ENGINEERING AND SCIENCE

MONTHLY

MAY 1948

ENGINEERING AND SCIENCE
Monthly

The Truth Shall Make You Free

CONTENTS FOR MAY 1948

With the Editor

AT THE POSSIBLE risk of indulging in a little self-admiration, we should like to record here a few of the things which have recently rewarded our publishing efforts.

Most of you will recall our Biology issue of a year ago . . . we heard just recently that the number of applications for admission to courses in that Division doubled after our issue of last May was published. And those who should know have implied that our Biology number was largely responsible.

Even more of you should recall our Geology Division issue of last February. Although it is too early for its effect on applications to be known, we can say that we've have to reprint 1250 copies. Some of the extra copies have gone to business firms who recognize the importance and value of the information contained in the magazine. At least one author now preparing a geology textbook has asked permission to reprint some of the material, giving appropriate credit, of course.

* * * * *

In our issues of April and October 1947 we told something about the Professional Engineers' Registration Act. As pointed out in the October article by Martin H. Webster, registration is provided without examination for qualified candidates until June 30, 1948. After that date, applicants must pass a written examination in order to receive a certificate of registration.

We have been asked by a number of practicing engineers for information or opinion which would help them in deciding whether they should apply for a certificate of registration. We feel that there is no one better qualified to give counsel on this matter than Professor Sorensen, a fellow member of the Association, a good friend, and a member of the State Board of Registration for Civil and Professional Engineers. It is with a real feeling of service to Tech alumni that we offer herewith Professor Sorensen's article on Professional Registration.

* * * * *

Whenever we have the opportunity we try to learn from fellow alumni how they like their magazine and what they would like added or omitted. While in San Francisco not very long ago we had the pleasure of seeing a number of San Francisco alumni at one of their regular Thursday luncheons. One of the ideas we gained there has resulted in the presentation in this issue of biographical sketches of two faculty members. We should like to publish more such sketches if our readers agree with us that they are a desirable feature.

* * * * *

Our next issue will be devoted to the story of the 200-inch telescope at Palomar Mountain and will be delayed a few days in order to give us a little more time for its preparation and to get it to you as nearly as possible on the expected date of dedication early in June. We plan to place this issue on sale at the Observatory as it will contain official stories of the entire project and will be available for purchase as a souvenir to visiting scientists and laymen at the time of dedication and subsequently.

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Professional Engineering Registration in California

By ROYAL W. SORENSEN

TO REGISTER or not to register! That is the question being considered by many California Chemical, Electrical, Mechanical, and Petroleum engineers, and engineers in training in these branches of engineering and also in Civil engineering.

This situation has been brought about by the September 19, 1947 amendment to "The Civil Engineers' Art" of California.

That amendment pertains to registering of professional engineers in the branches above named and also authorizes for all qualified persons registration as engineer in training in Civil engineering as well as in the other specified branches.

Registration is administered by the State Board of Registration for Civil and Professional Engineers. This Board has seven members, three Civil engineers, and one each for Chemical, Electrical, Mechanical, and Petroleum engineering. The Board has, at present, two offices. The principle office is in Sacramento and the other office is in the State Building, Los Angeles.

Prospective registrants may obtain the proper application forms together with a copy of the Act and instructions for filing applications by a written request to:

Pecos H. Calahan, Executive Secretary
529 Business and Professions Building
Sacramento, California

Persons qualified for registration as Chemical, Electrical, Mechanical, or Petroleum engineers or as engineers in training *may* be registered without examination under the so called "Grandfather Clause", provided an application for such registration is filed before July 1, 1948. Practicing Civil engineers *must* be registered and can obtain registration only by examinations as provided for in the Act. Structural engineers *must* be registered and must first be registered civil engineers.

Persons qualified in more than one of the branches of engineering for which registration is provided may register in all the branches for which they are qualified if they so desire. A separate application is required for each branch. The years of experience for each registration must be unique for the branch specified with the exception of graduation from an engineering school or college which may be used as experience in all of the branches for which registration is requested.

The act forbids the practice of Civil or Structural engineering without registration, and entitles only persons registered under the act to take and use the title, "Professional Engineer, Civil Engineer, Structural Engineer, Chemical Engineer, Electrical Engineer, Mechanical Engineer, Petroleum Engineer, or Engineer in Training".

The qualifications for professional engineer registration are at least six years of engineering experience. Graduation from an approved engineering college or school shall count as four of the six years. Without graduation from accredited schools each year of work accredited toward a degree counts for one-half year.

The qualifications for registration as engineer in training are graduation from an engineering college and endorsements as to good character.

One year of the six years' experience must be in responsible charge of engineering work. Civil engineers receive credit only for work done

(Continued on Page 11)

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COVER CAPTION

From the jaws of this hydraulic press capable of exerting a total pressure of 3000 tons, a Bureau of Mines laboratory aide has taken a freshly-compacted bar of titanium, one of the rare metals produced in the Bureau's pilot plant at Boulder City, Nevada. In this form, titanium, which is only half as heavy as as steel, can be fabricated like other metals for use in structural work. (Bureau of Mines photo)

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ENGINEERING AND SCIENCE
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Production Methods Yield 'NEW METALS' For Structural & Engineering Purposes

By JAMES BOYD*

MAN HAS PASSED successively through the stone age, the bronze age, and the steel age, and has now entered an age in which metals play a more vital role than ever before in the world's history. He needs more metals, better metals, and new metals to supply his ever-increasing demands and to meet specifications that are constantly growing more and more rigid.

The phenomenal developments in processes and equipment for both military and industrial use require metals that must withstand heavier stresses, higher temperatures, and unusual conditions of corrosion; in many cases there is a need for metals having such a combination of properties as light weight, strength, and resistance to fatigue.

Most of the chemical elements have been known and isolated for many years, but the true physical properties of certain metals were not recognized until they were prepared substantially free of contaminating impurities. Such metals, formerly regarded as of little industrial importance, when produced in pure form, exhibit properties that have opened up a wide field of usefulness.

WHAT ARE "NEW METALS"?

In a broad sense, the term "new metal" might include a multiplicity of special alloys, as well as a number of rare metals that have been brought into the economic picture because of certain desirable properties that they impart to steel and non-ferrous metals when added in minor quantities. Most of these rare elements, however, are relatively scarce and so costly that there is little likelihood of their ever being available in large quantities at prices that will permit their wide industrial use as primary structural materials. Molybdenum, vanadium, tungsten, and beryllium are relatively new, but they are marketed chiefly in the form of alloys and sold by the pound rather than on a tonnage basis.

