ENGINEERING AND SCIENCE

MONTHLY

MARCH 1948

BY-LINES

WILLIAM M. GOODALL

William M. Goodall is a research engineer for the Bell Telephone Laboratories of New York City. Born in Washington, D.C., he spent most of his early life in Southern California where he attended Hollywood High School and graduated from C.I.T. in 1928 with a B.S. in physics.

About to complete his twentieth year with the Bell Laboratories, Goodall has been working on research problems in connection with the ionosphere, radio transmission, early radio relay systems, radar modulators and most recently, microwave radio relay systems.

COVER CAPTION

Forms in place for the Biology basement addition. See story on page 5. This photograph, taken February 6, shows the corner of Wilson and San Pasqual streets, from the Biology parking lot. Bases for the ventilating machinery have already been poured, and may be seen with attaching studs in the bottom of the pit. The walls were poured on February 16.

"Wilson Hill", the dirt excavated from the pit, has settled so much that additional dirt may have to be brought in from the outside in order to fill around the basement walls.

This month's cover and the pictures on pages 4 and 6 illustrating "New Construction on Campus" were photographed by Ralph Lovberg, sophomore in physics from Missoula, Montana. Lovberg was last year's recipient of the Tau Beta Pi award to an outstanding member of the freshman class on the basis of scholarship and campus activity. His extracurricular activities include: staff photographer for the Big T, secretary of Blacker House, inter-house baseball, glee club, and work on Tech's analog computer project.

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ENGINEERING AND SCIENCE
Monthly
The Truth Shall Make You Free

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ENGINEERING AND SCIENCE MONTHLY

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Index to Advertisers

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Letters

SOME TIME ago I received a copy of your magazine ENGINEERING AND SCIENCE, which I have read from cover to cover. I frankly believe this magazine is the best of its kind.

Wm. V. Moseley, Jr.
Richmond, Virginia

(We couldn't leave this one out—Ed.)

I LIKED your article on Professional Engineering which appeared some time ago. The P.E.'s in this area do not have the life or incentive to organize properly—most of them arrived via the grandfather method. In the state of New York though, one may now obtain an automobile license with the letters PE preceding the numerals just as MD licenses indicate the medical profession. They are obtained through the National Society of Professional Engineers.

Beverly F. Fredendall '29
Poughkeepsie, New York

With the Editors--

IT IS NOT OUR usual custom to plug other colleges and universities in our columns; this is a C.I.T. journal and will remain so. In spite of that, we will here devote a word to Antioch College, Yellow Springs, Ohio.

This school has, for over 25 years, carried on a cooperative work training program with research laboratories, social settlements, government bureaus, newspapers, industrial plants, business offices, schools, hospitals, department stores, and other organizations throughout the country. Two school terms in the fall and two more in the spring give duplicate courses, permitting work periods totaling 26 weeks in length without missing the continuity of classes. Most jobs are held by two students who alternate, one working while the other studies. Staggered one-month summer vacations make it possible for year-round continuity of work. One year of full-time study plus four of alternate work and study is the usual Antioch course for the B.A. or B.S. degree.

All of this is leading up to the announcement that we are privileged to have the services of an associate editor, Miss Edith Whitfield, for a 10-week period which is to terminate at the end of March when she will resume classes at Antioch. Miss Whitfield, who is in the middle of her junior year, has in previous cooperative training periods worked for the United Press and **Mademoiselle**, and this past fall visited San Salvador in the Bahamas, on a movie-making expedition.

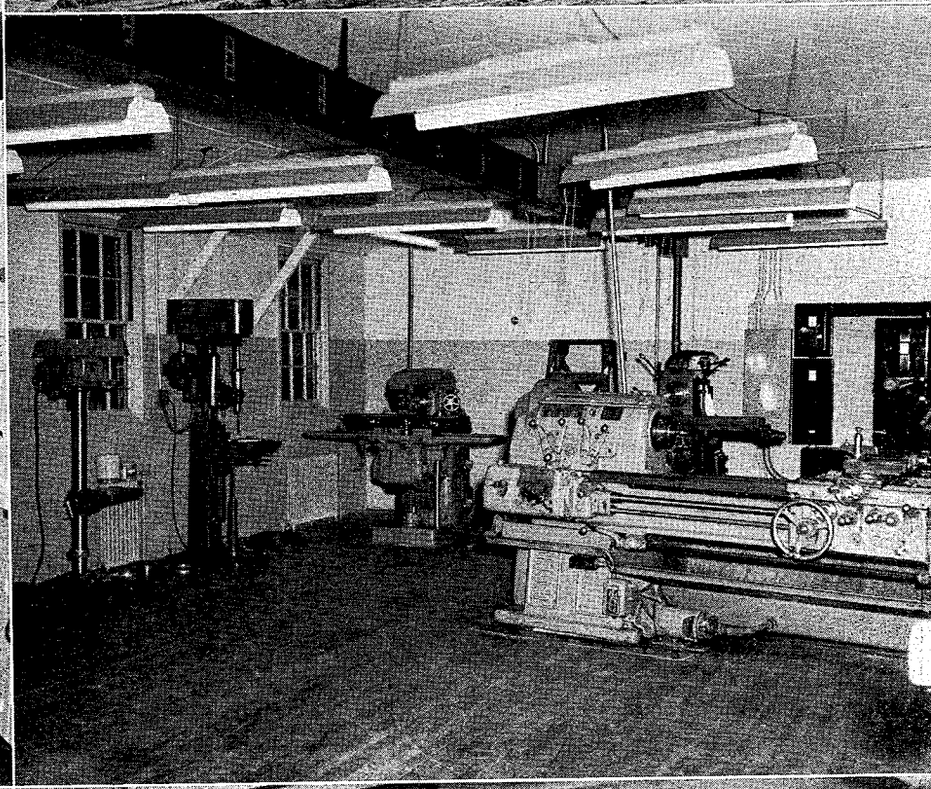
* * * *

Some advantages, we find, are inherent in the Editorial Office's location in temporary building T-2. This building, as pointed out in the article "New Construction on Campus," houses a rather cosmopolitan group, academically speaking at least. When W. M. Goodall's article "Removing the Distance Limitation in Communication" was being reviewed in this office, the editorial staff found itself slightly off base when it came to the "binary" number system used to represent Pulse Code Modulation. Down the hall, however, are half a dozen graduate assistants in mathematics, most of whom are candidates for the Ph.D. Two, Carl Savit '42 and Bob Benton '43, volunteered to annotate the text with a brief explanation of the "binary" system as it applied to author Goodall's illustration. Their clarification has been tried out on everyone visiting the office, and has met with general approval. While **E&S** is being published in T-2, we anticipate the solution of similar editorial problems in chemical, electrical, mechanical, and civil engineering in a manner just as painless.

* * * *

The issue to watch for this spring, we reiterate, will be the **E & S** featuring the Palomar Mountain installation. This number will reflect the years of work that have gone into the Palomar project, and will set forth some of the bright hopes for its future operation. One important article in this issue will be concerned with the administration of the Mt. Wilson and Palomar Observatories by CalTech and the Carnegie Institution of Washington acting jointly. This administration is as new as the Observatory, since Mt. Wilson has heretofore been operated by the Carnegie Institution alone, with the California Institute Division of Astrophysics cooperating in the research program.

W. P. B.



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NEW CONSTRUCTION ON CAMPUS

ONE CREW of the contractor Ray Gerhart has been eating in a little lunch stand at the corner of California and Lake streets for the last four years. Since construction was started on the receiving warehouse in 1944, there has been enough work on campus to keep the crew busy almost steadily.

The current project of Gerhart is an underground laboratory for Biology. This construction, now a hole 100 feet wide, 100 feet long, and 12 feet deep, near the corner of Wilson and San Pasqual streets, has eliminated a large part of the Biology parking lot. However, when the job is completed, the concrete roof slab will be finished near ground level, and the parking space will be back to its original proportions.

No new projects are planned for the additional space this basement will provide. Laboratory animals—rats, mice, and rabbits—will be moved from their present quarters in Kerckhoff basement to the new addition. An extensive ventilating system with both intake and exhaust blowers will provide an environment in which the animals can live and reproduce most favorably. Two temperature levels will be maintained — rabbits prefer cool living quarters, while rats and mice are happiest at normal room temperature. In addition, this push-pull fan system will maintain a slight pressure differential between Kerckhoff basement and the new laboratory, thus assuring that no air-borne infestations from animal litter can enter the main building. With both air-tight doors between Kerckhoff and the laboratory open, air will be drawn out of Kerckhoff.

Moving the animals out of the Kerckhoff basement will release space for the Biology shops and stock room. The room now filled with animal cages, originally designed for a storeroom, will be so used, while the present storeroom will provide added shop space.

More than two years of planning have gone into this project, on which work commenced last December. The construction is part of a long-range plan that will include an "L"-shaped addition to Unit 1 of Kerckhoff—the west half of the present laboratory—proceeding north and west. Planned to be a joint effort of Biology and Chemistry, this wing will house biochemistry and immunology laboratories. The roof of the animal quarters will form a court or terrace with Kerckhoff and the Biochemistry "L" on three sides and entrance from the west. A subway exit to the parking lot will eventually connect the animal laboratory and the projected Biochemistry addition. Footings for the walls of the new laboratory have been set sufficiently deep to permit construction of a sub-basement in the future wing without undermining present construction.

UPPER LEFT: Excavation for the new Biology basement annex from the top of Kerckhoff Laboratory. The parking lot entrance ramp can be seen outside the forms at right center.

