidential Medal for Merit (p. 5) and the 1947 John Fritz Medal, highest engineering honor awarded in this country.

At the traditional Medal Day ceremonies in Philadelphia on October 20, a Franklin Medal was also presented to Dr. Wendell Stanley, biochemist and director of the virus laboratory of the University of California. Previous Franklin medalists include Thomas A. Edison, Guglielmo Marconi, Niels Bohr, Orville Wright, Albert Einstein, Harlow Shapley, Enrico Fermi and Sir Robert Robinson.

Franklin Thomas, Professor of Civil Engineering and Dean of Students at Caltech, was nominated as the 1949 President of the American Society of Civil Engineers by the organization's board of directors at the Society's fall meeting in Boston. Dean Thomas, who was a national director of the Society from 1930 to 1933 and a Vice-President in 1944-45, will take office at the Society's annual meeting in New York next January.

Mr. Hunter Rouse, Assistant Professor of Fluid Mechanics at Caltech from 1933 to 1936, and now director of the Iowa Institute of Hydraulic Research and Professor of Fluid Mechanics at the University of Iowa, was the 1948 recipient of the $1,000 George Westinghouse Award of the American Society for Engineering Education. Presented annually by the society for distinguished contributions to the teaching of engineering students, Professor Rouse was cited "for his extensive influence upon the teaching of fluid mechanics, for his revealing synthesis of diverse information, and for his inspiring guidance to students and associates."

ALUMNI NEWS

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The San Francisco Chapter meets weekly for lunch at the Fraternity Club, 345 Bush Street, on Thursdays.

AMENDMENT TO THE BY-LAWS

AT THE MEETING held on September 21, 1948, the Board of Directors of the Alumni Association unanimously voted to amend the By-Laws of the Association to provide for the creation of a perpetual fund made up of the total of all existing and future life membership fees paid to the Association. Prior to this amendment, the By-Laws provided for the maintenance of a fund equivalent only to the total of fees paid by living life members.

The amendment as adopted reads as follows:

"The last sentence of Section 2.04 'Life Membership' which reads 'However, in the event of the death of a life member, an amount equal to the life membership fee paid by that member may be withheld from the next membership funds available for deposit and placed by the Association in its general fund.' is hereby repealed from the By-Laws."

Present and future life members of the Association are now assured that fees paid by them will be held in trust as an enduring and growing fund. The income from this perpetual fund will be available for the support of the Alumni activities carried on by the Association.

Your life membership now means much more than pre-paid annual dues. Your life membership fee now not only pays for your membership as in the past but, beyond that, it makes you a donor to a perpetual fund dedicated to the continued well-being of Caltech and our Association.

PALOMAR FIELD DAY

THE ALUMNI ASSOCIATION Field Day at Palomar Mountain on October 2 turned out to be one of the most successful alumni functions in recent years. Though 150 to 200 people were expected, more than 1,000 alumni and their families rolled in.

Edison Hogue, in charge of the outing, shifted his strategy on the spot. Instead of splitting up the visitors into small groups, for guided tours of the Observatory—as planned—he stationed men at the main points of interest to explain the workings of the Observatory. The Palomar staff proved to be fine hosts, worked overtime pushing buttons and demonstrating the operation of the instruments to the crowd, from 10:30 in the morning until the last stragglers left at 5:30.

HONORS AND AWARDS

IN ADDITION TO the faculty members listed on page 5, a number of Caltech alumni were recently honored by the government for their wartime work. Dr. Joseph David Foldare, '30, and Dr. Edwin Woolman Paxson, B.S. '34, Ph.D. '37, were awarded the Presidential Certificate of Merit at the ceremony held at UCLA last month. The Certificate was also awarded posthumously to Dr. John McMorris, Ph.D. '33. Foldare is now Associate Professor of English at the Santa Barbara College of the University of California. Paxson is in the Engineering Division of the Douglas Aircraft Company.

At the same ceremony, War-Navy Certificates of Appreciation were presented to:

Dr. Warren N. Arnquist, Ph.D. '30, Office of Navy Research

Dr. William H. Corcoran, '41, Ph.D. '48, Director of Technical Development, Cutter Laboratories, Berkeley

Quentin Elliott, '41, M.S. '42, Chemical Engineer, U. S. Naval Ordnance Test Station, Inyokern

Herbert B. Ellis, '38, M.S. '41, Project Engineer, Sierra Engineering Company

Paul A. Longwell, '40, M.S. '41, Technical Consultant, Development Division, Naval Ordnance Station, Inyokern

Conway W. Snyder, Ph.D. '48

Clarence E. Weinland, '25, Ordnance Engineer, U. S. Naval Test Station, Inyokern

Richard N. Wimpress, '38, Industrial Engineers, Inc.

