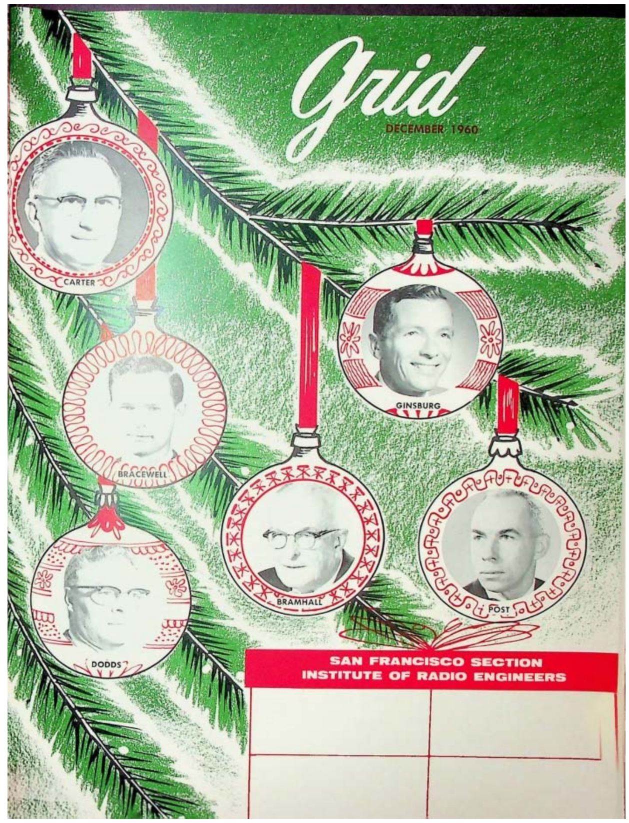
EDITOR'S PROFILE of this issue

from a historical perspective …

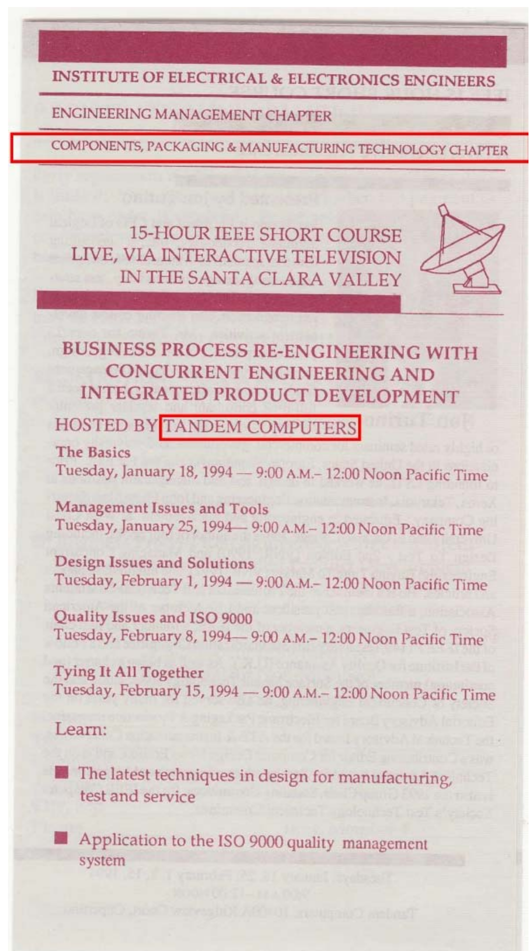
with Paul Wesling, SF Bay Area Council GRID editor (2004-2014)



DECEMBER, 1960:

Cover: photos: Prof. Ronald Bracewell of Stanford becomes a Fellow of the IRE for contributions to radio astronomy; his "dish" sits in the hills behind the Stanford campus. Charles Ginsburg was awarded the Vladimar Poulsen Gold Medal from the Danish Academy for developing the video tape recorder; it was Poulsen's Arc Transmitter, licensed to Stanford grad Cyril Elwell of Federal Telegraph in 1909, that kick-started what became Silicon Valley. (for more history, view my talk on YouTube: https://goo.gl/cSdSUH)