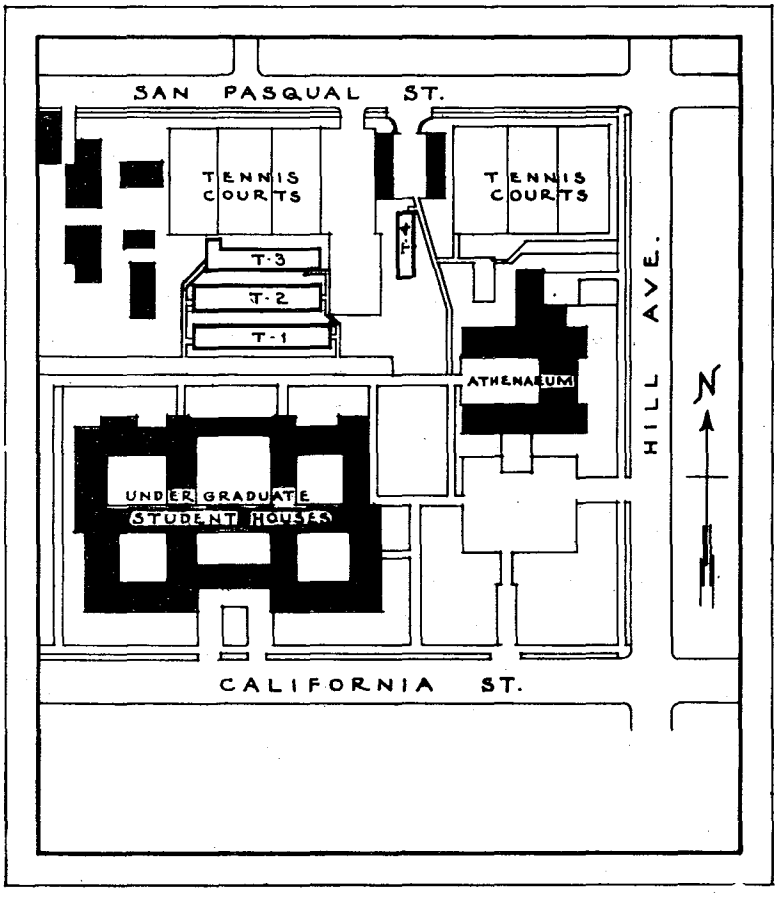
UPPER RIGHT: Temporary buildings T-1 and T-2 from the campus paint shop. Fleming House is on the right. T-3 is to the left of picture.

CENTER LEFT: Office of Dr. J. C. Shrader in the Health Center. Nurses Mrs. Jewell Johnson and Miss Elizabeth McMichael are recording a patient's troubles.

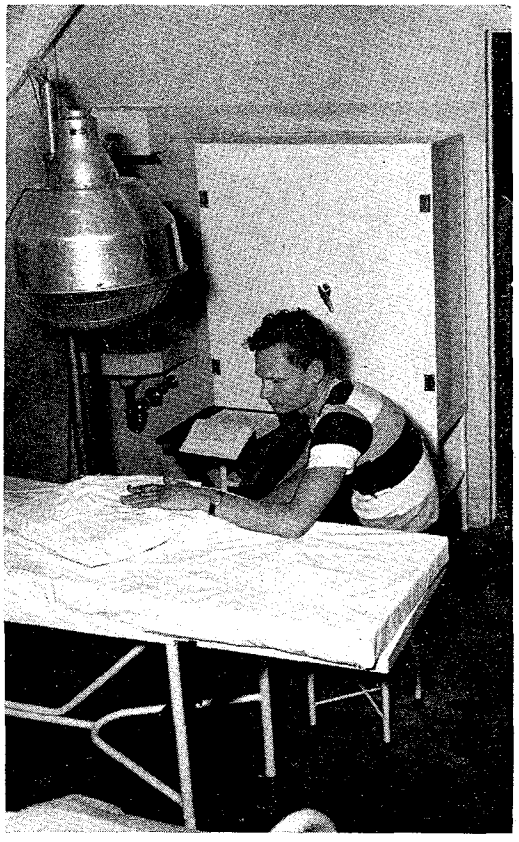
CENTER RIGHT: The new Chemical Engineering machine shop in T-3. Not finished when the picture was taken, it will be in operation this month.

LOWER LEFT: T-1, looking northwest from the student houses. This building provides room for the Athletic Office, and laboratories for soil mechanics, sanitary and structural engineering.

LOWER RIGHT: Interior of the expanded Athletic Office. Mrs. Miriam Coyle and Miss Louise McGee discuss the golf season with Throop Club President Bob Benton.



Plot plan of the east end of the Tech campus, showing the new temporary buildings.



Sophomore Dwight Schroeder bakes a cut finger under the sun lamp in the Health Center.

Of great importance to other overcrowded departments on campus are four newly erected buildings supplied by the Government from the Santa Ana Army Air Base. These temporary quarters, made available to C.I.T. through the act of Congress providing educational facilities for veterans, are shown on page 4. T-1 houses an expanded athletic office, and laboratories for soil mechanics, sanitation, and structural engineering. T-2 relieves crowding among graduate assistants, holding approximately 54 men in 28 offices. Represented are the mathematics, chemical engineering, mechanical, and electrical engineering departments, as well as public relations and **Engineering & Science.** T-3 is solely for the chemical engineers, providing shop facilities and drafting and computing rooms. Moved from Gates Laboratory basement, the shop will be less crowded, and at the same time permit the Chemistry Department shop to increase its own facilities.

Probably most important of all is the Health Center in T-4. Dr. Kremers and staff have moved from Kerckhoff into this building which has rooms for waiting, consultation, student infirmary, well-baby clinic, and emergency first aid. As this building was originally intended to house Dr. G. D. McCann's analog computor, it can be used only as a day clinic until negotiations are completed with the State Department of Health to permit its utilization as an infirmary.

Moving and erection of these buildings were accomplished at small cost to the Institute. The Government awarded contracts for transporting them from Santa Ana and for rebuilding with war surplus materials. However any needs not met by surplus stores were provided by C.I.T., such as connections for water, electricity, and sewers. Also, the buildings were reroofed with aluminum, which was located in war surplus.

Until the projected engineering quadrangle is completed, and additional housing units provided on campus for undergraduate and graduate students, these temporary buildings will give excellent service. Occupants of these shops, offices, and laboratories will have to move before any student housing construction can be initiated, as further units for undergraduate and graduate students will probably be constructed on the site now occupied by the temporary buildings.

Since the temporary quarters are now filled, and the Biology basement will be ready for occupancy in June, it is quite possible that Ray Gerhart's CalTech construction crew may change lunch rooms this summer, after four years.

Removing the Distance Limitation in Communication

By WILLIAM M. GOODALL

MANY READERS are familiar with the difficulties of long distance telephony. The signal currents, unless amplified, become attenuated and at a distance of a few hundred miles become lost in a background of noise. In telephone practice, this condition is avoided by amplifying the signal at frequent intervals. The amplifiers have come to be known as repeaters. Even in a system using repeaters, noise ultimately becomes a limiting factor, since the final noise output is the sum of the noise powers accumulated in each link. This is so because the noise from each link becomes part of the signal and is amplified by subsequent repeaters in the same manner as the original signal. In order to prevent the signal from being swamped by the noise, it is necessary to increase the signal power output from each repeater. A constant signal-to-noise ratio can be maintained by increasing the power of each repeater by a factor equal to the number of links in the system. Thus, for a 100-link system, the noise is increased 100 times and the power output of each repeater must be increased 100 times to maintain the same signal-to-noise ratio (S/N).

Since it costs money to provide increased power output from a repeater, it is important instead to decrease the noise arising in each link. There is a fundamental limit, however, to this process, and when the minimum noise has been attained the same limitation on power exists; it is still necessary to increase the power of each repeater in order to transmit over longer distances.

For telephone message circuits, this limitation has long since been overcome and long distance telephony is well established. For wide-band high-fidelity circuits, however, the limitation is more serious. Likewise for microwave radio relay systems, where high power is expensive and noise is more serious, the distance limitation is an important one. With this background, we proceed to a discussion of a method of transmission which avoids the addition of noise for each repeater link.

Before considering this method of transmission, it will be expedient to consider the types of signal waves used in electrical communication. It will be seen that in telegraphy, for example, a system of transmission which avoids the addition of noise at each repeater has been in use for some time. This consideration will indicate how the telephone signal could be modified to obtain the same transmission advantage.

Two broad classes of signals may be used: those with a limited and those with an unlimited number of conditions. In the first category is the On-Off type of signal used in most telegraph circuits. As is well known, perfect reception of telegraph signals can be obtained, provided only that it is possible to recognize whether the signal is on or off. Thus, it is seen that this type of signal is relatively insensitive to noise and distortion arising in the transmission medium. In fact, by regenerating the signal before it has become too badly distorted, it is possible to repeat a telegraph signal indefinitely without impairing the original message content. Regeneration is accomplished by retransmitting a new noise-free signal, controlled by a device which determines the presence or absence of a signal at the input to the regenerating repeater. Thus, in a system using regenerative repeaters, the noise does not accumulate from link-to-link and the output of the final repeater is as good as the output of the first repeater.

The second category includes unaltered signals from a telephone, those produced by a television system, and other similar signals. Here a wide range of finely graduated amplitudes or conditions is necessary for satisfactory reproduction at the receiving end. It has been common practice to transmit signals in this class so that there exists a one-to-one correspondence between the signal wave and either the amplitude or the frequency of a carrier wave. When this is done, the signal wave is transmitted by continuous modulation. Noise and distortion arising in the transmission medium add up for each repeater, as regeneration is not possible for a truly continuous signal.