Personals

1918

Corliss A. Bercaw, District Sales Manager of the Chicago Region of the Electromotive Division of General Motors for a number of years, has just been appointed Pacific Coast Regional Manager of the organization.

1925

Neal Smith is City Manager of Santa Cruz, Calif.—the first man to hold this job, under a new city charter. After having spent 11 years on the Colorado River Aqueduct project, Neal was City Manager of Ontario, California for six years, City Engineer of San Diego for a year and a half, and for the past year has been Assistant City Manager of San Diego. His son, Robert, is a sophomore at Caltech this year, following in his dad's footsteps as an engineer.

1926

Harold W. Lord, who has been a member of the General Electric Research laboratory since his graduation from Caltech, has just been granted his 57th patent. It's a "regenerative driver circuit", valuable in airborne radar. Using a single tube, it cuts the size of the circuit and eliminates much of the complexity of circuits previously used for generating pulses for radar.

1927

James Boyd is in the news again. In case you missed it, here's the story, as reported by Frank Macomber in his syndicated Washington column, **Capitol Scene,** on Sept. 4:

"Just be glad you aren't James Boyd, dapper director of the Interior Department's Bureau of Mines. He has taken to growing vegetables in his yard, to economize on the $10,000 annual salary he doesn't get.

"Boyd has been on the job without pay since Dec. 19, 1947, because the law denies him his salary. Here's why:

"President Truman nominated Boyd to head the Bureau of Mines more than a year ago, but he's still serving on an interim basis because the Senate never has confirmed his appointment. Therefore, no pay.

"It's no joke to feed a big family on $10,000 a year you don't get, Boyd says. He's on leave as dean of the faculty at the Colorado School of Mines. He may go back there if Mr. Truman isn't in the White House next year, or he may accept one of several jobs offered him since he came to Washington. All of them pay more than the $10,000 he doesn't get from the government.

"But he's going to stick it out—for a while even though he receives less than the stenographers who work for him, Boyd insists.

"I figure I'm the lowest-paid government employee, the mines chief grins when he talks about his predicament."

1932

Dr. Merit P. White, M.S. '32, was recently appointed Professor of Civil Engineering at the University of Massachusetts. He had been serving as engineering consultant to the War Department.

1934

Kenneth Willard, sales manager for Parks Aircraft Sales & Service, Inc. in East St. Louis, Mo., won top prize recently in an "Airmen of Vision" airplane design competition sponsored by Street & Smith Publications.

Willard's design for a four-place personal airplane features easy entrance from the ground, excellent visibility, and a cabin that looks a lot like the interior of a modern automobile. All this is intended to catch the feminine eye, on the grounds that "the women have controlled the design of the automobile, and they like it, so the logical thing to do is give them something they like—though it has to give the performance the old man wants too."

The plane has a 36-foot wing span, 215 hp engine, maximum speed of 150, landing speed of 48 miles an hour, and a range of 700 miles.

Dr. Nephi Albert Christensen, M.S. '34, Ph.D. '38, formerly Dean of Engineering at Colorado State College, Fort Collins, has been appointed Director of the School of Civil Engineering at Cornell University.

Harold Baum Johnson, Ex-'34 was married on Sept. 19 to Eldean Jean Shult. The Johnsons are living in Glendale.

1937

Claude B. Nolté writes: "As of October, 1946, I resigned from the Fluor Corp., where I was head of the Line Sizing and Instrument Department, to become Manager of Sales for the Barton Instrument Co. of Los Angeles. This company manufactures bellows-actuated flow meters.

From January to June of this year I was hospitalized and convalescing as a result of renal tuberculosis. It now appears the cure is complete, although there is a period of being careful ahead.

The middle of this month (Sept.) I am flying to the annual exhibit of the Instrument Society of America in Philadelphia. At this time will be unveiled two products of our company. These represent 15 months of development work in which I've had an active part."

1939

Warren E. Wilson, M.S., recently became president of the South Dakota School of Mines and Technology at Rapid City. Dr. Wilson was previously chairman of the department of fluid mechanics at the Armour Research Foundation in Chicago.