From a practical point of view, therefore, new structural metals may be defined as those that can be derived from abundant sources of raw materials, but have been produced heretofore in very limited quantities for one or more of the following reasons:

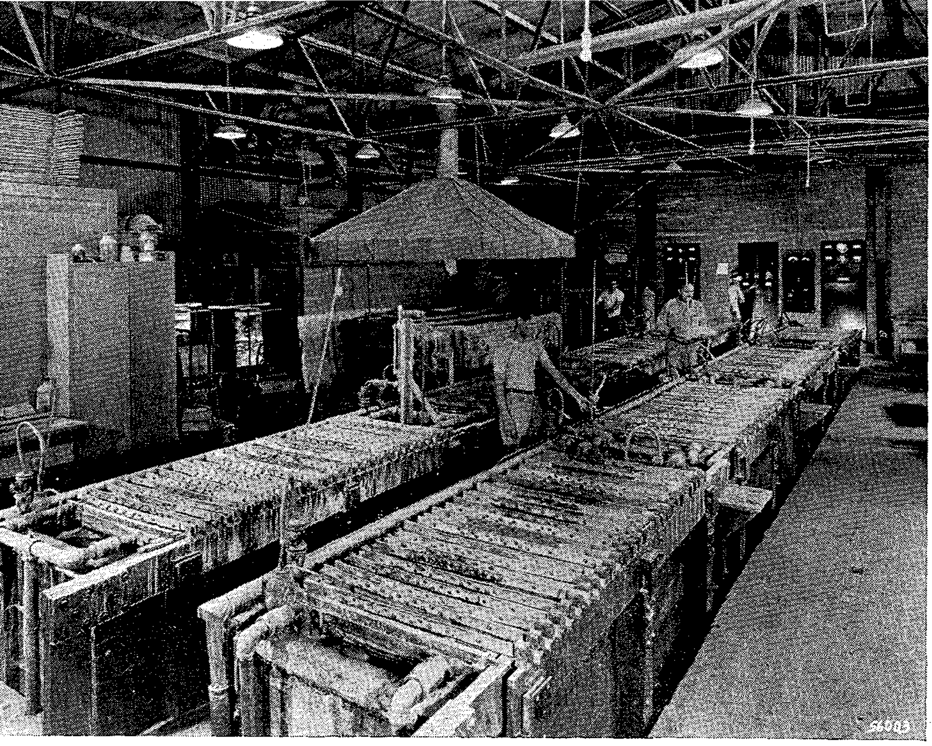
James Boyd recently left his position as dean of the Colorado School of Mines in Golden, Colorado to become Director of the Bureau of Mines in Washington, D. C.

Born in Kanowa, western Australia, in 1904, Dr. Boyd was educated both in the United States and England; received his B.S. degree in engineering and economics from CalTech in 1927, and took his graduate work at the Colorado School of Mines, where he received his M.S. in geophysics in 1932 and his Sc.D. in geology in 1934. He remained at the School of Mines as an instructor, an assistant, and then an associate professor until leaving for service in the army.

Attaining the rank of Colonel during World War II, Boyd served as chief of the Metals and Materials Section, Commodities Branch, Resources Division, Headquarters Services of Supply in 1941-42; and later in other administrative positions.

In 1945, before V.E. Day, Colonel Boyd was sent to Europe to direct the activities of the Production Control Agency under G-4 of the Supreme Headquarters of the Allied Expeditionary Forces and also the Industry Division of the Office of Military Government, the organization which helped to reorganize and re-establish German mines, mills, plants and other industries. Boyd remained in Germany until the summer of 1946, when he returned to the Colorado School of Mines. In recognition of his wartime services, he received the Legion of Merit award, with oak leaf cluster.

* Written in cooperation with the staff of the Metallurgical Branch, U. S. Bureau of Mines.



Cell room of the Bureau of Mines electrolytic manganese pilot plant at Boulder City, Nevada is shown here with the generator controls in the background. (Bureau of Mines Photo)

1. Incomplete knowledge of their properties
2. Technical difficulties in their preparation
3. High cost of production.

Fifty years ago, aluminum and magnesium were new metals so far as their production, price, and industrial uses were concerned, yet these so-called "light weights" are now produced in enormous quantities at a fraction of their former cost, and their value has been firmly established for a wide variety of uses; moreover, the raw materials containing these metals are so plentiful that, as technical knowledge advances, there is little possibility of a dearth of available sources of supply.

The present paper is confined to a discussion of three new metals—manganese, titanium, and zirconium—that are being produced in pure form by processes developed in the Bureau of Mines. The abundant supplies of raw materials available and the unique properties of these metals insure them a permanent and prominent place in the structural field. Their various applications are being determined by cooperation with the metal industry.

ELECTROLYTIC MANGANESE

Manganese, although known and used for many years in the form of ferro-manganese as a scavenger in the manufacture and purification of steel, has been produced in the pure form for only a relatively short time. Electrolytic manganese as developed by the Bureau of Mines may be considered a new metal. Because of its purity, it is extremely valuable in the production of high-quality, low-carbon steels, and as an ingredient of non-ferrous alloys. During the war, it was used as a substitute for nickel in five-cent pieces and it has a promising future as an ingredient of stainless steel.

Although marginal manganiferous ores do not lend themselves readily to the commercial production of ferromanganese, such ores can be used as raw materials for electrolytic manganese; hence, this development has rendered it feasible to exploit off-grade domestic manganese deposits formerly considered of little or no commercial importance.

The equipment and general scheme for the manufacture of electrolytic manganese from medium-grade or marginal ores can be briefly described as follows:

The plant consists of: (1) a crushing and grinding unit, (2) a roasting or reducing unit, (3) a leaching and purification unit, and (4) an electrolysis unit.

The ore is first crushed and screened to a suitable size, then ground in a ball mill to minus 48-mesh, dried and stored. In the next step, the ground and dried ore is fed to a multiple-hearth muffle furnace, where the manganese dioxide is reduced to the acid-soluble manganese oxide. The reduced ore or calcine is then cooled out of contact with air and conveyed to a storage bin.

The third step consists in leaching the reduced ore with spent electrolyte from the electrolytic cells, with sufficient make-up sulfuric acid added to insure that the manganese is dissolved. The leach is then neutralized with ammonia, and the residue, washed by counter-current decantation until free from soluble salts, is pumped to a tailings pond. The overflow solution from the primary thickener contains metallic impurities, such as arsenic, molybdenum, nickel, and copper, which are precipitated by hydrogen sulfide and removed by filtration. The filtered solution is freed from colloidal impurities by addition of a small quantity of ferrous sulfate solution, which is followed by oxidation, and precipitation of iron and all the remaining contaminants. After standing for several hours, the solution is again filtered and the filtrate is ready for the electrolytic cells.

In the fourth step, the solution of manganese sulfate and ammonium sulfate is fed to lead-lined electrolytic cells having false bottoms which serve as reservoirs for the manganese oxides that form at the anode and spall off periodically. The anodes are of lead containing 1 per cent silver and 0.5 per cent arsenic, and are perforated so as to be 40 per cent void. The cathodes are of stainless steel so treated that the deposit of manganese can be readily stripped off. A frame covered with a canvas diaphragm surrounds the anode, and prevents the acid at the anode from mixing with the solution at the cathode. Direct current for the cells is supplied by rectifiers, and a cathode current density of 45 amperes is maintained with a minimum current efficiency of 60 per cent. The cell potential is 5.3 volts. The cathodes are removed from the cells from time to time, and the deposited manganese is stripped off by flexing or striking the cathodes with a rubber mallet. The cathodes are then cleaned and returned to the cells. An over-all recovery of more than 88 per cent of the manganese from the ore is made.

Mainly through the efforts of the Bureau of Mines, whose publications give detailed descriptions of the various modifications of this process, an electrolytic manganese industry has now definitely been established.