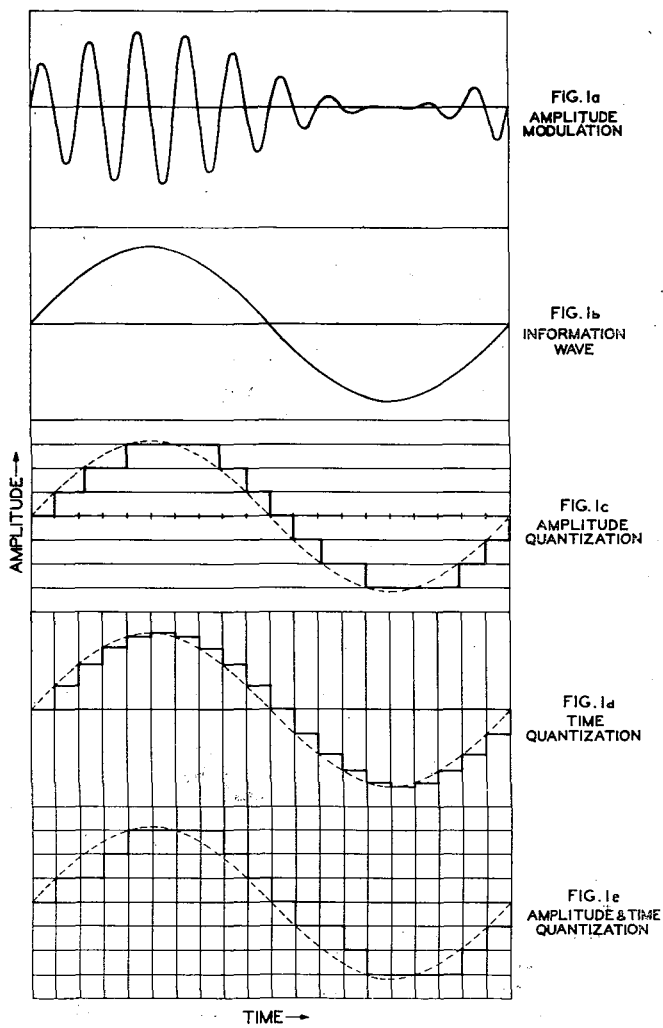


Fig. 1

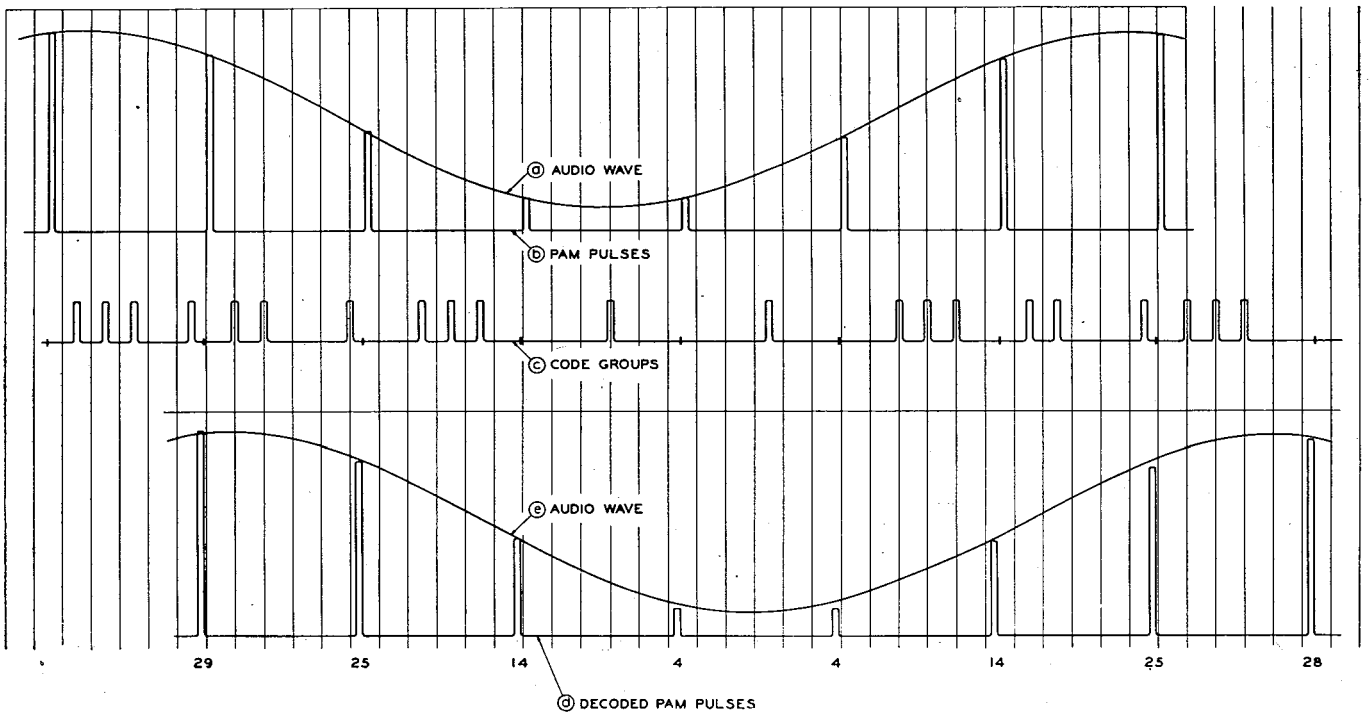


Fig. 2

Since regeneration can be used for signals representing a limited number of conditions, it would appear that it would be profitable to convert the continuous signal into a discontinuous one. The process whereby this is accomplished is termed "quantized modulation." The difference between quantized and continuous modulation is illustrated by waves shown in Fig. 1.

In continuous amplitude modulation, the instantaneous amplitude of the "carrier" varies in a continuous manner with the signal or information wave. This is illustrated by Fig. 1a, which shows the result of amplitude modulation of a carrier by the low frequency wave given by Fig. 1b. This is an example of a method of transmission where the signal-to-noise ratio obtainable in a single link limits the maximum length of the repeater system because of the accumulation of noise.

In quantized modulation, a wave quantized in either amplitude or time or both is generated under control of the information wave. Example of waves of this kind are given in turn by Figs. 1c, 1d, and 1e, where the dashed line represents the same information wave as is shown in Fig. 1b. In order to regenerate the wave, it is necessary to quantize in both amplitude and time. Thus Fig. 1e is an example of a wave that can be regenerated and repeated indefinitely without further distortion.

In Fig. 1c, which is an example of amplitude quantization, it is seen that the quantized wave changes from one level to the next at those times when the information wave has changed a full quantum. In practice, the amplitude quantum would usually be much smaller than the one chosen for this example. Even here, however, it is seen that the quantized wave gives a fair approximation to the original wave. Since it is not possible to represent the original wave exactly, a quantizing distortion results. If the magnitude of this distortion is sufficiently small, it has characteristics similar to random noise. However, the magnitude of this effect depends upon the size of the quantum chosen and not upon noise or distortion arising in the transmission medium.

Fig. 1d is an example of time quantization; here the quantized wave changes its amplitude only at definite time intervals. Pulse Amplitude Modulation, which is mentioned later in connection with Fig. 2, is another example of time quantization.

In Fig. 1e, both amplitude and time are quantized by the same rules as were used for Figs. 1c and 1d. It will be appreciated that had smaller quanta been chosen, the quantized wave would be a closer approximation to the original wave.

The quantized modulation systems just illustrated are not commonly used in practice. At this point, a description of a new system known as Pulse Code Modulation (PCM) will be given, since it is a promising application of quantized modulation. PCM involves the application of three basic concepts. Two of these have been mentioned before; they are the time and amplitude quantization principles. The third concept may be described as the digital coding principle. These concepts will be discussed in the order mentioned.

The particular form of time quantizing used in pulse systems is known as sampling. The essence of the sampling principle is that any input wave can be represented by a series of regularly occurring instantaneous samples, provide that the sampling rate is at least twice the highest frequency in the input wave. This result is well known and is the general basis for time-division or sampling systems.

For present purposes, the amplitude quantization principle states that a complex wave can be approximated by a wave having a finite number of amplitude levels, each differing by one quantum, the size of the quantum jumps being determined by the degree of approximation desired. This process, while comparatively new, appears to be of basic importance in many modulation processes.

Reference should now be made to the curves of Fig. 2. Here the information wave is given as curve (a). The sampling process yields the Pulse Amplitude Modulation (PAM) wave (b). This curve, of course, is an example of a time quantized wave. Each sample is

coded to produce the code groups (c). This coding is an application of the digital coding principle discussed below. The decoded pulses yield the amplitude quantized PAM pulses (d). The numbers below the pulses of curve (d) represent the quantized amplitude as an integral decimal number. Curve (d) is an example of an amplitude and time quantized system.

The digital coding principle allows the representation of the quantized amplitude or number by the digits of a number system. Thus, each quantized amplitude is represented by a code group of digits, the number of digits required being determined by the size of the quantum. For example, binary digits can be represented by two position or On-Off pulses. In a binary number system, each digit can have two values, while in a decimal number system, each digit has ten values. For binary numbers, then, 2^n discrete levels can be represented by a binary number of n digits. Thus, binary PCM represents each quantized amplitude of a sampling process by a code group of On-Off pulses, where these pulses represent the quantized amplitude in a binary number system.

The fundamentals of the digital coding principle are illustrated in Fig. 3. Here, beginning at the left, we have the quantized amplitude, the binary representation of that amplitude, the weighted equivalent, and the decoded number. A PCM system codes the quantized amplitude to obtain binary code groups. These code groups are sent over the transmission medium to the receiver, where they are decoded. One process of decoding involves obtaining the weighted equivalents and adding the result to obtain the decoded amplitude shown on the right.*

The binary number system is illustrated by the second column of Fig. 3. With five binary digits, all integral values between 0 and 31 can be represented.

*"An Experimental Multi-Channel Pulse Code Modulation System of Toll Quality" by L. A. Meacham and E. Peterson. Paper presented in BELL SYSTEM TECHNICAL JOURNAL, January, 1948.