1940

Charles S. Palmer and Lois Clare Hartman of Milwaukee, Wis., who were married in September, are continuing their graduate studies at Stanford University.

G. C. Barber and Mrs. Barber announce the birth of their third child, Christine Anne, on August 20. George is still working in the Power Plant at the S. M. Engineering Dept. of Douglas Aircraft.

Justus A. Olsson, M.S. '40, is now Senior Civil Engineer, Corps of Engineers, San Francisco.

Victor Wouk, M.S. '40, Ph.D. '42, and Mrs. Wouk announce the birth of a son, Jordan Samuel, on October 2.

1941

Ebenezer Vey, who received a degree of Doctor of Engineering last June from Johns Hopkins University, has been appointed Assistant Professor of Mechanics at the Illinois Institute of Technology in Chicago. For the record—he was married in February, 1947 to Georgiana Stacy of Pasadena.

William H. Corcoran, M.S. '42, Ph.D. '48, has joined the Cutter Laboratories in Berkeley, Calif., as director of technical development.

1942

David R. Howton, Ph.D. '46, is now with the atomic energy project at the University of California in Los Angeles.

Henry W. Menard, Jr., M.S. '47, and Mrs. Menard became the parents of a son last April. Named Andrew Ogden, he is their first child—contrary to a wild report appearing in these columns in 1944 to the effect that the Menards had had twins.

Richard Horton Cox and Mrs. Cox announce the arrival of Lydia Mary Cox on August 11. Lydia has two sisters —Midi, four, and Janet, two. Dick is now civil engineer for the McBryde Sugar Co. in Eleele, Kauaii, Hawaii.

Roger Brandt is teaching mathematics and science at the Hotchkiss School in Lakeville, Conn.

Charles W. Seekins, Ph.D., has been advanced from the rank of Assistant Professor to that of Associate Professor at the U. S. Naval Academy in Annapolis, Md.

Eugene W. Peterson, M.S., and Mrs. Peterson announce the arrival of Rolf Henry, their first child, on May 10, 1948.

1943

Alvin R. Eaton, Jr., now with the applied physics laboratory of Johns Hopkins University in Silver Springs, Md. attended the Seventh International Congress of Applied Mechanics in London this September.

1944

J. Robert Nicholas was ordained to the ministry at the Church of St. John the Evangelist in San Francisco on May 15. On August 12, he was married to Miss Barbara Baer of Boise, Idaho. The Reverend and Mrs. Nicholas now live in Kenilworth, Utah.

R. W. Block has joined the Interstate Engineering Corp. at El Segundo, now lives in Los Angeles.

1946

C. Richard McEwen is taking graduate work in chemistry at Stanford University. Since leaving the Navy in 1946, he has been instructor in mathematics at the University of Montana while earning his degree in chemistry.

1947

Calhoun Winfred Sumrall, M.S., and Miss Jean Eleanor McMurdie of Pasadena, were married on Sept. 10. They will live in Inglewood.

David L. Douglas, one of the 17 California applicants awarded research fellowships by the Atomic Energy Commission, received a fellowship in physical chemistry at Caltech.

Adrian Pauw has won a $1,000 interest-free ten-year loan to continue his graduate studies in engineering at Caltech—under the terms of a bequest in the will of the late Jacob Gimbel. He was selected by the Institute for outstanding scholarship and citizenship records.

1948

John Thurlow, Ph.D., has been employed by the DuPont Co. in Wilmington, Delaware.

Mayette E. Denson, M.S., has gone to work in the exploration department of the Stanolind Oil and Gas Co., in Casper, Wyoming.

Index to Advertisers

IN THIS ISSUE--cont.

Chester F. Carlson, the inventor of Xerography, describes this exciting new development in the graphic arts on page 11. A graduate of Caltech, Carlson received his B.S. in physics in 1930, went to work for the Bell Laboratories in New York City as a research engineer, later being transferred to the patent department. Now a practising patent attorney, he lives in Canandaigua, New York. He's been interested in the graphic arts since his high school days, when he planned to print a magazine for amateur chemists, but was thoroughly discouraged by the cost and technical difficulties of present reproduction methods. Later on, determined to find an inexpensive way to print some of his own manuscripts, he began a study of photo-conductive materials. His experiments led to patents covering the basic Xerography process.