DUCTILE TITANIUM

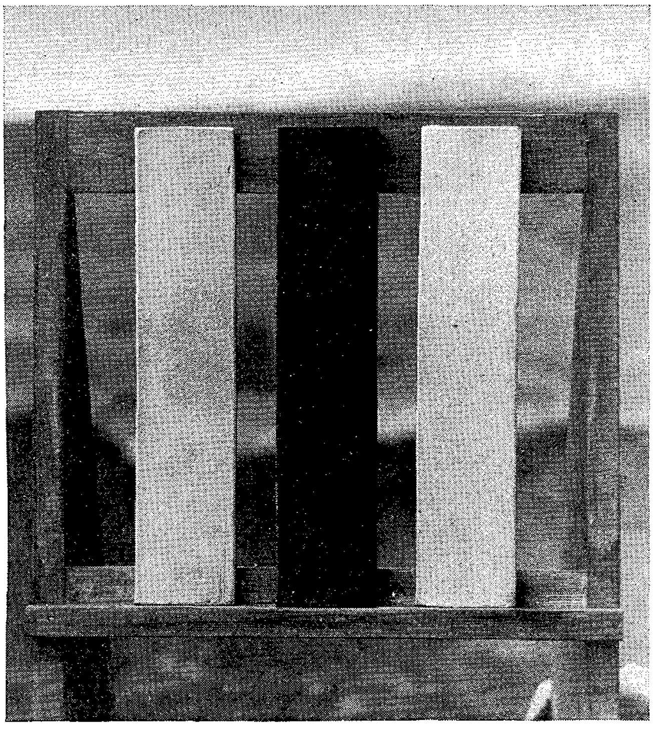
Titanium has been classed as a rare metal, although its ores are abundant and widely distributed; as a matter of fact, titanium is the fourth most plentiful metallic element in the earth's crust, being exceeded in quantity by only aluminum, iron, and magnesium. Substantial reserves of ilmenite ($FeTiO_3$), rutile (TiO_2), and other titanium minerals occur in many localities in this country. Certain domestic deposits were drawn upon liberally during the recent war, when imports of ilmenite from India were cut off, and it appears that our native ores will continue to furnish a considerable proportion of the nation's future needs for titanium minerals.

Componds of titanium have had important industrial applications for many years; the oxide is widely used in the manufacture of an exceptionally white, durable pigment; the chloride is employed in producing smoke screens, in the dyeing industry, and as an intermediate in the manufacture of organic compounds. The mineral rutile is used for coating welding rods and as a raw material for the manufacture of titanium carbide, a highly satisfactory substance for cutting tools.

Until recently, however, titanium itself was more or less a laboratory curiosity and was considered of little commercial significance. This was due to the difficulty and cost of preparing it sufficiently free from objectionable impurities to bring out its unusual and valuable properties.

Thus far, titanium has not been successfully reduced directly from its oxides, largely because reducing agents, such as carbon, silicon, and aluminum, introduce objectionable impurities into the metal. The Bureau of Mines, however, has developed a method of producing pure ductile titanium by reducing the chloride with metallic magnesium. This process may be briefly described as follows:

Reduction is accomplished in an unlined iron pot fitted with a tight cover and provided with an inlet tube and a well for thermocouple. This pot is heated to 500° C while hydrogen is passed into it to reduce any oxides formed on the interior surfaces. After cooling, clean magnesium ingots are introduced through the inlet tube, and the assembly is again heated to 150° C under reduced pressure to remove absorbed gas. A stream of helium is then passed into the container to provide a neutral atmosphere and the temperature is raised to about 750° C. Liquid titanium chloride is added, at first slowly and then more rapidly as the reaction proceeds, the heat evolved being sufficient to maintain the temperature of the chamber for about two-thirds of the run, after which it is again necessary to apply external heat. A maximum temperature of



Long exposure to the weather has little effect on bars of the rare corrosion-resistant metal, ductile titanium. In contrast to the rusting of the steel bar (center), the titanium bars (left and right) retain their luster. (Bureau of Mines photo)

Demonstrating the unusual tensile strength of ductile titanium, produced in the pilot plant at Bolder City, this smiling laboratory helper is easily supported by a strip of the rare metal about as wide and half as thick as an ordinary book match. The titanium link above the girl's head is 0.131 in. wide and 0.027 in. thick. (Bureau of Mines photo)

900° is reached and held for a full half hour after all the titanium chloride has been added. When the reaction chamber cools, the charge is removed, leached with cold hydrochloric acid, the leached metal dried, finely ground, again leached with 10 per cent hydrochloric acid, and finally washed and dried at room temperature. The titanium thus produced is pressed into compacts which, after sintering for 16 hours at 1000° C under a vacuum, are quite ductile and can be readily fabricated.

This process, with certain substantial improvements, is being employed by the Bureau of Mines at its Boulder City Station, Nevada, where a pilot plant having a maximum capacity of about 100 pounds of titanium metal per day is in operation.

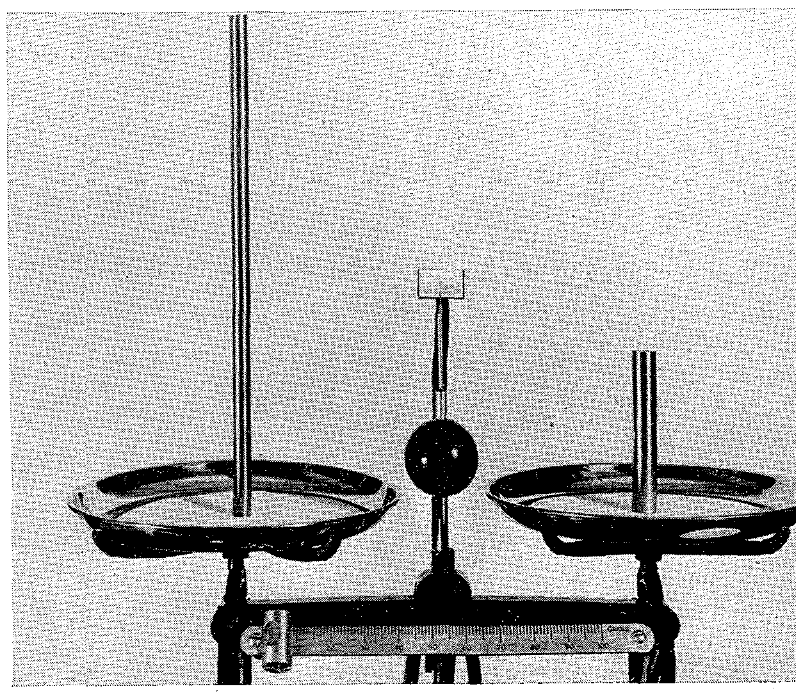
The three outstanding properties of titanium that insure its industrial usefulness are: high stress, light weight, and resistance to corrosion. The proportional limit of cold-worked titanium is as high as that of heat-treated steels and aluminum bronze, but its density is only about half as great. In many respects it is similar to stainless steel, yet it has the advantage of a much lower specific gravity, making it an ideal metal for certain vital airplane parts subject to the corrosive action of salt air and sea water.

Substantial quantities of pure ductile titanium are being distributed to various industrial concerns which report to the Bureau the results of tests conducted to determine the purposes for which this new metal seems best adapted.

METALLIC ZIRCONIUM

Zirconium is another new metal appearing on the industrial horizon that offers many advantages in the structural field.

Although this element is not as abundant as titanium, it is more plentiful than copper, zinc, and lead combined, and its ores are widely distributed. The main zirconium mineral available in this country is zircon ($ZrSiO_4$), which is present in substantial quantities in many beach sands. The zircon can be separated from other heavy minerals by standard ore-dressing methods.