p. 6: The editorial by Charles Susskind covers part-time graduate work at the local universities (UC-B, Stanford, SJSU, Santa Clara U). Santa Clara University had its "early-bird" program of masters-level engineering classes that could be attended prior to going to work. Profiled is Stanford's Honors Co-op Program, which allowed working engineers to collect full salary at their company while taking one or two courses on the campus. This expanded (under Jim Gibbons) to the "tutored videotape instruction" program, where videotapes of lectures were delivered by courier to HP, Lockheed, and other companies, to play at lunchtime, and tests were sent out and returned. These off-campus students often did better than on-campus ones, since the proctor could stop the tape and discuss questions and clarify principles, as documented in several papers by Jim. This later grew into a microwave broadcast network covering the Bay Area; I used this TV broadcast system for IEEE evening multi-week classes (see profile in the *GRID* issue of December 1980, p. 4 ff). One such class (on Winchester Disk Drives) had over 700 local engineers attending – about 350 spread across the Terman and Skilling video-equipped lecture halls, and the rest in classrooms at companies around the Bay Area. I had a database of over 3,000 past attendees on my Apple II+, and composed the mailed flyer (which Gerry Helmke ran off at the IEEE office at 701 Welch Rd); my wife and boys attached the mailing labels and bundled by postal code on our dining room table, to get the 3rd-Class non-profit rate (using our IEEE bulk-mail permit at the Palo Alto Post Office). My sister-in-law and her husband prepared snacks for the class break.



INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS

ENGINEERING MANAGEMENT CHAPTER

COMPONENTS, PACKAGING & MANUFACTURING TECHNOLOGY CHAPTER

15-HOUR IEEE SHORT COURSE
LIVE, VIA INTERACTIVE TELEVISION
IN THE SANTA CLARA VALLEY

BUSINESS PROCESS RE-ENGINEERING WITH CONCURRENT ENGINEERING AND INTEGRATED PRODUCT DEVELOPMENT

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The Basics
Tuesday, January 18, 1994 — 9:00 A.M.– 12:00 Noon Pacific Time

Management Issues and Tools
Tuesday, January 25, 1994— 9:00 A.M.– 12:00 Noon Pacific Time

Design Issues and Solutions
Tuesday, February 1, 1994 — 9:00 A.M.– 12:00 Noon Pacific Time

Quality Issues and ISO 9000
Tuesday, February 8, 1994— 9:00 A.M.– 12:00 Noon Pacific Time

Tying It All Together
Tuesday, February 15, 1994 — 9:00 A.M.– 12:00 Noon Pacific Time

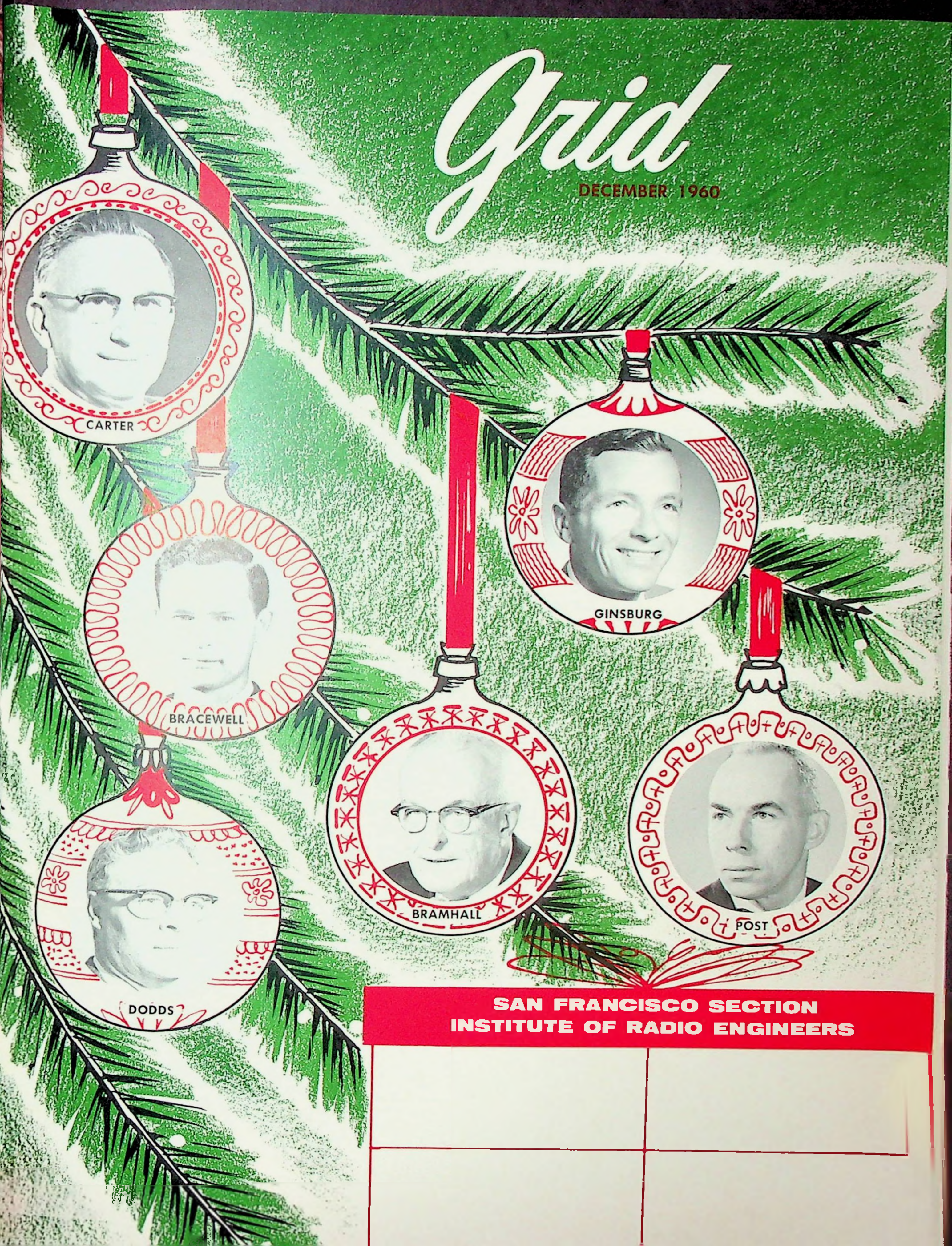
Learn:

- The latest techniques in design for manufacturing, test and service
- Application to the ISO 9000 quality management system

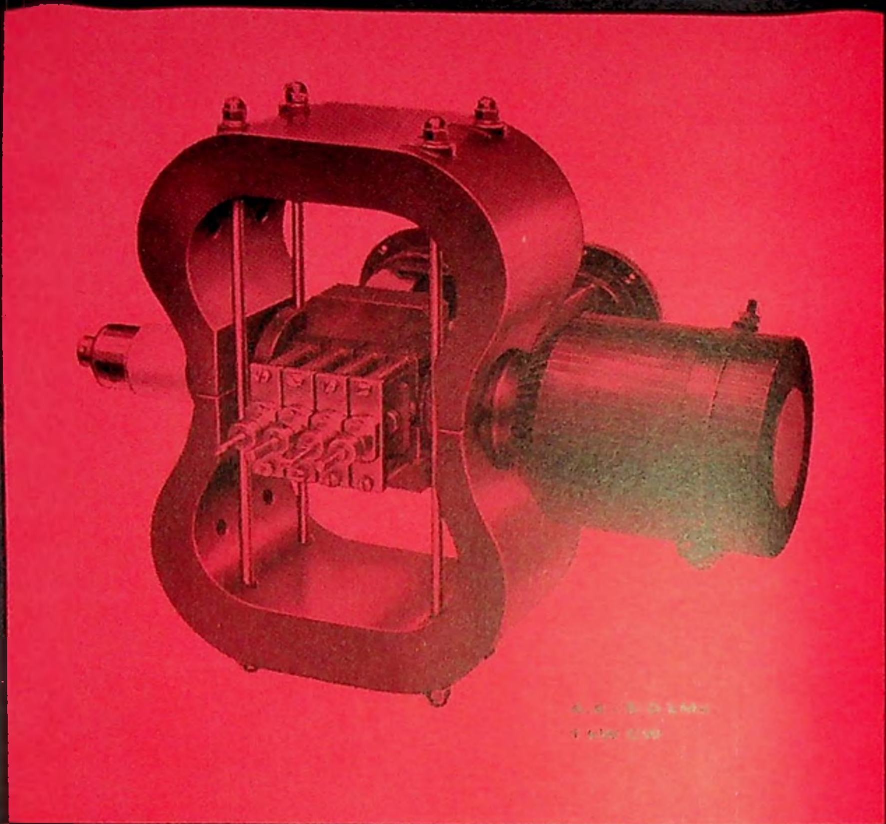
Shown: panel from a flyer for a 1994 5-day class that I organized for the (now) Technology and Engineering Management and the (now) Electronics Packaging Society chapters. This long series of classes grew out of the courses I ran on Stanford's network. For details, see the December 1993 *GRID* Magazine.