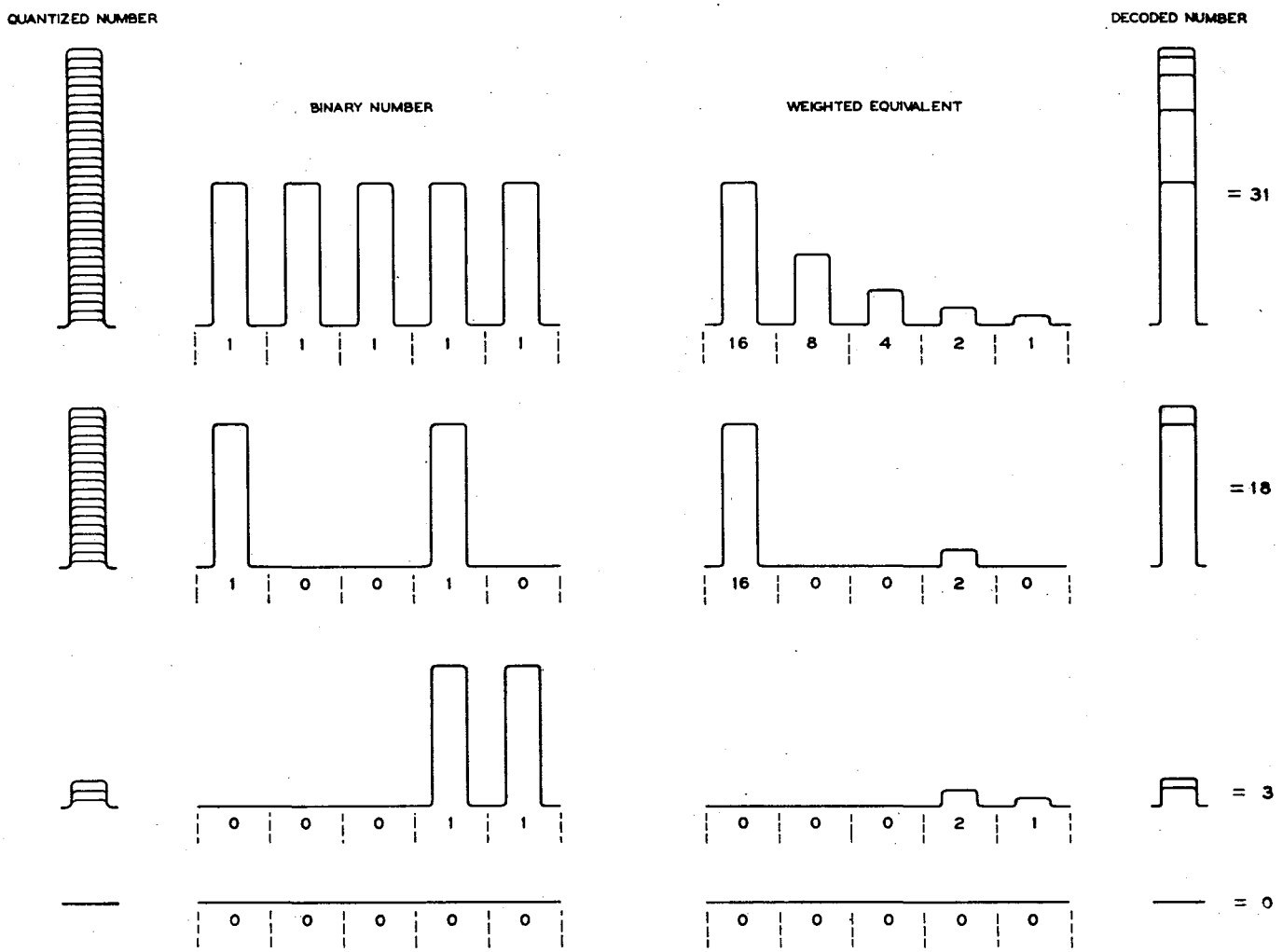


Fig. 3 The four columns in the figure illustrate the steps involved in the representation and subsequent interpretation of numbers in the "binary" system of notation. The first, or "Quantized Number" column, represents the desired number as a sum of "ones" (e.g. $3 = 1+1+1$). The second, or "Binary Number" column, shows how the number may be written as a sum of powers of 2 with coefficients zero or one (e.g. $18 = 1\times2^4 + 0x2^3 + 0\times2^2 + 1\times2^1 + 0\times2^0$. This process is completely analogous to the usual or "decimal" representation of a number in which, for example, 5301 represents $5\times10^3 + 3\times10^2 + 0\times10^1 + 1\times10^0$. Thus 31 may be written as 11111 and 18 as 10010 in the binary system. The third or "Weighted Equivalent" column depicts in decimal notation the individual terms involved in the binary representation (e.g. $18 = 1\times2^4 + 0\times2^3 + 0\times2^2 + 1\times2^1 + 0\times2^0 = 16+0+0+2+0$). The last column, of course, represents the actual numbers desired as a total made up of the parts indicated by the previous column.

Thus, the top row of this column represents the number 31 in the binary system. Likewise, the remaining rows represent the numbers 18, 3, and 0 in turn.

Although any signal quantized in time and amplitude can be regenerated, one involving two position or On-Off pulses is almost ideally suited to this process. Thus, it is seen that binary PCM is likely to become a very practical example of a system of transmission that overcomes the distance limitation in the transmission of wide-band high-fidelity material over radio relay systems.

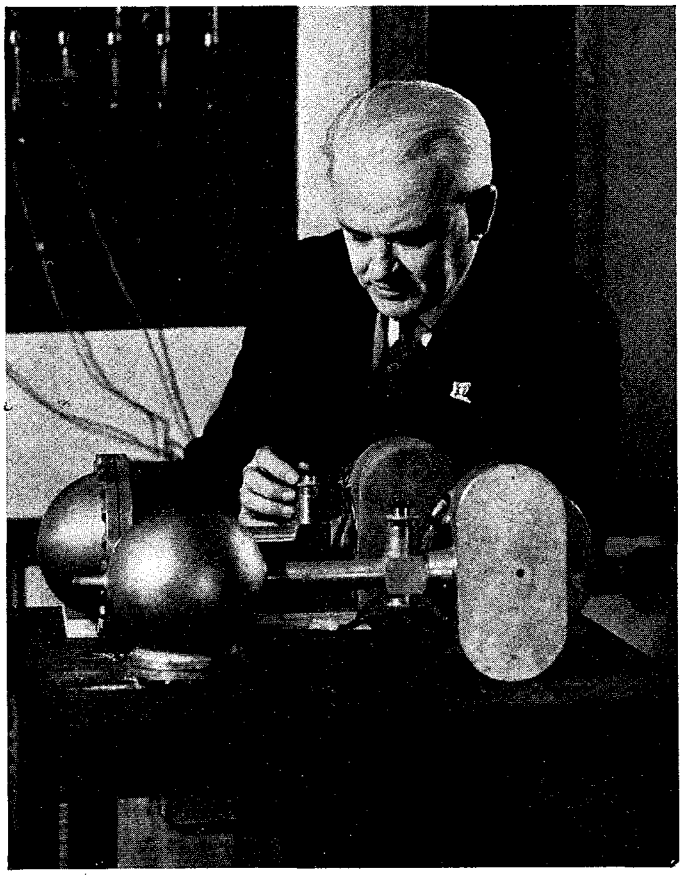
In addition to the regenerative feature of PCM, another important property involved in the digital coding process is brought out by the following discussion. In microwave systems, where relatively wide bands are available, it is desirable at times to trade band width in the medium for signal-to-noise advantage. Wide-band frequency modulation is a well-known example of this method of operation. Here if the band width is doubled, the signal-to-noise power ratio is increased by a factor of 4. For a PCM system, however, a much greater factor is obtained. If we double the band width, we can send twice as many digits. Thus, if we start with a 5-digit system and double the band width, a 10-digit system results. Since a 5-digit system has 32 levels and a 10-digit system has 1024 levels, the signal-to-noise power ratio has increased by $(1024/32)^2 = 1024$ times. From this discussion, it appears that the digital coding principle allows the trading of band width (necessary for the increased number digits) for noise on a much more favorable basis than that realized in ordinary frequency modulation.

Summarizing: We have seen that for continuous modulation systems the accumulation of noise in a repeater system results in a definite limitation to the length of the system. By using quantized modulation where both time and amplitude are quantized, it is possible to use regenerative repeaters and avoid the accumulation of noise in a long system. In addition, PCM, which is an example of a signal that can be regenerated, also has the property of trading band width for noise on a very favorable basis.

The curves shown in Figs. 2 and 3 of this article are taken from a paper by the author, "Telephony by Pulse Code Modulation," BELL SYSTEM TECHNICAL JOURNAL, July, 1947.

ROBERT A. MILLIKAN CELEBRATES 80TH BIRTHDAY

ON MARCH 22, Dr. Robert A. Millikan celebrated his 80th birthday. In honor of this occasion, the Associates gave a dinner on March 15, at the California Club, Los Angeles, and the faculty, under the chairmanship of Professor William Fowler, are planning a dinner early in April at which Dr. Millikan will be presented with a special issue of "Review of Modern Physics", published in his honor. This volume of the "Review", combining both the January and April issues, is comprised of articles on Millikan's scientic interests written by his former students and associates.



Dr. Robert A. Millikan

Dr. Millikan, having retired in 1946 from his administrative positions as director of the Norman Bridge Laboratory of Physics and chairman of the Executive Council at the Institute, is now acting in an advisory capacity as vice-chairman of the Board of Trustees and continuing his research work and writing. Prior to his retirement, Millikan had been with the Institute since 1921 when he left his position as professor of physics at the University of Chicago, where he had been in the Physics Department for 25 years.

A native of Iowa, Dr. Millikan received his A.B. degree from Oberlin College in 1891, his Ph.D. from Columbia University in 1895, and took advanced study in 1895 and 1896 at the Universities of Berlin and Gottingen. Although he took only one semester of work in physics during his undergraduate course, Millikan acquired a lifetime interest in this field when he helped work his way through college by teaching elementary physics during his junior year, and upon graduation, when he accepted a position as a physics tutor at the Oberlin Academy.