This laboratory balance helps demonstrate the unusual lightness of ductile titanium, one of the "rare" metals produced in the Boulder City pilot plant. Although slightly smaller in diameter, the titanium forged bar in the left balance pan is more than three times as long as the steel forged bar in the right balance pan—yet the two metals balance evenly. (Bureau of Mines photo)

Zirconium minerals and compounds have been used for a variety of purposes. Zirconium oxide withstands temperatures as high as 2900° C, or nearly twice the melting point of steel, and hence is finding an increasing market as a refractory; zircon also plays an important role in superdielectrics, heavy-duty porcelain bodies, vitreous enamels, and pottery clays.

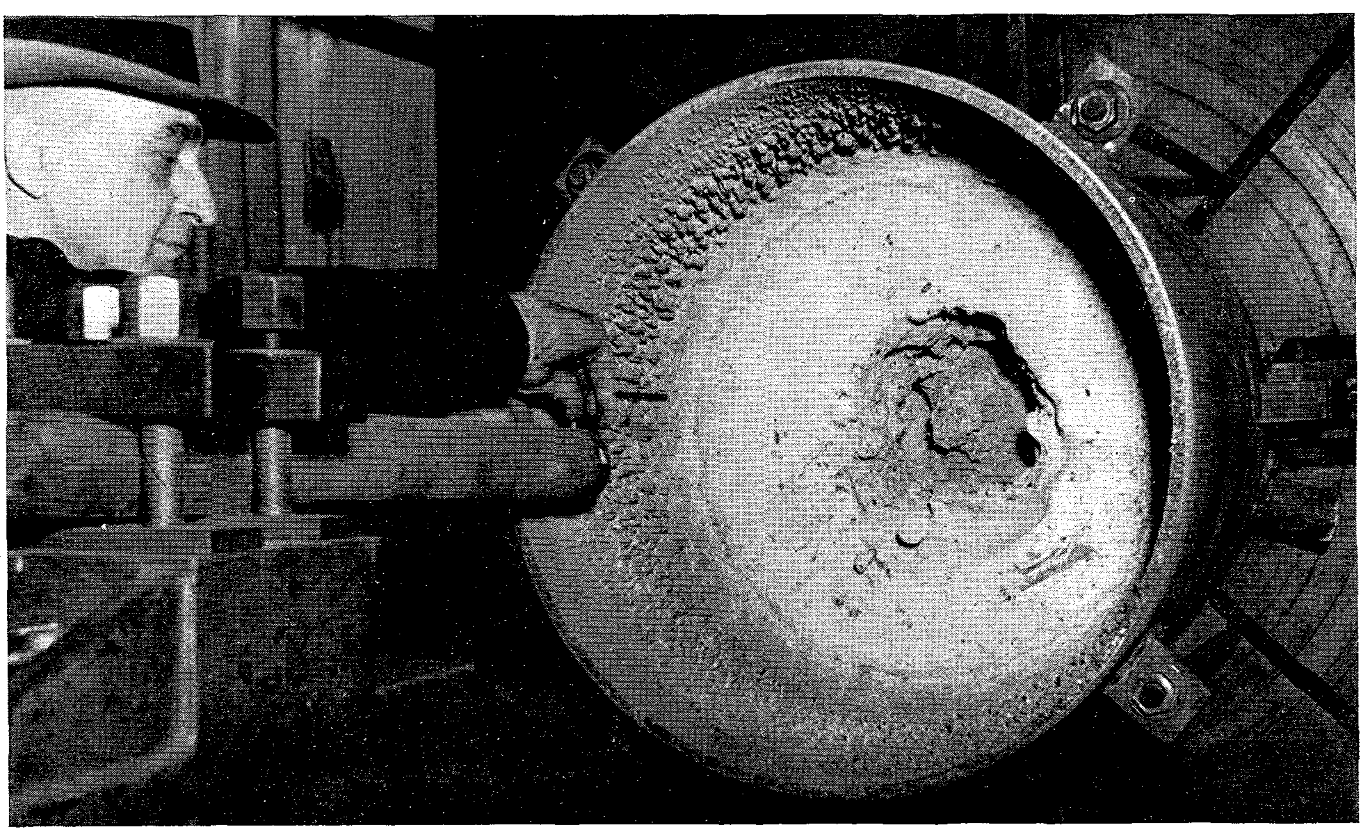
As in the case of titanium, the value of metallic zirconium has only recently been recognized, because of limited knowledge of its true properties when produced in relatively pure form. The presence of small quantities of other elements seriously affects these properties.

The process for the manufacture of metallic zirconium is similar in many respects to that employed in the production of titanium. Both metals are produced from their own chlorides, but whereas titanium chloride is a liquid that is rather readily obtained in pure form, the chloride of zirconium is a solid that absorbs water from the air, forming oxychloride which gives up its oxygen during the reducing step, seriously contaminating the zirconium metal. The manufacture of zirconium from zircon may be briefly described as follows:

A mixture of zircon and carbon is first reduced to zirconium carbide and silicon carbide in an electric furnace. These carbides are then converted into the corresponding chlorides by passing anhydrous chlorine over or through them at a temperature of 500° C. As the vapor of zirconium chloride is more rapidly condensed than that of silicon tetrachloride, it may be collected relatively free from impurities. However, if it becomes contaminated with other metallic chlorides, it can be purified by resubliming in an atmosphere of hydrogen. After separation, the solid purified zirconium chloride is vaporized and the vapor brought into contact with molten magnesium metal and reduced to metallic zirconium. The special furnace employed is operated at a temperature of 850 to 900° C and must be tight but provided with valves to permit evacuation of air and flushing with a neutral gas. Provision must also be made for the automatic release of excessive pressures.

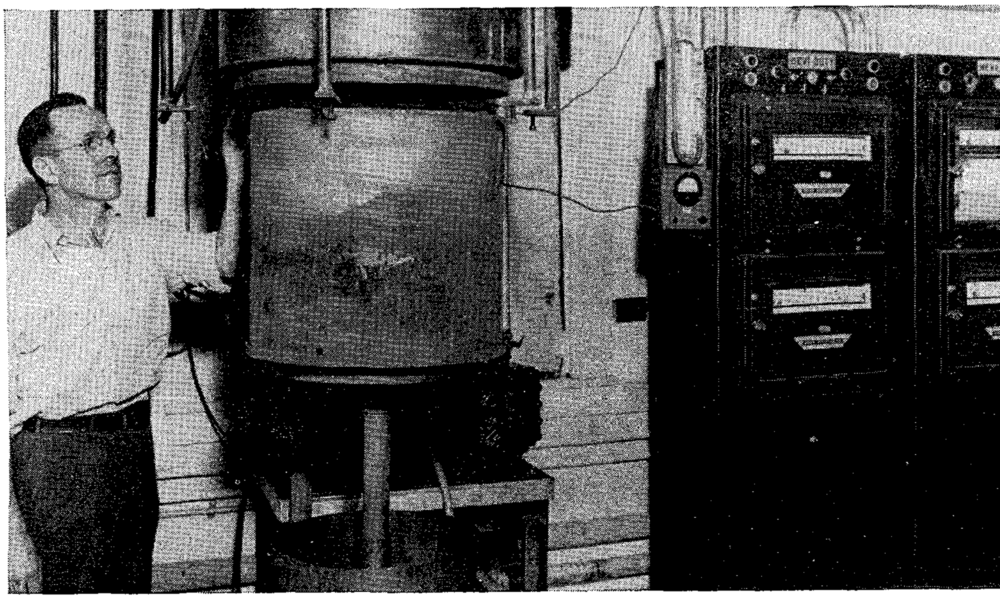
The product obtained consists of a mixture of zirconium metal, magnesium chloride, and residual magnesium. Separation of the zirconium from these other products requires a special step consisting in distilling off the contaminants under a high vacuum at 900° C. The pure zirconium remains in the furnace and, after cooling, is remelted in an atmosphere of helium and cast into ingots for subsequent fabrication. A recent advance in the metallurgy of zirconium has been the development of a successful technique whereby the metal is melted directly in a graphite crucible under vacuum, using a resistance furnace.