Grid

DECEMBER 1960



SAN FRANCISCO SECTION
INSTITUTE OF RADIO ENGINEERS



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volume 7
number 4

Grid

December 1960

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contents

about the cover

Current decorations for the San Francisco Section's figurative Christmas tree include several members to whom special honors have befallen, both within and without the Institute itself. Dr. E. Finley Carter, president of SRI, has been elected a director at large, 1961-1963. Fellow citations have been received by R. N. Bracewell, professor, Stanford University, for contributions to radio astronomy; F. B. Bramhall, Lenkurt Electric Co., for contributions to the theory and practice of electrical communications; Wellesley J. Dodds, Varian Associates (now vice president Bomac Labs), for technical contributions and leadership in the development of microwave tubes; and E. A. Post, Stanford Research Institute, for contributions to aeronautical electronics. Charles P. Ginsburg of Ampex Corp. has become the first native-born American to receive the Valdemar Poulsen Gold Medal awarded by the Danish Academy of Technical Sciences. Valdemar Poulsen was the discoverer of magnetic recording; Ginsburg, developer of the Videotape recorder.

Susskind

from the chairs

DON'T STOP NOW!

Several opportunities to continue his professional education are available to the Bay Area electronics engineer, both on the undergraduate and on the graduate level.

The electrical-engineering undergraduate curricula of four local institutions are accredited by the Engineers' Council for Professional Development: San Jose State College, Stanford University, the University of California, and the University of Santa Clara. In principle, a student can pursue a full-time undergraduate program leading to the BS degree at any one of the four while he is employed at a rate that is nominally reckoned as being anywhere from half to full time.

Whether the job has anything to do with his future career is another matter. "Working his way through college" is the time-honored right of any red-blooded American boy, much celebrated in fiction. One of the protagonists of Eugene Burdick's novel, "The Ninth Wave," comes to mind: you will recall that Hank Moore makes it through Stanford (after his winnings from a monumental poker game are gone) by working in a bakery from eight to twelve every night.

But would not employment in a student's future specialty represent a solution nearer the optimum? Many Bay Area electronics firms have seen the light and make every effort to encourage their employees to continue their education. However, this policy is not as widespread as it might be. IRE members employed by less enlightened (or unaware) firms will do the profession a service by calling the several programs to the attention of their companies.

On the undergraduate level, perhaps the most elaborate formal scheme is the University of California's Cooperative Work-Study Program in Engineering, under which the students combine periods of regular employment in industry with alternate periods of study. The scheme is similar to one that originated in Britain (where it is designated by the gastronomically ominous name of Sandwich Plan) and has caught on at a number of U.S. colleges. At U.C. the plan ordinarily takes five years: one year at the University, six half-year periods alternating between study and work, and then the uninterrupted senior year at Berkeley.

Students are paired off and alternate, so that one is on the job and the other in college at all times. The employer pays no salary during the study periods (although some have made private arrangements)—all he needs to do is to guarantee the student a job on his return. Over fifty firms are on the growing list of participants. Further information may be obtained from the Coordinator, Cooperative Work-Study Program, 308 Engineering Building, University of California, Berkeley 4, Calif.

On the graduate level, San Jose State College has a flourishing program of graduate classes going on at Terman Junior High School in Palo Alto, with laboratory sessions held at San Jose. Graduate courses, most of them acceptable for credit toward the MS degree, are scheduled for the early morning hours (7:30 a.m.) and the late afternoon and evening (4:30-10:00 p.m.), so that a man can hold a full-time job in industry and still pursue a graduate education. During the current semester, for instance, 170 people from industry are enrolled at San Jose State, largely in electrical engineering, mathematics, and physics; over 75 are programmed toward meeting MS degree requirements. Further information may be obtained from the Coordinator of Engineering Extension, San Jose State College, San Jose 14, Calif.

Part-time attendance at Stanford University is possible on the graduate level only under the Honors Cooperative Program, a special scheme in which more than thirty companies have contracted to participate; almost all give the men time off from work without salary deductions. A student normally attends two courses (6 units) each quarter, so that he can complete the requirements for the MS degree in 24 months. The student pays tuition on a per-unit basis, and the company makes a matching payment directly to the student's department. (Since tuition is considered to pay for less than half of the total cost of the student's education, the matching payment is needed to pay for the other half.)

Students attend regular daytime classes, and quotas are set up for each participating company to prevent the industrial students from dominating the classroom: of the 372 graduate students in electrical engineering currently enrolled at Stanford, only 158 are on the Honors Cooperative Program. Further information is available from the School of Engineering, Stanford, Calif.

University of California offers many electrical-engineering courses in its large Engineering and Sciences Extension, with evening classes given (some for undergraduate credit) in Berkeley, Mountain View, Redwood City, San Francisco, and Walnut Creek by highly qualified lecturers drawn from industry. To obtain an advanced degree, a student must actually enroll at Berkeley, which he may do on a part-time basis (for as little as 4 units a semester), with only an incidental fee and no tuition if he is a resident of California; however, he must attend regularly scheduled classes.