A recipient of many medals of honor, among them, the Nobel Prize in Physics from the Royal Swedish Academy in 1923, the Faraday Medal from the Chemical Society of London in 1924, and in 1937 the Franklin Medal from the Franklin Institute of the State of Pennsylvania, Millikan is best known for his work on the isolation and measurement of the electron; the direct photo-electric determination of the fundamental radiation constant known as Planck's h; his study of Brownian movement in gases; his more recent study of the nature and properties of cosmic rays, and the 18 books of which he is either the author or joint author.

A former president of the American Physical Society, and the AAAS, Dr. Millikan is an honorary member of many other scientific societies, among them, the National Academy of Science, the American Philosophic Society, and several foreign groups, and has received honorary degrees from 20 colleges and universities in this country and abroad

C. I. T. NEWS

FIRST TEST OBSERVATIONS MADE WITH PALOMAR MIRROR

MAX MASON, chairman of the Observatory Council at the California Institute, has announced that the first test observations, preliminary to the work of making adjustments on the 200-inch telescope, have been made at the Palomar Mountain Observatory. These test observations, both visual and photographic, were taken with the telescope at vertical position, at 60 degrees and at 30 degrees both north and south.

Dr. John A. Anderson, executive officer of the Observatory Council, who figured the mirror and supervised its grinding and polishing, was the first Palomar observer. He used a small reading glass for an eye piece to peer at the image formed by the big mirror. Others who followed him included Dr. Ira S. Bowen, who will direct both Mt. Wilson and Palomar Observatories; Dr. Edwin Hubble and Dr. Milton L. Humason of the Mt. Wilson staff; Dr. Russell W. Porter, who designed the observatory building and assisted in design of the entire telescope; Marcus H. Brown, who had charge of the CalTech optical shop during the 11 years of grinding and polishing; Bruce Rule, project engineer; Byron Hill, construction engineer at the Observatory; and Professor J. G. Oort, visiting astronomer from Leiden, Netherlands.

These first test observations were made in order to locate the point where the axis of the telescope cuts the photographic plate and to check the entire instrument under actual operating conditions. A great deal of additional completion work and adjusting remains to be done; therefore, the telescope will not be ready to begin an actual research program until the summer.

A final grant of $300,000 has been made to the California Institute by the Rockefeller Foundation to complete the Palomar Telescope, primarily to cover costs of auxiliary equipment, such as a number of special cameras to be used at the Coude focus, spectographs, photometers, and other astronomical instruments. The original grant was made in 1928 for $6,000,000 and an additional grant of $250,000 was made last year to cover both the rising costs of materials and the maintenance costs that continued during the war when no work was done on either the telescope or its 200-inch mirror. This brings to $6,550,000 the total cost of the Palomar project which includes an astrophysics laboratory, optical and machine shop on the CalTech campus, and numerous installations atop Palomar Mountain in addition to the 200-inch telescope and the 8-, 18-, and 48-inch Schmidt Cameras.

C.E. STUDENT PLACES IN SALT LAKE SPEECH TOURNAMENT

IRVING SULMEYER, civil engineering senior, placed third in oratory at the Western Association of Speech Tournament held in Salt Lake City late in December. His paper, "The Golden Thread" was based on Wendell Wilkie's "One World" and traced Wilkie's contribution to constructive thinking on world peace. Approximately 80 colleges all over the country were represented at the Tournament.

VON KARMAN RECEIVES '47 JOHN FRITZ MEDAL

THEODORE von Karman, director of the Guggenheim Laboratory of Aeronautics at the California Institute, has been named to receive the 1947 John Fritz Medal, highest engineering honor awarded in this country.

In choosing Dr. von Karman as the '47 Fritz Medal recipient, the combined engineering societies of the United States cited him as "a creative leader, stimulating teacher and wise counselor in engineering and physical research in the fields of aeronautical and structural sciences; for his many applications of mathematical and physical theory to the sound solution of engineering problems."

Von Karman recently returned to the Institute, having served during the war as aeronautical consultant to the War Department. A native of Hungary, where he had been director of the Aeronautical Institute at the University of Aachen, von Karman first came to CalTech in 1928 as professor of aeronautics, and was recently elected to the British Royal Society, was awarded the honorary degree of Doctor of Science by Princeton University, and was the 1946 Wright Brothers Lecturer of the Institute of Aeronautical Sciences.

KOEPFLI IN ENGLAND WITH STATE DEPARTMENT

DR. JOSEPH B. Koepfli, research assistant at the Institute, has been appointed a member of the U. S. State Department mission on science and technology. He left for England early in January aboard the S S Queen Elizabeth with his wife and two children. Dr. Koepfli is attached to the U. S. Embassy in London as senior scientist for a period of one year on this new mission, the first provision made by the government to provide assistance to European science and scientists at the diplomatic level.

Headed by Dr. Earl A. Evans Jr., chairman of the Department of Biochemistry at the University of Chicago, the mission will cover all fields of science by means of a rotation service whereby leading men in various scientific fields will be appointed for one year. The initial staff, of which Dr. Koepfli is a member, will include biochemistry, organic chemistry, physics, engineering, biology, and agronomy.

Koepfli obtained his A.B. and M.A. degrees at Stanford University and the D. Phil. at Oxford. Before coming to CalTech in 1932 he was an instructor in Pharmacology at the Johns Hopkins School of Medicine. A great deal of Dr. Koepfli's recent work at the Institute has been concerned with the study of antimalarials, and in collaboration with other CalTech chemists, he recently announced successful extraction, from the leaves and roots of a Chinese plant, Ch'ang Shan, of two new anti-malarial chemicals, one of them 100 times as powerful as quinine.

CHARLES NEWTON -- DUBRIDGE'S NEW ASSISTANT

CHARLES NEWTON, New York advertising man, arrived on campus February 15 to assume the duties of assistant to President DuBridge. Newton will work with the President on administrative matters and will have the responsibility for official C.I.T. publications, including the publishing of **Engineering & Science** and the attainment of funds for the Institute, also working with the Alumni Fund Committee. Newton, who is regarded as one of the leading younger copy writers in the advertising field, has had successful experience in both that field and in publication work.

A native of Kentucky, Newton obtained a Ph.B. Lit degree at the University of Chicago in 1933 and has since worked as feature writer and rewrite man on the **Chicago Herald Examiner,** commercial radio writer and radio director for H. W. Kaston and Company, Chicago, and group copy chief for J. Stirling Getchell, New York.

In 1938, Newton returned to Chicago as radio director for the University of Chicago and was in charge of the planning and production of local and network educational programs. The following year, Mr. Newton returned to New York as group copy chief for Geyer, Cornell and Newell in charge of Kelvinator refrigerators and Schlitz beer advertising. A couple of years later, he left his next position, senior copy writer with the McCann-Erickson advertising agency, to become associated with Dr. DuBridge at the Radiation Laboratory at M.I.T., as group head of special publications. In 1946 he became senior copy writer for the Duane Jones Company, New York advertising agency, where he remained until coming to CalTech.

FRIDAY EVENING DEMONSTRATION LECTURES SCHEDULE

THE FRIDAY EVENING Demonstration Lecture series will continue through May, meeting in Room 201, Norman Bridge Laboratory of Physics at 7:30 p. m. Demonstration Lectures for spring, 1948 will be:

"Radar", by Dr. W. H. Pickering, Professor of Electrical Engineering, February 27

"The Pitch of Pure Tones", by Dr. L. A. Jeffress, Hixon Visiting Professor of Psycho-biology, March 5

"Engineering Research at the California Institute", by Dr. F. C. Lindvall, Professor of Electrical and Mechanical Engineering, March 12

Two Friday evenings, March 19 and March 26, will be omitted because of Spring Recess. The series will resume in April with:

"Ancient Reptiles of the California Coast", by Dr. Chester Stock, Professor of Paleontology and Chairman of the Geology Division, April 2

"The Chemistry of Plastics", by H. J. Lucas, Professor of Organic Chemistry, April 9

"Electricity in Nerves and Muscles", by Dr. A. van Harreveld, Professor of Physiology, April 16

"Alaska", by Dr. R. P. Sharp, Professor of Geomorphology, April 23

"The Problem of Flight", by Frederick Felberg, Lecturer in Aeronautics, April 30

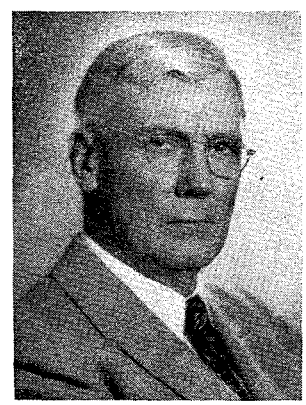
"Nuclear Physics", by W. A. Fowler, Professor of Physics, May 7

"The Salt of the Earth", by Dr. Ian Campbell, Professor of Petrology, May 14

"Cosmic Rays and the Fundamental Particles of Matter", by Dr. C. D. Anderson, Professor of Physics, May 21.

FREDERICK W. HINRICHS JR. MEMORIAL AWARD

ESTABLISHMENT of the Frederick W. Hinrichs Jr. Memorial Award to be made annually at commencement was announced late in January by the Board of Trustees. The award will go to the graduating senior student who, in the opinion of the undergraduate deans, has throughout his days at the Institute made the greatest contribution to the welfare of the student body, and whose qualities of leadership, character and responsibility have been outstanding. The award may be given to more than one senior if there are two whose contributions are of equally high quality, or it may not be given at all if no suitable candidate is available.



Dean Hinrichs
1878 - 1944

The award was named in honor of the late Dean Frederick W. Hinrichs Jr. who, as Dean of Upperclassmen at CalTech from 1923 until his death in February 1944, was respected as much for his knowledge and understanding of the problems of students as the problems of applied mechanics that he taught. A graduate of Columbia and West Point, Hinrichs came to CalTech in 1921 as assistant professor and became full professor in 1923. He had previously taught at the University of Rochester from 1910 to 1917. In 1917, he was recalled to active duty with the Army and served until 1919, retiring with the rank of lieut. colonel.