Zirconium ingots may be rolled hot or cold; but in the former case, care must be exercised to protect the metal against oxidization. This can be done by enclosing it in a metal sheath, which is subsequently stripped off.



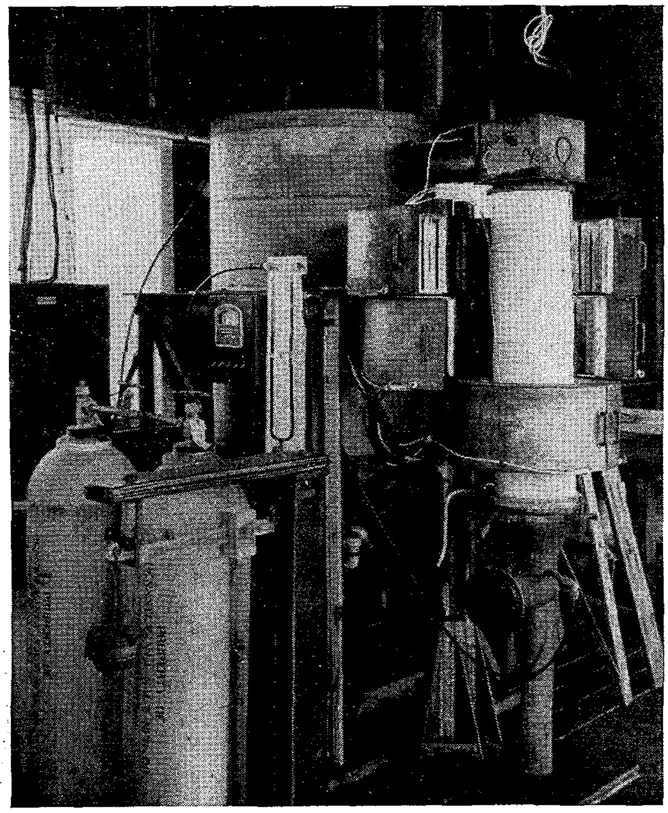
Titanium reduction pot set in lathe ready to cut out charge inside pot. (Bureau of Mines photo)

Vacuum distilling unit showing inverted container from zirconium reduction furnace containing sponge zirconium, excess magnesium and magnesium chloride, and receiver for molten magnesium chloride.



Zirconium is harder than titanium and has greater tensile strength, but is considerably heavier and melts at a higher temperature. One of the most valuable properties of zirconium is its resistance to corrosion by concentrated mineral acids; in this respect it is equal or superior to titanium, a metal that is heavier, less plentiful, and considerably more costly.

Certain military applications of both zirconium and titanium are being developed in cooperation with and with assistance from the armed forces. It is expected that these metals and their alloys will find an important place in our military machine.



CONCLUSION

These "new metals", as the term implies, are still industrial infants. Their properties and structural value have already been demonstrated, but the processes of their manufacture must be improved, simplified, and rendered more economical before such products can be made available at a price insuring production on a tonnage scale.

The three metals discussed in this paper typify the over-all objective of the metallurgical research conducted by the Bureau of Mines. Similar investigations are being carried forward on chromium, cobalt, and other critical metals, as well as on nonmetallic minerals and their products.

The Bureau's established policy is to demonstrate the feasibility of using domestic mineral resources through improved technology and to make available to industry new and better processes and products. The work is usualy conducted in several logical steps: first, certain basic principles are established through laboratory research; second, if the results obtained in the first step warrant it, the work is expanded to study factors that can be determined only by larger-scale experiments. This may be the end-point of the investigation, but it is usually necessary to demonstrate the value of the process or product on a semi-commercial scale before industry is willing to adopt it. Therefore, when funds permit, the new development is tested in a pilot plant of sufficient size to prove its commercial practicability. The Bureau then turns over the process or product to industry for commercial exploitation.

Large scale laboratory chlorination unit for production of crude zirconium chloride from zirconium carbide.

C. I. T. NEWS

STERLING APPOINTED DIRECTOR OF HUNTINGTON LIBRARY

HISTORY PROFESSOR J. E. Wallace Sterling will become director of the Henry E. Huntington Library and Art Gallery, Dr. Robert A. Millikan announced in March. His appointment is to be effective July 1, 1948. The directorship of the Library has been vacant since the retirement of the late Dr. Max Farrand several years ago.

Before coming to CalTech in 1937, Dr. Sterling served as a member of the Research Staff of the Hoover War Library at Stanford University and also did the work for his Ph.D. which he received from Stanford 10 years ago. Now Edward S. Harkness Professor of History and Government at the Institute, Sterling has been on leave twice since joining the faculty: as a Fellow of the Social Science Research Council in 1939-40; and as a member of the resident civilian faculty of the National War College, Washington, D. C. in 1947. Acceptance of the Directorship will necessitate Dr. Sterling's resignation of his regular academic post at the California Institute, but it is anticipated that he will continue to give occasional lectures there.

Announcement was also made of the reelection of Dr. Edwin P. Hubble as a trustee of the Library for an additional 10-year term. In addition to Dr. Millikan and Dr. Hubble, the other three trustees of the Library at the present time are former President Herbert Hoover, William B. Munro, and James R. Page.

METEOROLOGY DEPARTMENT DISCONTINUED

EFFECTIVE JULY 1, 1948, teaching and research in meteorology will be discontinued at the Institute, and Dr. Irving P. Krick, professor of Meteorology and several other members of the Department will resign from the Institute's faculty.

Dr. Krick and his associates plan the formation of an independent non-profit corporation to carry on meteorological research. Krick also intends to continue his activities as a meteorological consultant. Associate professor Paul E. Ruch, assistant professors Robert D. Elliott and Newton C. Stone, and instructors Loren W. Crow and Theodore B. Smith are other members of the CalTech Meteorology Department who will join him in the new organization.

President DuBridge announced that there would be no connection between the Institute and Dr. Krick's new actitivies. He also stated that CalTech had no immediate plans for re-establishing a Meteorology Department in the near future.

TOLMAN CITED BY BRITISH EMPIRE

DR. RICHARD C. TOLMAN, cited "in recognition of the valuable services rendered the Allied cause in various fields of scientific research and endeavor," was appointed as an Honorary Officer of the Order of the British Empire.

During World War II, Tolman served as vice-chairman of the National Defense Research Committee and as scientific advisor to General Groves on the Manhattan Project, for which work he was awarded the Medal for Merit. Immediately after the war he was appointed advisor to the U. S. Delegate on the United Nations Atomic Energy Commission, and now, in addition to his work at CalTech in the fields of thermodynamics, statistical mechanics, and relativity, Dr. Tolman continues to serve as a consultant to General Frederick H. Osborn, present U. S. representative on the U. N. Atomic Energy Commission.

SPRING TERM ATHLETICS

Track

TEN RETURNING lettermen form the nucleus of CalTech's 1948 track team. Dr. Floyd Hanes and Coach Mason Anderson, who is handling the field event men, expect the squad's main strength to lie in the middle distances, pole vault, broad jump, shot put, and discus. Newcomers out for track add strength in the sprints, mile, and high jump.