Several firms make it possible for an employee to attend graduate classes in Berkeley by reducing (or shifting) his work load, without salary deductions. Graduate studies under a scheme similar to the undergraduate cooperative program can also be carried on, as noted above. A program under which approximately half the requirements toward the MS degree can be satisfied by courses taken in evening classes is conducted at Livermore: during the current semester, 12 of the 237 graduate students enrolled in electrical engineering at Berkeley actually attend classes at the U.C. Lawrence Radiation Laboratory in Livermore.

(A similar program on the Peninsula, introduced last year on the basis of interest expressed by a large number of potential students, was abandoned when the ratio of potential students to students who actually enrolled proved to be too overwhelming to make the scheme feasible.)

Information on evening classes is available from the U.C. Engineering and Sciences Extension, 2451 Bancroft Way, Berkeley 4, California; and on graduate enrollment, from the Department of Electrical Engineering, University of California, Berkeley 4, Calif.

The University of Santa Clara has a graduate program specially tailored to benefit industrial students: courses leading to the MS degree are held between 7 and 9 a.m. Additional information may be obtained from the University of Santa Clara, Santa Clara, Calif.

If you can persuade your firm that continuing education for employees is a morale builder and a splendid long-range investment, and not merely some personnnel man's idea of a recruiting gimmick, you will have deserved well of your profession.

Charles Süsskind

—CHARLES SUSSKIND, TREASURER, SFS

How to determine high-frequency characteristics of precision film resistors

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TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDM⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDM¼	¼	RN65B	10 Ohm-1 Meg	500
CDM½	½	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1000
CDM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE†

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CD⅛R	⅛	—	10 Ohm-1 Meg	350
CD¼R	¼	RN10X	10 Ohm-1 Meg	500
CD½PR	½	RN15X	10 Ohm-3 Meg	650
CD½MR	½	RN20X	10 Ohm-5 Meg	750
CD½SR	½	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1000
CD2R	2	RN30X	50 Ohm-50 Meg	2000

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TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CG¼	TI ¼ MIL ⅛	RN60B	24.9Ω to 82.5 K	350

†All values available in 1% tolerance, nominal lead length 1.5 in.
**Nominal lead length 1.5 inches, resistance values available in ± 1%, ± 2%, ± 5% tolerances

***sensistor** SILICON RESISTORS**

Standard available resistances @ 25° C
68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, 1800 ohms ‡

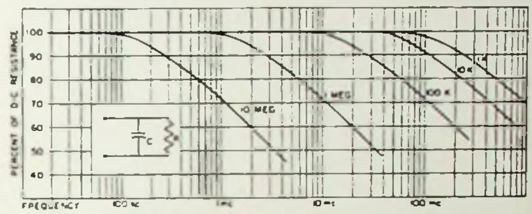
Type No.	Wattage Rating W	Body Dimensions Length	Body Dimensions Diameter	Average Temperature Coefficient %/°C	Resistance Tolerance %
TM ¼	¼	0.585"	0.200"	+0.7	±10
TM ⅛	⅛	0.406"	0.140"	+0.7	±10
TC⅛	⅛	TO—5	Transistor	+0.7	±10

* TRADEMARK OF TEXAS INSTRUMENTS INCORPORATED
‡ Other resistance values and tolerances available on special order

In high frequency applications, precision film resistors are superior to composition or wirewound resistors; skin effect of the thin film is negligible.

OHMIC VALUE vs FREQUENCY

Precision film resistors of a given physical size have the same distributed capacitances regardless of their ohmic value. As the frequency increases, the shunting effect of the distributed capacitance causes the effective parallel resistance to decrease. The reactance of the stray capacitance becomes a relatively good shunt when it approximates the ohmic value of the resistor. The smaller the ohmic value of a precision film resistor (for a given physical size), the higher its usable frequency range.



HIGH FREQUENCY RESISTANCE OF PRECISION FILM RESISTORS

INDUCTANCE CONSIDERATIONS

The inductance caused by helixing the higher value resistors is negligible throughout the "useful" range of frequencies at which the resistance is greater than 60% of its d-c value.

When resistors under 500 ohms are measured using high frequency meters, the reactive component of the equivalent parallel circuit appears inductive because of lead and binding post inductance. However, the resistor itself is capacitive.