Robert P. Sharp, author of "Project Snow Cornice", on page 6, claims his interest in glaciers and glaciation was born at the tender age of eight, when he trudged over the moraines of the Mono Basin with his grandfather, in search of trout streams and lakes. Subsequent wandering in the glaciated terrains of the Sierra Nevada served to heighten this interest, and Bob went on to investigate glaciation in New England, Illinois, Minnesota, Arizona, and Wyoming. His studies of living glaciers started in 1941 in the Yukon Territory, and war-time activities in Alaska and the Aleutians brought a further acquaintance with the great ice masses of that region. A Caltech graduate ('34), Bob returned to the campus in 1947 as Professor of Geomorphology.

Books

RADIANT HEATING

by R. W. Shoemaker, '03
McGraw-Hill Book Co., New York, 306 p.p. $4.00

THIS IS A BOOK which ought to prove useful not only to the expert in the field of radiant heating but also to the amateur who is looking for information, or the householder who is considering a radiant heating installation. Profusely illustrated, it covers all aspects of the field—design, equipment, and installation—and manages to provide both technical and practical information in each case.

One of the most interesting sections of the book concerns the control systems available for radiant heating. These range from simple thermostats which maintain a certain temperature of water, to involved anticipatory systems which will predict imminent changes in the room temperature and also keep the water in the heating coils within adjustable maximum and minimum ranges. The anticipatory control involves the use of an exterior thermostat. This outside bulb notes a drop in the outdoor temperature and starts the ball rolling by means of a mechanical "brain" which can prepare the heating system to deliver heat as soon as the inside thermostat requires it, or can eliminate a drop in inside temperature entirely. Carrying the point even farther, a special outside thermometer has been designed which takes into account whether or not the sun is shining.

In the course of the book Mr. Shoemaker makes a pretty solid case for radiant heating. Some of the advantages he claims for it are worth summarizing:

1) It gives use of space taken by conventional heaters.
2) There is no need to worry about keeping furniture away from the heating area.
3) It makes possible relocation of partitions, is especially applicable to changing office installations.
4) It suppresses air currents and drafts.
5) It eliminates hot air ducts, and possible fire hazard.
6) The work of the heating contractor is finished at the time of rough construction.
7) It is cheaper by 20 to 30% (if you use it constantly during the winter).
8) Lower indoor temperatures are possible for the same sensation of warmth—less heat is lost to the outside through walls or open doors or windows because of the lower heat gradient.
9) It keeps your feet warm in a big office.
10) You can zone your coils to give more heat in areas near windows or doors, etc.

Despite this impressive barrage of advantages, the pipes, the boilers, the insulation to keep the heat from leaking to the ground, the circulating pumps, the valves, the fancy control systems needed for satisfactory operation, and the elaborate installation are all expensive items. A reader can't help figuring that, unless the heating bills were pretty high, it would take too long to pay for the setup by the economy of operation.

—Tom Tracy '48

MAKERS OF MATHEMATICS

by Alfred Hooper,
Random House, New York, 402 pp. $3.75

THE TITLE suggests emphasis on biography. Actually the biographical material is slight, except in the case of Newton, who gets 50 pages including the mathematical material. Lagrange and Gauss each get three pages; Riemann 15 words. In fairness to the author it should be said that he makes no extravagant claim for what he terms his "modest little volume" as that on the dust jacket: "Moving from primitive ideas of numbers to the most advanced concepts, it includes the contributions of Thales, Pythagoras, Archimedes, Euclid, Descartes, Newton, Leibniz, Gauss and the moderns." "The moderns" presumably would include the later contemporaries and successors of Gauss. In addition to Riemann with his 15 words, the moderns Dedekind and Cantor share one sentence. Other moderns — Abel, Galois, Cauchy, and many others — are not mentioned.

From the material presented, it appears that the author's aim is to give non-mathematical readers some idea of how **elementary** mathematics developed. After the first chapter of 26 pages on "The birth of numbers," the narrative ignores the Babylonians and passes at once to the Greeks, 57 pages, emphasizing their geometry. Then come similar chapters on the most elementary school algebra, 41 pages; the barest rudiments of trigonometry, 61 pages, followed by a chapter of 24 pages on the invention of logarithms. The sixth chapter on forerunners of Newton disposes of the lives and achievements of Galileo, Kepler, Tycho Brahe, Descartes, Fermat, Pascal, Desargues, Cavalieri, Wallis, and some others mentioned in passing, all in 79 pages. The emphasis here is on the early attempts to calculate areas, from Archimedes to Wallis. The chapter on Newton continues this theme, and there is an intuitive approach to the notion of a derivative hardly suitable for a college freshman who wishes to avoid an emphatic flunk.