Three Interhouse Meet records were broken in the season's opener, and four more marks were set in the Interclass Meet, which was open to lettermen. In the 440, Stan Barnes, next year's ASCIT president, broke A. F. Du Fresne's 1938 record of 52.4 s by 0.1. Dwight Schroeder took 0.3 s off Doug Perry's mark of 26.3, set in 1928. Elroy Chinn extended the broad jump record for both the Meet and the school, with 22′ 6½″ displacing Frank McCreery's 21′ 7½″ set in 1938 and his own of 22′ 5½″ made last year. The Junior class bested the Juniors of 1926 in the half-mile relay, with 1:33.8 replacing 1:34.2.

In the Conference Relays at Occidental, CalTech came in fourth, ahead of Pomona.

Baseball

With practically a veteran lineup, Coach Ed Preisler, in his first year as varsity baseball coach, is frantically searching for a pitcher. Returning from last year's squad are 10 lettermen, but the list does not include an experienced pitcher. Best prospects are football player Glenn Chaffee, who is playing his first year of baseball, and Chuck Norman, stellar shortstop, who will be generously used if someone can be found to take over his regular position.

Very little is known about the various conference teams, but the only game played saw Redlands come from behind to trim Whittier, the defending champions 6-4.

COMMUNITY CHEST HEAD ELECTED TO BOARD OF TRUSTEES

EDWARD R. VALENTINE of San Marino has recently been elected to the Institute's Board of Trustees. Mr. Valentine, vice-president and treasurer of the Fullerton Oil Company, is also a director of the Security-First National Bank of Los Angeles, the J. W. Robinson Company, and the Automobile Club; a trustee of the Barlow Sanitarium Association and a regional vice-president of the State Chamber of Commerce. This year, he is again heading the Los Angeles Community Chest Campaign, having guided that charity drive through a successful year in 1947.

ALUMNI NEWS

PAUL MANNING '17 HONORED IN N. Y.

PAUL D. V. MANNING, M.S. '17, was recently elected to a fellowship in the New York Academy of Sciences. Election to a fellowship in the academy is conferred upon a limited number of active members who, in the estimation of the academy council, have done outstanding work towards the advancement of science.

Dr. Manning, now vice-president in charge of research for International Minerals & Chemical Corporation, was invited to join this organization in 1941 to organize and administer a new research program which has subsequently filled a vital role in the expansion and diversification of the company's efforts in the production and utilization of phosphate, potash, amino acid products, and in the field of agronomy.

WHITTIER ALUMNI NOW MEETING FOR MONTHLY LUNCHEONS

ORGANIZED THIS spring, a luncheon group of CalTech alumni in the Whittier area is meeting on the first Wednesday of each month. Any alumnus interested in joining the Whittier club should contact J. C. Harper '40, of the California Research Corp., Whittier 4-3461; or Howard Farmer '43, at Security Engineering Co. Inc., ANgelus 1-3165 or Whittier 4-2004.

Present at the April luncheon besides Harper and Farmer were: E. R. Atkins Jr. '43, Union Oil Co.; R. A. W. Bultmann '15, Union Oil Co.; W. T. Cardwell Jr. '38, California Research Corp.; I. Fatt '44, California Research Corp.; Mel Levett '38, California Research Corp.; R. S. Ridgeway '24, Standard Oil Co.; K. H. Swart '32, Security Engineering Co. Inc.; and J. W. Whittlesey '40, Standard Oil Co.

Inaugurating a new section in E&S, short biographies of two faculty members are here presented. In this issue the Department of Electrical Engineering is represented by its senior member and by the professor most recently arrived at C.I.T.

ROYAL W. SORENSEN

ONE of the most recent of many honors accorded Professor Royal W. Sorensen, head of the Department of Electrical Engineering, was his appointment a year ago as one of six prominent American scientists who visited Japan last summer. This group, the Scientific Advisory Committee, selected by the National Academy of Sciences, was sent to survey the reorganization of scientific and industrial development in Japan and to advise General MacArthur's staff concerning the proper evaluation of plans for the continued advancement of research in that country.

Consultation and research have long been specialties of Dr. Sorensen. After his graduation from the University of Colorado in 1905, he entered the General Electric Company, where he worked with design research and the solution of special problems until he joined the faculty of Throop Polytechnic Institute in 1910 to undertake the development of a Department of Electrical Engineering. Since that time, Sorensen has designed the high voltage laboratory which was built at the Institute in 1921 and taken a very prominent part in the design of many of the transmission lines so necessary for Southern California's industrial development.

Dr. Sorensen includes "thirty-seven years learning from students and faculty of the California Institute of Technology" as a very significant part of his technical education. In recognition of these many years of post-graduate learning and of his services to the profession, the University of Colorado conferred the honorary D.Sc. degree on him in 1938.

GILBERT D. McCANN

APPOINTED full professor of electrical engineering July 1, 1947, Gilbert D. McCann joined the Institute's faculty in 1946 as associate professor.

Dr. McCann first came to CalTech in the early 1930s, receiving his B.S. degree in '34, his M.S. in '35, and his Ph.D. in '39. From 1935 to 1938, he was also a teaching fellow in electrical engineering.

In 1938, Dr. McCann joined the Westinghouse Corporation in Pittsburgh as central station engineer. In 1941, he became transmission engineer in charge of lightning research and in 1946 was made consulting transmission engineer in charge of their Analysis Laboratory and lightning research, in which position he remained until joining the Electrical Engineering Department at CalTech in 1946.

At the Institute, McCann has continued the development of an electric analog computer and is engaged in a high voltage research program on the dielectric recovery characteristics of power system insulation. The high voltage research program is being supported cooperatively by the Southern California Edison Company, the Kelman Electric Company, and the Department of Water and Power, City of Los Angeles. The analog computer, which was described in a talk before the alumni in 1947 ("The Development of an Electrical Calculator"), is now being used on engineering problems for the Institute and numerous engineering organizations in Southern California.

A member of AIEE, ASME, Sigma Xi, and Tau Beta Pi, Dr. McCann was awarded the AIEE National Best Paper Prizes in 1941 and 1946, and received honorable mention for the Eta Kappa Nu award for "the outstanding young electrical engineer in the United States" in 1942.

With the Board

IT WAS WITH great pleasure that the Board of Directors recently voted Professor Sorensen an honorary member of the Association. This action, although a sincere attempt to express heartfelt gratitude to a great and good friend, seems inadequate as a means of expressing the appreciation and good wishes felt by all alumni. We know however, that Professor Sorensen will understand that this action bespeaks friendship and respect beyond the ability of any medium to convey fully.

* * * * *

Fred Schell told of plans that Fred Peterson is making for an Alumni field trip in May. The place to be visited had not been decided by deadline time, but perhaps by now you know. Our bet, based on the discussion, is that it will be a good trip.

Fred Schell also told of plans for the annual banquet and of his attempt to hold this at the Athenaeum. In the past the banquet chairman has been on the horns of a dilemma; either he holds it at the Athenaeum and has to reject some late applications for reservations, or he holds it at some remote and less desirable location and doesn't attract as many reservations as could be accommodated. It seems that perhaps the best solution is to hold it at the Athenaeum and reward the early applicants with tickets.

* * * * *

By the time this appears the Annual Seminar will have been held and an experiment which now seems very attractive will have been tried. As a result we shall have some information on the desirability of providing a program for alumni wives. When Carl Tutschulte started to prepare a wives' program he wasn't fully convinced that it would be popular. As he got into his planning, however, he found that the wives who were asked were very enthusiastic in supporting and cooperating in the arrangement of such a program.