TI TYPE	SIZE (WATT RATING)				
	⅛	¼	½	1	2
MIL-LINE (CD)	0.2	0.1	0.25	0.5	0.6
MOLDED (CDM)	0.3	0.25	0.45	0.7	0.7
HARD GLASS HERMETIC (CG)	0.25	0.15	0.25	0.3	

CAPACITANCE IN μμf OF TI PRECISION FILM RESISTORS

CAPACITANCE CONSIDERATIONS

The average measured capacitance of Texas Instruments Precision Film Resistors is determined primarily by the end cap-to-cap capacitance which is proportional to the dielectric constant of the core and encapsulating material.

MOUNTING

Precision film resistors of 200 ohms or less perform satisfactorily at 5000 mc and higher if placed in a well-designed coaxial mount. A coaxial mount constructed from a standard UG-18B/U Type N plug can be used effectively. In conventional terminals, correct mounting of the body of the resistor off the circuit chassis and the use of short leads will minimize the stray capacitance and lead inductance.

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MEETING CALENDAR

PROFESSIONAL GROUPS

Antennas & Propagation — 8:00 P.M. • Wednesday, Jan. 11

"Some Recent Antenna Innovations"
Speaker: J. William Carr, research specialist, electromagnetic division, Lockheed MSD
Place: Room 101, Physics Lecture Hall, Stanford University
Dinner: 6:30 P.M. (Happy Hour 6:00 P.M.), The Red Shack, 4085 El Camino Way, Palo Alto
Reservations: Odette Moore, DA 6-6200, Ext. 2414, by January 10

Engineering Management — Wednesday, Jan. 11

Details to be announced

Instrumentation — 8:00 P.M. • Thursday, Jan. 12

"Instrumentation Workshop I, State of the Art: Kilomegacycle Oscilloscopes"
Speakers: Representatives from Hewlett-Packard and Textronix
Place: Room 320, Geology Building, Stanford University
Dinner: 6:00 P.M., L'Omelette Restaurant, 4170 El Camino Real, Palo Alto
Reservations: Nicholas Pappas, DAvenport 3-1411

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meeting ahead

ANTENNA INNOVATIONS

In January, PGAP will present J. William Carr of Lockheed talking about recent antenna innovations. See the Calendar, page 8, for detailed information.

The author will give a brief discussion of several antennas on which he has conducted experimental research during the past year. Two novel antenna types plus some basic modifications in log-periodic structures will be discussed.

meeting review

DOWNRANGE DATA

For its meeting on the first of November, the Professional Group Chapter on Instrumentation presented the story of special missile-range instrumentation as it exists at the Eglin Bay, Florida, facility.

Since the speaker was Alan Smolen, director of ITT special range laboratories, Nutley, New Jersey, one of his Palo Alto colleagues, Robert Stack of ITT Laboratories, performed the introduction and gave some background in the corporation. A source of some confusion is the fact that ITT does not install and does not operate telephones in the United States, although it has about 40,000 employees in this country and 95,000 elsewhere—principally in Europe.

In Smolen's description, the test range is about 450 miles long and 150 miles wide, and facilities exist so that three missiles can be fired and tracked simultaneously. Equipment had to be designed from scratch to very great stability, for example, oscillators have a stability of one part in one million.

Radars feed data into an IBM 704 computer which keeps the control room fully informed of all stages of the flights. ITT designed and had equipment built and installed without a single redesign of units. Some wiring difficulties developed, but this was to be expected.

Communications equipment was furnished by Philco, who used a basic Lenkurt carrier system. All in all, the cost of the installation came to $22 million.

Smolen showed slides of various installations both under construction and completed. The very intricate wiring was explained by means of a film which showed the overall operation. Some of the particular problems discussed were those involving friendly interference in the range of 10 kc to 15 kmc, and the

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ire office

SPACE PROBE

Note that the Palo Alto Office has moved from the second to the first floor, in order to gain a few more feet of needed space. The correct address is now Suite 110, 701 Welch Road, Palo Alto, instead of the former Suite 205.

MEETING CALENDAR

Instrumentation — 8:00 P.M. • Tuesday, Feb. 7

"State of the Art, More Precise Phase Measurements in Very Low to High Frequencies"
Speaker: Paul Yu, president and chief engineer, Ad Yu Electronics Labs, Passaic, New Jersey
Place: Cubberly Auditorium, Stanford University

Reliability & Quality Control — 8:00 P.M. • Wednesday, Dec. 21

"Reliability Through Redundancy & Monitoring"
Speaker: Roger MacDonald, reliability section supervisor, Sylvania
Place: Room 101, Physics Lecture Hall, Stanford University
Dinner: 6:00 P.M. (Social Hour 5:30 P.M.), Chez Yvonne, 1854 El Camino Real, Mountain View

CHRONOLOGICAL RECAP

December 21—Reliability & Quality Control

January 11—Antennas & Propagation, Engineering Management

January 12—Instrumentation

February 7—Instrumentation

presentation was concluded with the conventional question-and-answer period.