Mathematics after Newton is covered in the 60 pages of the concluding chapter: "Leibniz, Gauss and Others." Fourteen pages of this chapter are devoted to a further elucidation of the calculus, Eighteenth Century style, and 14 to the graphical representation of complex numbers as in the usual high school course.

To sum up, the mathematical material presented is a small part of what a student in a reputable college or technical school will have mastered correctly by the end of his first term, or earlier in school, and in its most advanced parts, still elementary, is presented from the obsolete point of view of the Eighteenth Century. The layman may be incapable of understanding more. If so, his appreciation of mathematics as it is today, or even as it has been for over a century, will be negligible.

—E. T. Bell

A Letter to the Alumni

THIS IS A LETTER of thanks and commendation to the alumni of Caltech for their earnest and successful efforts toward bringing to reality that long-cherished dream of the Institute that it would some day have a gymnasium and other needed athletic and recreational facilities for its students.

"The California Institute of Technology is a college, graduate school, and institute of research in science, engineering, and the humanities." So reads the statement of the educational policies and objectives of the Institute formulated by the late Dr. Arthur A. Noyes and adopted by the Board of Trustees on November 29, 1921.

In the past 27 years the great achievements of the Institute as a graduate school and a research institute have sometimes overshadowed in the public mind the fact that one of our basic purposes has been to conduct an undergraduate college of a unique type. If the earnest efforts and remarkable achievements in creating such a college have not reached the pages of the newspapers, this goal has nevertheless been a primary interest of the Institute administration and faculty throughout the Institute's hisory.

This 1921 statement goes on to say in part:

"It is hoped . . . to make the undergraduate courses of the Institute a combination of fundamental scientific training with a broad cultural outlook. . . . Every effort shall be made to develop the ideals, breadth of view, general culture and physical well-being of the students of the Institute. To this end the literary, historical, economic and general scientific subjects shall continue to be taught by a permanent staff of men of mature judgment and broad experience; . . . moderate participation of all students in student activities of a social, literary or artistic character shall be encouraged; students shall be required or encouraged to take regular exercise, preferably in the form of games or contests affording recreation. **It is the purpose of the Trustees to create as rapidly as possible additional facilities for these student activities by the erection of a student union, a gymnasium and dormitories."**

In 1922, at the end of his first year at the Institute, Dr. R. A. Millikan reported to the Trustees the accomplishments of the year and the pressing needs for the future. A large section of this report was devoted to the problem of "the creation of more satisfactory conditions for student life." He discussed particularly (a) the need for additional land for athletic facilities and the immediate erection thereon of a gymnasium, (b) the need for student dormitories, (c) the need for "student clubhouse and commons with which the social, religious, recreational and dining needs of the Institute students may be adequately provided for."

As the years have gone by, generous Institute donors have provided funds for urgently needed buildings to house scientific and engineering laboratories. Funds were also raised for a splendid, though now outgrown, student dormitory and for a beautiful clubhouse for faculty and graduate students. In spite of an energetic search, however, funds have never been found for the erection of a gymnasium and a student union, two needs which are far more urgent in 1948 than when Dr. Millikan outlined them so urgently in 1922.

A major step in this direction occurred in 1947 when the Institute arranged to purchase most of Tournament Park from the City of Pasadena at a cost of $280,000. An ideal site for the development of adequate athletic and recreational facilities is now available. The next step is to build these facilities as soon as possible.

From what source can the funds be secured? It appears still to be true that prospective donors are more inclined to provide funds for scientific, educational and research purposes than for the critical needs of student life. This is not an unusual situation, since nearly every institution in the country has faced the same problem. The older institutions of the East have depended on their alumni for help in providing such facilities. Until recently the California Institute Alumni consisted of a relatively small group, a young group, and a group which, by and large, had not attained positions of affluence which enabled them to return generously of their substance to their Alma Mater.

This situation is rapidly changing. The alumni themselves sensed this two years ago and an energetic group of Alumni Association officers, believing the Association had come of age, organized the Alumni Fund.

The first question which these officers asked Institute officials was, "To what purposes should the initial proceeds of this Fund be devoted?" The answer to that was relatively easy. The Institute had a long list of urgent needs for funds. Which of these needs could most readily command the enthusiasm of the alumni and for which of them would it be most difficult to find support from other sources? The needs of the students for recreational and athletic facilities seemed to be the obvious answer. It was, therefore, agreed that the first goal of the Alumni Fund would be to provide for the erection of a gymnasium.