The Board of Directors and Seminar Committee would appreciate receiving your opinion of this experiment as an aid in guiding future Seminar Committees. A card to the Editor will do it.

H. K. F.

Professional Engineering Registration in California

(Continued from Page 2)

under the direction of a Civil engineer legally qualified to practice. All applicants must be of good character and Civil engineers must be at least 25 years old.

Since engineers other than Civil engineers may practice engineering in California without registration one may well ask, "Should engineers register?" The number of applications received by the Board since September 19, 1947 as listed below, in round numbers, may serve to answer the question for some.

Number of applications for Professional engineering registration September 1947 to March 31, 1948:

Chemical	300
Electrical	750
Mechanical	1300
Petroleum	300

About 1,000 Civil engineers applied for registration during 1947 and the applications filed to date indicate the same number for 1948.

Civil engineers have been registering in California since the passing of the original Act in 1939. That act has been amended several times. The first amendment provided special registration for Civil engineers acting as structural engineers, and the last one, September 19, 1947, provided for registration of Chemical, Electrical, Mechanical, and Petroleum engineers.

Who is qualified for Registration? Obviously the first requirement is excellence of character.

The second is a proper knowledge of the fundamental sciences, and the mathematics that are the tools of the engineer.

The third is a conception of the principles of engineering in terms of the physical use and dimension parameter of the material and methods involved.

In evaluating these characteristics, it is obvious the many persons not engineers use engineering methods to a limited degree and are thereby often specialty technicians rather than engineers. So long as these men do not call themselves engineers they have no reason for registration, and by the same token should not per se consider a knowledge of codes as qualification for professional engineering registration.

Those who have operated under the registration act viz the Civil engineers have found the act good and it is the opinion of the writer that the engineers now registering will, as time passes, learn that much has been gained in fixing the standards of the engineering profession.

The writer is a member of the present Board of Registration, but the views expressed are solely his own individual opinions and should not be construed in any way as official Board regulations.

PERSONALS

1920

WILLIAM C. RENSHAW, formerly with the San Francisco Water Department's engineering organization, has recently been appointed water engineer for Inglewood, California.

1927

ROBERT B. VAILE JR., Ph.D. '36, is now employed in a supervisory capacity by the Armour Research Foundation, Chicago. From June 1941 to October 1945, Bob was on the staff of the Naval Ordnance Laboratory as chief of the Applications Subdivision of the Research Division, engaged in research and development of naval ordnance.

1930

HERBERT H. DEARDORFF, with the State Division of Highways, has recently been transferred from San Francisco to the Sacramento office of the Division.

WALTER C. MICHELS, Ph.D., has returned to Bryn Mawr College, where he is professor of physics. In 1941 and 1942, Michels was with the Naval Ordnance Laboratory. After September 1942 he entered the office of the Chief of Naval Operations, first as a civilian and later as a naval officer, serving a short term with a Naval Technical Mission to Japan.

1931

LUCAS A. ALDEN, Ph.D. '35, is assistant treasurer in International Trade, Shipping & Banking at W. R. Grace & Company, New York.

CHARLES K. LEWIS, M.S. '32, formerly with Morrison-Knudson Company, Inc., has accepted a position with Clingan and Fortier, Inc., San Francisco. Lewis has charge of engineering and the general supervision of the reinforcing and structural steel placing and erection operations of this firm.

CHARLES A. WILMOT, with the Ethyl Corp., was transferred to Baton Rouge, La., at the first of the year. Charles continues as a chemist.

1932

LYNN H. RUMBAUGH, Ph.D., is chief of the Research Department of the Naval Ordnance Laboratory in Washington, D. C. From October 1940 to December 1941 Rumbaugh was engaged in degaussing work at the NOL and then spent the major part of 1942 in the South

Pacific, and Southwest Pacific areas in ordnance and advance base planning work. During the war, his principal activities were in torpedo development and various other problems such as the development of magnetic airborne magnetometers for geophysical survey.

MERIT P. WHITE, M.S., Ph.D. '35, is professor of Applied Mechanics in the Department of Civil Engineering at the University of Massachusetts. A School of Engineering has been established at the University in the last year, and White writes that "it is already doing rather well".

1933

EDGAR G. CRAWFORD is the project manager for J. E. Haddock Company, Contractors, on a large home-building project for Marine View Inc. in the San Pedro hills.

RAY H. CRIPPS and ARTHUR E. LAMEL, partners in American Electric Motors, Inc. of Los Angeles, have just announced a plan to give 10-year employees of their factory a year's paid vacation. In partnership with Philip W. Zonne, Ray and Arthur took over the direction of American Electric Motors, Inc. a year ago.

1935

LAWRENCE W. BALDWIN has been promoted to head the External Instrumentation Section of the Naval Air Missile Test Center, Point Mugu, Calif.

1936

TYLER THOMPSON is the minister of the Weston Methodist Church in Weston, Mass. Ty and family are considering a return to the Orient after he receives a Ph.D. in philosophy some time in the near future.

1937

COL. DONALD P, GRAUL, M.S., former commanding officer of the Air Materiel Command's Watson Laboratories at Red Bank, N. J., was named deputy chief of the Electronics Subdivision of the AMC Engineering Division, Wright Field, Dayton, Ohio.

NEWMAN A. HALL is now professor of Mechanical Engineering at the University of Minnesota.

JACK KINLEY is doing the research for the M. M. Kinley Company, Oklahoma on applications of explosives to the oil industry and on new tools and servicing methods. Kinley has assisted his father for six years in oil and gas well fire-fighting and blowout plugging.

DEAN NICHOLS has started a medical practice in his home town, Helena, Montana. Dr. Nichols served his internship in Baltimore city hospitals and later became a fellow in dermatology and syphilology in the Mayo Foundation Graduate School of the University of Minnesota at Rochester. He will limit his practice to diseases of the skin and syphilology.

1938

WILLIAM R. SEARS, Ph.D., was recently inducted as a fellow of the Institute of the Aeronautical Sciences. Sears received a certificate in recognition "of valuable contributions to the advancement of aeronautics" at the Institute's Honors dinner last January. He has served as director of Cornell's Graduate School of Aeronautical Engineering since it opened in 1946. From 1941 to 1946 Sears was chief of aerodynamics for Northrop Aircraft, Inc., at Hawthorne. He is also a member of the scientific advisory board to the commanding general of the Air Forces and the aerodynamics committee of the National Advisory Committee for Aeronautics.

HOWARD SEIFERT, Ph.D., lecturer in jet propulsion at the Institute, informs us that his wife, Mary Harris Seifert, has just been awarded a Eugene Saxton Memorial Fellowship by Harper and Brothers, publishers. The fellowship consists of a grant of $1,200 for the year 1948 to assist her in the completion of a novel portraying American family life. Mary previously was secretary to the Institute's Physics Department and to the Purchasing and Building and Grounds Department, and wrote a column for the "California Tech".

1939

CAROL M. BEESON, Ph.D., has resigned from the Production Research Division of General Petroleum to take the position of associate professor of Petroleum Engineering at USC.

GEORGE M. HOTZ married Miss Elizabeth B. Armiger of Washington, D. C. last February.