METALLURGIST JOINS M.E. DEPARTMENT

NEWCOMER IN the Mechanical Engineering Department is Wilbur R. Varney, recently appointed assistant professor. Professor Varney will teach the undergraduate course in materials and processes and will assist in metallurgy.

Before the war Varney worked in the East with Bethlehem Steel and Taylor-Wharton Iron and Steel Companies and later was an instructor of metallurgy and metallography at Lafayette College, Pennsylvania. During the war he served as a lieutenant in the Navy, and since his release from the service has been working as a metallurgical engineering consultant.

DU PONT AWARDS CHEMISTRY FELLOWSHIP TO C.I.T.

THE CALIFORNIA Institute was among 45 universities throughout the country to receive a Du Pont post-graduate fellowship award in chemistry. The Du Pont Company Fellowship Plan is designed to encourage advanced study in the fields of chemistry, physics, chemical, mechanical, and electrical engineering, and metallurgy. Each post-graduate fellowship provides $1200 for a single person or $1800 for a married person, together with an award of $1000 to the university. The selection of candidates for the awards is left to the universities.

PROFESSORS SCHUTZ AND McCREERY WIN HISTORICAL AWARDS

DRS. JOHN A. SCHUTZ and Henry F. McCreery, assistant professors of history in the Humanities Division, recently won 1947 awards from the Pacific Coast Branch of the American Historical Association.

Dr. McCreery received the award for his manuscript "German Opinion of the United States during the 1916 Submarine Crisis", and Dr. Schutz received his award for the paper "Thomas Pownall: an Early Champion of Anglo-American Cooperation". Dr. Schutz's award was shared with Professor Wilbur Jacobs of Stanford University.

C.I.T. BIOLOGISTS DEVELOP PLANT GROWTH INHIBITOR

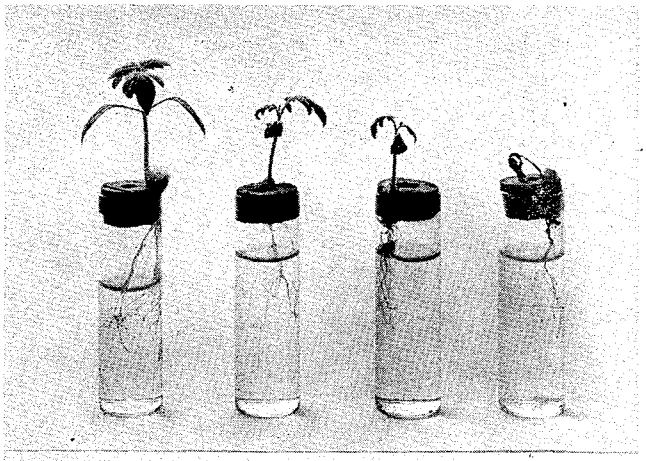
FROM THE LEAVES of a low, dome-shaped desert plant which Americans call the Brittle Bush, the Mexicans and Indians call Incienso and known to science as Encelia farinosa, a new plant growth inhibitor, and possibly a weed killer, has been developed at the California Institute. Not only did biologists James Bonner and Reed Gray determine what the leaves of Encelia carried that inhibited the growth of other plants, but they also have been able to reproduce the inhibitor synthetically. Called AMB for short, its is 3-Acetyl-6 Methoxybezaldehyde, a new chemical compound.

Dr. Bonner's obesrvations of Encelia farinosa plants growing on California and Arizona deserts led him into the investigation. He noted that while many desert plants apparently attract and favor growth of plants around them, Encilia farinosa had little, if any, such plant life about it. It was his curiosity about this occurrence that led to the development of the new plant inhibitor.

Tests of the growth inhibiting qualities of both the extract from Encelia leaves and the aromatic synthetic compound containing an aldehyde and ketone group on the same ring were made on tomato seedling plants in nutrient solutions (See Figures), sand cultures, and rich garden soil. Marked inhibition of growth was noted, and water and ether extracts of leaves fed to tomato seedlings in solution culture caused death within one day. Tests showed the extract to be almost as toxic to tomato seedlings grown in sand cultures but less effective in action on tomato plants grown in rich garden soil. The explanation for this may be that bacteria of the soil reduce AMB's toxic effects.

Although Brittle Bush resin had been used as a painkiller, an incense, and a varnish, it was in the leaves, not the stem or roots that the biologists found the plant growth inhibitor. Produced synthetically, it is a compound that has never before been reported.

Research on AMB as a spray to kill remains to be done —all information to date has been obtained through introducing the inhibitor into the root systems. It was found that if a plant took up as little as one milligram of AMB, growth was markedly inhibited. If it took up as much as two milligrams it died.



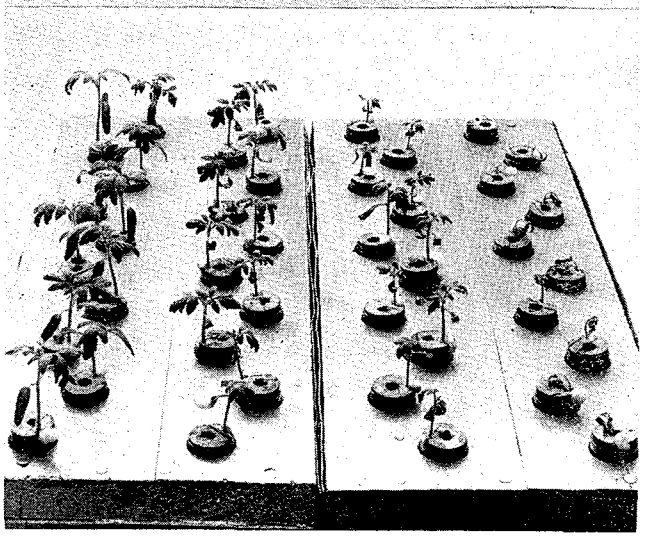


Fig. 1 Tomato seedlings grown in solutions containing various amounts of Encelia toxic substance (AMB) for two days. Left to right: (A) no toxic substance; (B) 0.5 mg per plant; (C) 1.0 mg per plant; (D) 2 mg per plant.

Fig. 2 Experimental setup for testing effect of AMB on tomato seedlings. The glass containers shown in Fig. 1 are placed in rows of 10 in wooden boxes so that the roots are in the dark. Left to right: (A) each plant receives nutrient solution but no toxic substance; (B) each plant receives nutrient and 0.5 mg per plant of AMB; (C) each plant receives nutrient and 1.0 mg per plant of AMB; (D) each plant receives nutrient and 2.0 mg per plant of AMB. The picture was taken two days after placing plants in solutions.

ALUMNI NEWS

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

ETA KAPPA NU HONORS THREE TECH GRADUATES

ETA KAPPA NU, national honorary electrical engineering society, gave recognition awards to three California Institute graduates at the annual mid-winter meeting of the American Institute of Electrical Engineers held in Pittsburgh last January. Usually made on a yearly basis, the recognition awards for work of distinction in the field of electrical engineering covered the period from 1942 through 1947, since annual dinners were not held during the war years.

Among the 21 men to receive this honor were Dr. John R. Pierce '33, M.S. '34, Ph.D. '36, now associated with Bell Telephone Laboratories in New York, who received the top award for 1942; Dr. G. D. McCann '34, M.S. '35, Ph.D. '39, professor of electrical engineering at C.I.T., who received honorable mention for the same year; and Dr. J. W. McRae, M.S. '34, Ph.D. '37, also with Bell Telephone Laboratories, who was accorded honorable mention for the year 1943.

These three honored graduates were students of Professor Royal W. Sorensen, who has been with the Institute's Electrical Engineering Department since 1911.

ALUMNI DINNER-DANCE MARCH 20

THE ALUMNI DINNER-DANCE will be held at the Oakmont Country Club in Montrose, on March 20 from 8:30 until midnight. The affair will be semi-formal, and music will be furnished by an organist during dinner and intermissions and by Hal Lomen's nine-piece orchestra and vocalist during the rest of the evening. Alumni may bring guests, and the Social Committee suggests that groups make up parties for dinner and arrive early enough to secure adequate tables.

The Oakmont Country Club is located on Country Club Drive, off Verdugo Road.

DUBRIDGE AT CALTECH CLUB DINNER, NEW YORK

DR. LEE A. DuBRIDGE was the guest speaker at the CalTech Club dinner held in January in New York City. President DuBridge reviewed the happenings at the Institute during the past year, and discussed plans for its continued growth during the years to come.

Also from New York comes news of the CalTech Club's dinner held last October which included after-dinner movies by William R. Hainsworth '18, vice-president of Servel, Inc., and producer of professional quality color films as a hobby; an informal talk on current economic problems by Leonard E. Read, president of the Foundation for Economic Education, and former general manager of the Los Angeles Chamber of Commerce (1939-1945).

ACS DESIGNATES A. R. KEMP '17 ONE OF COUNTRY'S 10 ABLEST RUBBER CHEMISTS

ARCHIE R. KEMP '17, M.S. '18, rubber technologist and insulation engineer at Bell Telephone Laboratories, has been designated one of the country's 10 ablest chemists in the field of rubber chemistry by his fellow experts in the American Chemical Society.

Mr. Kemp, a veteran of nearly 30 years with the Bell Laboratories, joined them in 1918 after receiving the first B. S. degree in Chemistry given by Throop Polytechnic, C.I.T.'s predecessor. He received his M.S. from Throop after a year's work as a teaching fellow, during which time he also assisted Dr. A. A. Noyes, who was engaged in studies of qualitative analysis. Kemp also worked with Dr. Noyes in 1918 on studies of incendiary bombs for the first World War.