—LES BURLINGAME & GEORGE SPELVIN

meeting review

MAGNETIC TOURISM

The Professional Group on Product Engineering and Production held its November meeting at Palo Alto Engineering, a subsidiary of Hewlett-Packard Co. The topic was "Design and Fabrication of Magnetic Components."

After the usual introduction by Messrs. Bud Eldon and Dale Fuller of PGPEP, L. Burkhart, chief design engineer of Paeco, informed the crowd of some 65 visitors about problems in designing magnetic components.

Burkhart received his BS degree at San Jose State in 1951. After some graduate work at UC, he went into the Navy and joined Paeco in 1953. He was the company's tenth employee and has progressed with the company through many different departments including production, engineering, sales, and design.

The next speaker on the agenda was J. Biggerstaff, new product development engineer at Paeco. He received his BS degree at UCLA in 1957. Prior to joining Paeco, Biggerstaff had experience in semiconductor and magnetic circuitry with Lockheed, Palo Alto, in the telecommunications department. Prior to joining LMSD, he was assistant chief engineer of California Magnetic Corporation, Los Angeles.

After a general review of Paeco's birth and growth during the years, presented by J. Burkhart, general manager of Paeco, a plant tour followed.

At first glance, it would appear to be a simple matter to make transformers, as you merely wind a coil and add some insulation and put these on a piece of metal and there you are. The tour, through Paeco, under expert guide, reveals there are many variables in manufacturing that need close control for processing.

As a matter of fact, the entire transformer is quite a compromise. You would like it to run cool, but if you do then it becomes too big and bulky for most applications. You therefore decrease the size. But when you do, you take a chance of producing a transformer that may be driven too hard, therefore creating noise. You also want the unit to be attractive in appearance but if you go overboard in this respect, the cost becomes prohibitive. The tour through Paeco showed to participants that the company has reached a happy medium in many respects.

The production facilities display quite some ingenuity with regard to equipment, layout, and process flow. Much

(Continued on page 10)

Speakers for the November 22 PGPEP meeting and PGPEP officers: Lloyd Burkhart, Bud Eldon, Jack Beckett, Dale Fuller, and J. Biggerstaff —George Reyling photo

MORE TOURISM

of the equipment has been designed and built by the company itself. Semi-automatic testing is being used throughout the plant and it is heavily conveyorized.

The do-it-yourself philosophy is prevalent. Wherever you go, jigs and fixtures designed and made by the company are being used. Injection molding machines were purchased for the purpose of making bobbins but were found so useful, the company is now making cases for manufacturing.

After the tour, refreshments were served and during this time the guides were most cooperative in answering all questions that were asked by the tourists. —OLOF LANDECK

meeting review

GAUSS-TRAPPED ELECTRONS

On November 9 Dr. Rolf Dyce of Stanford Research Institute spoke to the San Francisco Chapter of PGAP at Stanford University on "The Trapping of Electrons from a Nuclear Detonation in the Earth's Magnetic Field."

The earth's field can act as an efficient container of charged particles provided these particles do not enter regions where the atmospheric density is appreciable. When a fast-moving charged particle is injected into the earth's magnetic field by a high-altitude nuclear detonation the particle describes a corkscrew-shaped trajectory, the center line of which lies along a magnetic line of force. At the lower end of its trajectory, called the turning point, the particle goes into a flat spiral and then winds back along a similar path to the turning point in the other hemisphere, making the transit in a second or so. During this time its line of travel drifts eastward slowly around the earth.

The nuclear detonations discussed included the Argus, Teak, and Orange shots. Since the Explorer IV satellite was in orbit at the time of the explosions obtaining data on the Van Allen belts, its readings were also used to give a detailed picture of the position of the electron shell formed by the explosions and the intensity of the radiation. This was illustrated by slides showing the reduced data from the satellite's instruments. As a further verification of the trapping action, visual auroras caused by collisions with the atoms of atmospheric gases were observed in both the detonation and magnetic-conjugate areas.

Rolf B. Dyce was born on October 12, 1929, in Guelph, Ontario, Canada. He received an AB degree in physics from Cornell University in 1951. His graduate work was done in the school of electrical engineering at Cornell, where he was engaged in research on the reflec-

Rolf Dyce, speaker at the November PGAP meeting
—SRI photo

tion of vhf radio waves from the aurora borealis. Portions of 1953 and 1954 he spent in field research at the Geophysical Institute of the University of Alaska. In 1955, he received the PhD degree in electrical engineering.