1940

JOHN M. WILD, associate professor of the Graduate School of Aeronautical Engineering at Cornell University, spoke at the 16th national meeting of the Institute of Aeronautical Sciences in New York last January on the research in aerodynamics carried on at Cornell during the past year. Before going to Cornell in September 1946, Wild worked with Northrop Aircraft, Inc. in Hawthorne as supervisor of aerodynamics.

1941

LEO C. LEVITT received an M.A. in physics from Princeton in April.

JOSEPH WEISS was married in February to Miss Phyllis Kaligan of Hollywood. Joe is working for the Westinghouse Electric Corp. in Los Angeles as a panelboard sales engineer.

1942

FOREST M. CLINGAN, a lieutenant in the Navy, is presently stationed in Washington, D. C.

SYDNEY K. GOLD, who is working with the Bahrein Petroleum Company Limited in New York City, has been in California recently for a couple of months on an engineering assignment, working with the Bechtel Corporation in San Francisco.

ROBERT F. HALL is working as an engineer for Western Electric Company in Kearny, New Jersey. Bob has a 15-month-old son, Robert Davies.

WARREN HALL is a full time lecturer in the UCLA Engineering Department. He is also registration advisor to all transfer students.

CARTER HUNT, with Hiram Walker & Sons, Inc., was transferred this spring from Peoria, Ill., to their West Coast offices in San Francisco.

JOHN W. MILES, M.S. '43, A.E., Ph.D. (E.E.) '44, is an assistant professor in the UCLA Engineering Department. In addition to teaching courses in electrical, and aeronautical engineering, he has done some consulting work for local industrial firms and teaches ccurses in mathematical analysis.

MEREDITH M. NYBORG is now a test engineer at the U. S. Naval Air Missile Test Center at Point Mugu, California.

GEORGE P. SUTTON writes that he is now a research engineer with North American Aviation. He informs us that DOUGLAS HEGE and TOM COLEMAN (both M.S. '46) are also working for North American, and that MERLE SMALLBERG '42 is with Marquard Aircraft.

1943

RICHARD A. SUTTON, M.S. '47, has recently started work for the Creole Petroleum Corporation and is stationed in Marcaibo, Venezuela.

FRED H. TENNEY, reported a medical student at the University of Rhode Island in the March issue of **E&S,** writes to correct the item: "I am currently a graduate student at the U of Rochester with hopes of a Ph.D. in physics. The medical student of closest kin is my wife who is also enrolled in the U of R."

1944

GEORGE E. ALVES has just become engaged to Miss Marguerite Ethel Wilson of Delaware. George is doing research at the E. I. du Pont de Nemours experimental station in Wilmington and his fiancee is teaching in the Newark, Delaware school system.

1945

WILLIAM B. ROGERS married Miss Martha E. Young of Kalamazoo, Michigan last February. Bill also graduated from the University of California's school of engineering at Berkeley in February.

FRANK M. DAY became engaged to Miss Doris Anne Weyl of New York last February. Frank is now working with The Budd Company in Pennsylvania.

1946

CHARLES HENRY KING JR., M.S., was married to Miss Nancy Arnold of Rhode Island last December. Charles is now a research chemical engineer with the Pratt and Whitney Division of United Aircraft Corporation in Hartford, Connecticut.

HENRY THOMAS PONSFORD, M.S., A.E. '47, now studying for a Ph.D. at the Institute, married Miss Marian Madden of San Francisco last December.

STUART A. WARREN, M.S., is now operations coordinator at the rocket test station of North American Aviation in Inglewood. Stu's family has just been increased by a girl—he now has three daughters.

1947

BURTON CRUMLY entered General Electric's test program after graduation, and spent August and September on Locomotive Control Engineering. Burt was then accepted for the Advanced Engineering Course and was transferred to Schenectady, where he worked on Steam Turbine Test. At the time of writing he expected Industrial Control to be the next step in his training program.

HARRY H. HAUGER was the recipient of the ASME's **Spirit of St. Louis** award for 1945 through 1948 at the Southern Calif. Section's Junior Awards Dinner, March 30. Harry is an air conditioning engineer with Douglas Aircraft.

ALLEN EUGENE SENEAR, Ph.D., became engaged to Miss Virginia Koch of Illinois last January. During the war, Allen worked for the Institute on government-sponsored research, and he is now located in Santa Barbara, where he is an instructor in chemistry at Santa Barbara College.

ANNUAL ALUMNI
Banquet & Meeting

JUNE 11 ATHENAEUM
6:30 P. M.

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Dr. Ray E. Untereiner, Professor of Economics, will speak.

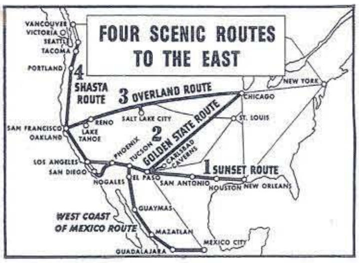
Topic: "How's Every Little Thing?"

ATTENDANCE AT DINNER WILL BE LIMITED TO 200

NOTICES WILL BE MAILED TO ALUMNI

The Main Line

MAY, 1948



JUNE WILL SOON be bustin' out all over. That means final exams, graduations —and school vacations. That means weddings—and honeymoons. That means the start of office vacations—and two weeks with pay. Add them all up and the total is *travel*—and lots of it.

So, friends, a suggestion: the time has come for you to start planning *your* summer vacation.

Have you decided on where, how and when you are going? We have some suggestions for you—four routes-worth of them. We sum up these suggestions (capsule them) thus: "Go one way, return another, see twice as much en route." Expanded slightly, here's our story:

Southern Pacific is the only railroad with four routes East from the Pacific Coast. You can dream up *six* completely different roundtrip expeditions East via S.P.—and experience practically every scenic thrill America has to offer. (And if you want an extra portion of any of the thrills, you can stop over anywhere en route.)

Our routes—as per the little map—are:

1. Sunset Route—the colorful Los Angeles-New Orleans route across Southern Arizona's dude ranch area, through rolling rangeland deep in the heart of Texas, and along Gulf-side bayou country to the center of the Old South.

2. Golden State Route—the direct, *low-altitude* way from Los Angeles to Chicago and all the East, along the Longhorn Trail of the pioneers.

3. Overland Route—the shortest, fastest route between San Francisco and Chicago over the High Sierra and Rockies.

4. Shasta Route from San Francisco via the Evergreen Pacific Northwest connecting with eastbound lines from Portland, Tacoma, Seattle, Vancouver.

(P.S.: West Coast of Mexico Route, too—*si quere viajar a* Mexico City.)

There's lots more to the story of vacations via S.P. We couldn't possibly give it all here—even as a serial. So look what we've put at the bottom of the column: a coupon, with lots of space for you to let us know what *you'd* like to know re S.P. vacationing. Fill it out, drop it in the mail, and we'll send back—posthaste—just the information you require. There's no obligation, of course —but do it now, because time is of the essence in vacation planning.

DOES YOUR BUDGET threaten to ball-and-chain you to an at-home vacation? We've got some thoughts on how to fit a trip to your purse—three to be precise. They are, from left to right:

Rail Traveloans—a way to go traveling on time payments. You can even finance your hotel bills, equipment (including clothes) and incidentals. Rates are low, monthly payments are tailored to fit your pocketbook, and you don't start paying until after your vacation.

Chair cars offer a neat combination of comfort and economy on some of our topmost trains.

Tourist sleepers—comfortable, modern Pullman travel for dollars less—both for rail tickets and for berth charge. They're in service on trains on all S.P. lines out of Los Angeles.

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