In 1922-1923 Kemp was supervising engineer at the Western Electric factory in Hawthorne during the manufacture of the San Pedro-Catalina cables and was in charge of some phases of laying the cables in May 1923.

During nearly all of his time with the Bell Labora-

tories, Kemp has been concerned with organic research on rubber and other insulating materials. Among his many contributions is the development of paragutta, a special type of rubber insulation, which he introduced into European factories in 1929 and 1930. He was also responsible for the development of the pressure equalizer material used on the first and succeeding high speed permalloy loaded submarine telegraph cables, the first of which was laid by the Western Union between New York and the Azores in 1924. In recent years, Kemp has been especially active in the development of synthetic rubber compounds, and was responsible for the introduction of synthetic rubber in the Bell System networks.

Kemp is a member of numerous scientific organizations, among them the AAAS, New York Academy of Science, and the ACS. He has published 48 articles in the fields of organic and analytic chemistry, rubber science and technology, and electrical insulating materials. Kemp has also been issued more than 40 patents.

With the Board

JOSEPH J. PETERSON '37, in charge of social affairs, reported at the January meeting that the annual dinner-dance would be held at the Oakmont Country Club on March 20, 1948. The Oakmont Club has been rebuilt following the fire of about two years ago, so once again we can enjoy dinner and dancing where so many pleasantly remembered dances have been held. Joe said, although he hadn't decided on the exact amount, that he expected tickets to be a little less than four dollars each.

* * * *

Edward D. Lownes '24, who is handling chapter relations, told the Board at the January meeting of the projected visits in April of L. W. Jones, Institute Dean of Admissions, in a number of eastern cities. These visits will be made in the course of Dean Jones' annual trip in connection with the selection of Institute students. Ed Lownes planned to notify all groups in cities included in Jones' itinerary of the expected visits, as he had expressed willingness to meet with alumni along his route. The Association has aided Dean Jones in his admissions work in other years and assured him of any aid possible in connection with the 1948 work. Any eastern groups wishing Jones to meet with them should write directly to him to make their arrangements.

* * * *

Membership, in exceeding 2000, has passed a new milestone and for this reason we feel that it is again worth mentioning. In January 1947 our membership was 1508 annual and 350 life members: This January it was 1629 annual and 378 life members, a growth of 149.

One of the consequences of the growth is, of course, more office work. Address changes are more numerous; (they run as high as 50 per day now), every group mailing takes more time, more individual correspondence is handled. As staff services have to be added in discreet steps, we must run behind in our service quite a bit before we can justify further assistance. At present we are almost to the point where additional office force must be added. But once the services are increased we can handle many more members and do a better job all around. So if membership keeps growing, the Association can do a more efficient job for all.

But, unless considerable more growth is experienced, it is conceivable that dues must be increased. This will be studied by the Board in the near future.

—H. K. F.

PERSONALS

1921

EDWARD G. FORGY, who is working with Westinghouse Company, has just moved from Pittsburgh to New York City.

1924

FRED J. GROAT is back in California. Fred is district sales engineer with the Bureau of Reclamation and was recently transferred from Pheonix, Arizona to Merced.

VLADIMAR A. KALICHEVSKY is working for the Magnolia Petroleum Company, Beaumont, Texas, where since June 1944 he has been consulting chemical engineer.

1925

THOMAS P. SIMPSON, working as assistant director of research in the Research and Development Department of the Socony-Vacuum Oil Company, Inc., at Paulsboro, N. J., participated with more than 40 members of the staff in the installation of a new Socony-Vacuum unit of the Society of the Sigma Xi last November.

1926

ALPHEUS M. BALL was married to Miss Frances S. Tattnall of Wilmington, Delaware last fall. Ball is now associated with the Hercules Powder Company Experiment Station in Wilmington.

BURT BEVERLY JR. has been geologist and geophysicist with the Arabian American Oil Company for 11 years, working in Arabia, Egypt, the Dutch East Indies, and Venezuela. He is now stationed at Bahrein Island, in the Persian Gulf.

1927

JOHN A. MAXSON, M.S. '28, Ph.D. '31, left the Institute, where he was assistant professor of geology, the first of last year to become division geologist with the Bay Petroleum Company in Denver.

LAYTON STANTON, Ph.D. '31, is division geologist for the Union Oil Company and for the past couple of years has been in charge of their exploration work in Oregon and Washington.

1928

FRANK BELL, M.S. '33, and ALEX CLARK, M.S. '32, are working for the Shell Oil Company of California. Bell heads the oil development work at Sacramento and Clark has charge of petroleum exploration in the Rocky Mountain district.

HAMPTON SMITH, Ph.D. '34, has resigned his position as chief geologist for the Texas Company of California in order to engage in consulting practice in Los Angeles. He is currently lecturer in petroleum geology at the Institute.

1929

CHARLES BOSSERMAN has been working with Boeing Aircraft Company in Seattle since 1938 and is at prsent group engineering supervisor of the Super Bomber, B-50.

THOMAS CLEMENTS, M.S., Ph.D. '32, is head of the Department of Geology at USC.

THOMAS H. EVANS, M.S. '30 who is head of the Department of Civil Engineering at Georgia Tech, has been elected vice-president of the Georgia Section of the ASCE.

WILLARD A. FINDLAY, M.S. '32, Ph.D. '40, is now working in San Francisco as chief geologist for the Richmond Petroleum Company.

1930

FRANCIS D. BODE, M.S. '31, Ph.D. '34, is with the Texas Company. During the war he had charge of the development and drilling program in the Pacific Northwest and he is now a district geologist in Los Angeles.

ROLLIN ECKIS, M.S., is chief geologist for the Richfield Oil Company, Los Angeles.

NORRIS JOHNSTON, Ph.D., writes that he has just changed his job from physicist in the Production Department of the General Petroleum Corporation to general manager of the Petroleum Engineering Associates, Pasadena. His oldest son, John, is a Freshman at C.I.T. Johnston also informs us that FLORENT H. BAILLY '27 is chief engineer of the Pantepec Oil Company of Venezuela and gives "invaluable assistance on reservoir problems".

TRUMAN KUHN is associate professor of mining geology at the Colorado School of Mines in Golden, Colorado.

OSCAR VAN BEVEREN has been with the Standard Oil Company of California since 1933, working in the Dutch East Indies and Saudi Arabia. At present, he is stationed in the Dutch East Indies.

ROBERT W. WILSON, Ph.D. '36, has just resigned from the faculty of the University of Colorado to become professor of geology at the University of Kansas. Wilson spent last year at the Institute as a National Research fellow.

1931

WILLIAM COGEN, M.S. '33, Ph.D. '37, research geologist for the Shell Oil Company of Texas in Houston, served in Army Air Intelligence on the Burma front.

RAYMOND A. PETERSON, Ph.D. '35, is vice-president in charge of research for United Geophysical Company in Pasadena.

1932

FREDERICK W. BOWDEN is associate professor of aeronautical engineering at USC's College of Aeronautics.

ELBERT N. HARSHMAN, M.S. '33, now geologist for the U. S. Bureau of Reclamation in Denver, worked for Neilson and Company in the Philippines until he and his wife were captured and interned at Santo Tomas Prison by the Japanese.

VINCENT C. KELLEY, M.S. '32, Ph.D. '37, is an associate professor of geology at the University of New Mexico. He has spent many summers with the Metals Section of the U. S. Geological Survey, chiefly in Colorado.

PHILIP SCHOELLER, working with the contracting firm, Miller - Knudsen Company, has just been transferred from Karachi, India to Kabul, Afghanistan where the firm is building public works.

1933

DR. GEORGE ANDERSON is vice-president of the Lone Star Steel Company at Dallas.

YGNACIO BONILLAS, M.S. '35, is resident geologist for the Richmond Oil Company in Colombia, South America.

PAUL R. ENGEL, presently a student at Southern Methodist University, has conceived and built the largest telescope made for primary visual purposes in the nation. The telescope was first used at the Texas State Fair last October.

WILLIAM A. LARSEN, M.S., has a teaching fellowship in civil engineering at the Institute.

1937

ROBERT DREYER, M.S., Ph.D. '39, is presently associate professor of geology at the University of Kansas. He is also a recent recipient of a Penrose Research Award of the Geological Society of America. This award will permit him, with some colleagues at Northwestern University, to investigate the mechanism of mineral replacements.

JOHN R. SCHULTZ, Ph.D., after completing a tour of duty with the Navy, took a position as geologist with the Nicaragua Canal Survey Division of the U. S. Engineers. Last September, Schultz joined the Brown University faculty as associate professor of geology.

1938

JAMES BALSLEY is chief of the section of geophysics of the U. S. Geological Survey in Washington, D. C. Balsley has had a great deal to do with the development of the wartime magnetic airborne detective as a peace-time instrument for rapid geological reconnaissance.

ROGER COWIE is at present associate professor of geology at the Missouri School of Mines, Rolla, Missouri.

JACK DOUGHERTY, M.S. '39, is now with DeGolyer and MacNaughton, Consulting Geologists and Geophysicists in Dallas.

NEWMAN A. HALL, Ph.D., was recently appointed professor of thermodynamics in the department of mechanical engineering at the University of Minnesota, at Minneapolis. Before taking this position, Hall was with the United Aircraft Corporation in Connecticut where he was head of the analysis section of the research department.

PAUL C. HENSHAW, M.S., Ph.D. '40, is chief geologist for the San Luis Mining Company at Tayoltita, Mexico and father of Paul Jr., born in November 1947.

JACK KNIGHT recently left the Texas Company where he had been geologist in the Bakersfield office to become geologist for the British American Oil Company in Los Angeles.

ELBERT F. OSBORN, Ph.D., has been chairman of the division of earth sciences in the School of Mineral Industries at Pennsylvania State College since 1946.

CLAY T. SMITH, M.S. '40, Ph.D. '43, is associate professor of geology at the New Mexico School of Mines. Smith returned to Tech last summer to conduct a very successful Summer Field Camp near Castaic.