The initial response to the Alumni Fund gives assurance that the alumni are eager to seize this opportunity of aiding their Alma Mater. The news of the purchase of Tournament Park and the possibility of erecting thereon a gymnasium was a tonic to the undergraduate students last year. At long last they felt that the Institute would have the necessary facilities to insure a well-rounded student life.

We are now trying to determine how the most adequate athletic facilities can be provided at the minimum cost. New developments in construction techniques give promise that an excellent gymnasium, suited to the needs of the Institute program and adapted to the conditions in Southern California, can be erected at a cost of $250,000. The assured contributions to the Alumni Fund already amount to one-third of this sum. The day when the first basketball game and the first Alumni dinner will be held in the new gymnasium may not be too far distant.

To every alumnus who has contributed money or effort to this Fund the sincere thanks of the Institute are hereby extended. To every alumnus who has not yet participated the Institute extends a cordial invitation to use this opportunity of rendering urgently needed assistance to his Alma Mater.

L. A. DuBridge

Foster Strong G 37
California Institute of Technology
Pasadena 4, Calif.

The Main Line

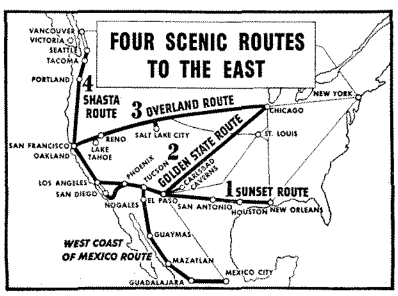
NOVEMBER, 1948

LIKE PIGEONS, wild geese, and the swallows that come back to Capistrano, man has a homing instinct—and it's never stronger or more compelling than in the Fall.

So it's Home for the Holidays—home for Thanksgiving, home for Christmas, for New Year's...

How's it with *you*? Are you planning a pilgrimage to the old homestead? Then take some tips from us:

Tip One: Next time, try the train! You're going home to enjoy yourself—to do a lot of visiting, partying. Go by train—let the engineer do the driving—get there fresh as a daisy, ready for a good time.



Tip Two: Next time, try an S.P. train! If your destination is "back East" (by western definition, that means "anywhere East of Kansas City"), plan to go via one of S.P.'s four routes from the Pacific Coast, return via another—and see twice as much en route on your roundtrip.

(Remember, only Southern Pacific offers you a choice of four routes. As the little map shows, the routes are the *Golden State*, Los Angeles to Chicago; the *Sunset*, Los Angeles-New Orleans; the *Overland*, San Francisco-Chicago; and the *Cascade*, via the Evergreen Pacific Northwest.)

Tip Three: Lots of people are going to be traveling from now until year's end. So complete your plans now, make your reservations with Southern Pacific early and get exactly the accommodations you want.

If any plan-making difficulties come up, see your near-by S.P. Agent—an expert at smoothing out schedules, doping out connections. Obligation? None at all.

Tip to people who can't go home on a trip because they're at home now: how about a Fall and/or Winter vacation somewhere in the Southwest—or farther East by South?

There is California's Palm Springs, and out thar beyond is Southern Arizona's resort and guest ranch country. Then, pardner, there's Texas—El Paso (with old Mexico just across the river and fabulous Carlsbad Caverns just a few hours away), Dallas, San Antonio, Houston and points between. And 'way down yonder is New Orleans, fairest flower of the South, suh!

Plenty of places to go—plenty of interesting sights en route. And via S.P. you can get where you're going quickly, comfortably. *Sunset Route* trains, headed by the *Sunset Limited*, serve all above-mentioned places. (You can go *Golden State Route*, too—as far as El Paso.) Why not drop in on your S.P. Agent and let him show you how and why to vacation via S.P.?

Speaking of Thanksgiving—here's an item of interest to anyone destined to be en route somewhere on S.P. that day. To provide Thanksgiving turkey dinners just for travelers outbound from Los Angeles, our Dining Car Service expects to prepare some 5,000 pounds (2½ tons!) of gobble-meat—and to bake close to 600 assorted pumpkin and mince pies to top off the meal.

So if you'll be traveling instead of being at home on Thursday the 25th, despair not—at least, not completely. There'll be a complete-with-stuffin' Thanksgiving dinner for you in your S.P. train's diner.

S•P the friendly Southern Pacific