1939

DELOS FLINT resigned from the U. S. Geological Survey to enter the Marine Corps during the war. Since his discharge, he has returned to the Survey and is working in the Metals Section.

DR. RICHARD H. HOPPER has been with the Standard Oil Company of California in the Dutch East Indies since receiving his degree. After serving on General MacArthur's staff as a lieutenant colonel of engineers, he returned to Batavia to assist in the reconstruction of the Company's interests. Last summer he came to the U. S. for several months work with Standard in San Francisco, and is now back in Batavia, Java.

MELVIN LEVET, M.S. '40, except for three years as an AAF weather officer, has been in petroleum work since his graduation. Mel has worked with Chanslor, Canfield and Midway Oil Company, Lane Wells, and since February 1947 with the California Research Corporation in Whittier.

LOUIS REGAN JR., M.S. '41, Ph.D. '42, left the Texas Company a little over a year ago to become geologist for General Petroleum in the Santa Maria district.

1940

KEITH ANDERSON, after serving with the Army Engineers during the war, is now specializing in water supply problems as a geologist with the Missouri State Geological Survey.

BARNEY HAFFNER is working in New York with the Titanium Alloys Division of the National Lead Company.

STUART A. KRIEGER is with Northrop Aircraft in Hawthorne as supervisor of the Aerodynamics Department.

CHARLES D. RUSSELL is presently working with the Carter Oil Company in Oklahoma as a research chemist.

MORTIMER STAATZ is busy with pegmatite investigations for the U. S. Geological Survey in the Black Hills of South Dakota.

DAVID VARNES, with the Metals Section of the Geological Survey since finishing his graduate work at Northwestern, is currently working in Denver.

ROBERT WALLACE, M.S., Ph.D. '46, is assistant professor of geology at Washington State College. From 1942 to 1946 he served with the Alaskan Branch of the USGS, spending most of his time in permafrost studies for the U. S. Army Engineers.

RICHARD WASEM is now secretary-treasurer of the Geophoto Services, Inc., a company which he and three partners established in Denver.

1941

ROBERT GALESKI, after terminating his service with the Navy in 1946, returned to the United Geophysical Corporation in Santa Barbara. Last summer he left the Corporation to join the Honolulu Oil Company in Los Angeles.

LT. WILLIAM C. HALL, USA, recently married Miss Mary Elinor Gass of Washington, D. C. Bill is stationed at Picatinny Arsenal in Dover, N. J.

FRED ODER, M.S., who is remaining in the army with the permanent rank of major, is currently assigned for study and research at the Institute of Geophysics at UCLA.

LIVINGSTONE PORTER is working for the Standard Oil Company of California and is now stationed in the Pacific Northwest.

JOSEPH F. ROMINGER, having served during the war in the Metals Section of the USGS and in the Navy, is now back in the Geology Department at Northwestern University, where he is completing work for his doctorate.

CLIFFORD A. TRUESDELL, M.S. '42, is chief of the Theoretical Mechanics Subdivision with the Naval Ordnance Laboratories and also assistant professor of mathematics at the University of Maryland. Currently, he is doing research in mechanics, particularly gas dynamics.

DALE TURNER has been working since 1942 with the Geophysical Department of the Superior Oil Company, Madera.

1942

ROBERT ANDERSON is now working as a geologist with the Signal Oil Company in Los Angeles. During the war he served as a photo intelligence officer with the Navy.

OSCAR A. HEINLEIN, M.S., is a colonel with the General Staff of the War Department working in the Research and Development Division at the Pentagon in Washington, D. C.

WILLIAM MENARD, M.S. '47, has a fellowship at Harvard this year. Last summer Bill was field geologist with Amerada Petrol Company in Utah.

1943

LEONARD B. EDELMAN, M.S., became engaged to Miss Ellen Harteveldt of New York City last October. During the war, Len was a lieutenant (j.g.) in the Navy, supervising jet-propulsion development at the experimental station in Annapolis, Maryland.

ERNEST A. FEAZEL, M.S., is captain with TWA, for whom he has been flying since 1940.

JOHN ISE JR., M.S., married Miss Barbara Fricke of San Francisco in September.

FRED H. TENNEY is currently a medical student at the University of Rhode Island. Previously, Fred worked with the Eastman Kodak Company, as development engineer, and spent two years in the Pacific as a radar officer.

1944

STANLEY DAY is working at Grand Junction, Colorado as a geologist with the Shell Oil Company.

JAMES R. FREEMAN married Miss Elizabeth Jeffery of San Marino last August. During the war, Freeman served as an ensign in the Pacific and since his release from the Navy has been attending UC, Berkeley, where he obtained his master's degree.

DONALD A. KEATING married Miss Lucile Neubert of Missouri early last fall.

J. STEWART MARTIN, M.S. '47, is working with the TWA Oil Company at Bakersfield, California.

LOUIS S. OSBORNE is presently taking a graduate course in physics at MIT.

JOSEPH M. PHELPS, M.S. '47, was married to Miss Louise Flux of Hartford, Connecticut last September.

1945

ROBERT E. ROWLEY married Miss Beverly Louise Underhill last September. Both Bob and his bride are attending San Jose State College.

ENSIGN ROBERT F. SCHMOKER writes that he is working at the Naval Air Station in Honolulu as public works officer and has charge of all construction and maintenance of buildings, roads, grounds and utilities at the Air Station. Bob, his wife, Donna, and 14-month-old daughter, Linda, are living at 227 Plantation Drive, Honolulu, NHA #1, T. H.

MARTIN STEVENSON is at present working on systems and trajectories in a ground-to-air guided-missile project for General Electric's Aeronautics and Ordnance Divisions in Schenectady. Previously, Martin had spent a year "on test" with GE and taking a course in servomechanisms at Union College. He is planning to return soon to Southern California with his wife, Velma, and Kenneth Martin III, born last September.

GRANT D. SULLIVAN is working in the Production Department of the Tidewater Associated Oil Company. Grant is also the father of eight-month-old Michael.

1946

GEORGE M. PALMER, M.S. '47, returned to Purdue University last September to do government research work and continue work toward his Ph.D. degree in aeronautical engineering, majoring in theoretical aerothermodynamics.

NATESAN SRINIVASAN, M.S., left last September for his home in India, where he expects to enter the Indian aircraft industry.

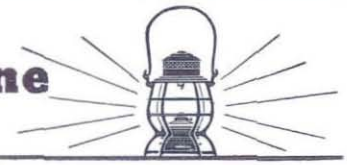
1947

HAROLD M. DEGROFF, M.S., married Miss Sarah Elizabeth Meek of Connecticut in August 1947.

WILLIAM D. GRAZIANO, M.S., married Miss Mary Joyce Plourde of Altadena last fall.

STANFORD G. STILES is now working as an engineer in training in the Production Department of the Shell Oil Company, Bakersfield.

The Main Line



MARCH, 1948

Judging by its frequent appearance in the public press, some form of self-inflicted I.Q. test must be America's favorite indoor sport. Unfortunately, however, even after you've cribbed your way to a passing grade in one, you rarely have any information that will fit into normal conversation. Your dearest friends seldom plumb your depths for late word on binary fission in the amoeba.

As a service to our readers, therefore, we have prepared the following *useful* quiz program. Knowing all the answers isn't guaranteed to make you the life of any party—but when the talk gets around to train travel, you'll at least be able to hold up your end.

Q. *What's the fastest, most luxurious form of low-cost transportation?*

A. Rail coach travel. Southern Pacific's finest, fastest trains carry streamlined, air-conditioned reclining chair cars at lowest fares—e.g. *City of San Francisco*, *San Francisco Overland*, the *Daylights*, the *New Golden State*.

Q. *How low are "lowest fares"?*

A. Really low! For example: Only $48.79 (plus Federal tax) from San Francisco or Los Angeles to Chicago. Big reductions on roundtrip tickets.

Q. *What do you mean by "fastest trains"?*

A. 39¾ hours, San Francisco-Chicago on the *City of San Francisco* ($5 extra fare); 45 hours, Los Angeles-Chicago on the *New Golden State* ($3.50 extra fare); 48 hours, San Francisco to Chicago on the *San Francisco Overland*—no extra fare (only two nights en route on these trains and on the *Sunset Limited*, Los Angeles-New Orleans, and the *Imperial*, Los Angeles-Chicago); 9¾ hours, San Francisco-Los Angeles on the *Daylights*.

Q. *What about stopping over en route?*

A. You can stopover anywhere—continue your trip the following day—or following week—or even later.

Q. *What can I do on the train?*

A. Practically anything you can do at home—and then some. Read, write, play cards, relax, sleep, walk around, smoke, enjoy a cool drink, or watch the scenery.

Q. *How much do tickets cost for my children?*

A. If they're under five, they ride free. From five through eleven, half fare.

Q. *If my children ride free, do I have to hold them on my lap?*

A. No, they get a seat of their own. (On the *City of San Francisco* a charge of $5 plus tax is made when a child under five occupies a separate *chair car* seat.)

Q. *What about meals on the train?*

A. Eating on the train is half the fun of traveling, and Southern Pacific's dining car service is comparable to that of the finest restaurants. Some of our trains to the East have coffee shop cars for chair car passengers. These cars are used as a lounge car between and after meals. Other long distance trains carry dining cars which coach and chair car passengers may use. In addition, on many trains sandwiches, coffee, etc. are sold by news agent.

Q. *How about restroom facilities?*

A. Available at all times, on all trains.

Q. *Do I have to leave a coat or something on my seat to be sure of having it when I get back from dinner?*

A. No. On our most popular trains all seats are numbered and should be reserved in advance. You have exclusive use of your seat for your entire trip.

And there you have it. Next time somebody asks you, "What do you know?" you'll be able to tell him.

—R. G. BEAUMONT