From 1955 to 1957, Dr. Dyce served as Air Force officer in the propagation section of Rome Air Development Center, where his duties included the monitoring of research contracts and consultation on propagation problems.

In July 1957, he joined the staff of Stanford Research Institute's communication and propagation laboratory, where he is now assistant head of the propagation group. At SRI, he has been chiefly concerned with radar studies of auroral, meteor, lunar, and satellite echoes, high-altitude nuclear-weapon effects on the ionosphere, and electromagnetic effects of missile flight. He is the author or co-author of a number of papers on radio propagation effects associated with the aurora, moon reflections, and earth satellites.

Dyce is a member of PGAP, the American Geophysical Union, Sigma Xi, and Commission 3 of the U.S.A. National Committee of URSI.

—H. ROTHMAN

meeting review

OUR REPORTER GETS THE BUSINESS

One of the outstanding meetings of the year in PGEM was held November 17 at Stanford Research Institute. SRI was host to the group for the purpose of giving everybody an opportunity to run a do-it-yourself business. While the participation was limited because of the limits in SRI facilities, the interest was high and everybody hopes we will be able to impose upon SRI's good nature to repeat the game.

Ben Lefkowitz and Dr. Clay Perry were hosts for the game. The situation was competitive. Five teams: that is,

(Continued on page 12)

Ben Lefkowitz, SRI operations analyst, addresses the PGEM group during the November executive decision game
—Joseph Del Gaizo photo

MORE BUSINESS

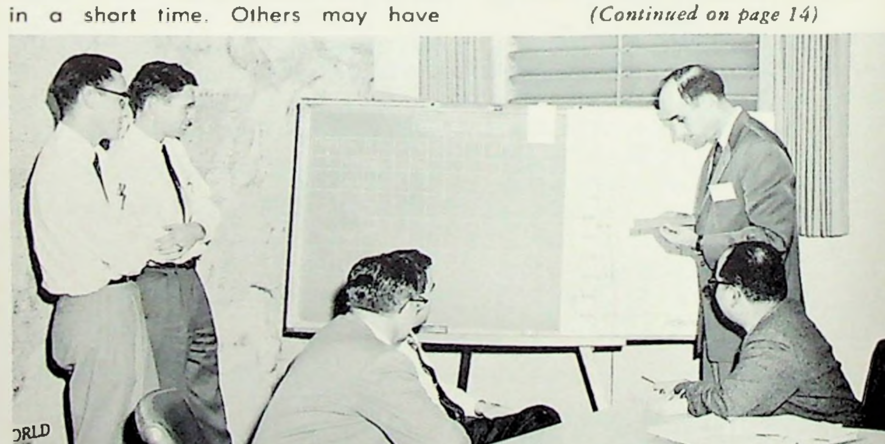
five companies, were competing in the transistor market. Each team picked its own objectives: for example, some operators may have wanted to cut prices, corner the market, and make a clean-up in a short time. Others may have wanted to stay small and solvent while waiting for Litton Industries to buy them out. At intervals of about ten minutes, each team was required to make a decision on its next fiscal quarter operation with respect to price, production, volume, advertising budget, research and development budget, and plant investment. The ground rules put forth by Ben Lefkowitz included the assumption that no dividends would be declared and that the company would not be one in which widows and orphans would be likely to invest.

One of the executive groups completes data being picked up by William D. McGuigan for the computer
—Joseph Del Gaizo photo

The game was played on a Burroughs 220 Computer, programmed to take account of the effect each company's decisions would have on its competitors.

As soon as the computer had accepted the decisions, the price and total volume of sales were posted for each company. After this cycle, a new set of decisions was required from each company, pointing toward next quarter's operations. Each time the price structure was announced, the computer

(Continued on page 14)



Dr. Clay Perry, SRI manager of mathematical sciences, charts the computer readout into some pretty dismal-looking sales curves
—Joseph Del Gaizo photo

Prof. Anthony E. Siegman, speaker at the November PGED/PGMTT meeting and Perry H. Vartanian Jr., vice chairman PGMTT

MORE BUSINESS

printed out an operating statement for each competing company. The National Economic Index was also a factor cranked into the computer.

At the end of the four-hour session, everyone was exhausted and some were sadder and we hope wiser. This reporter was a member of the team making the poorest showing. He will hereafter stick to reporting.

—L. M. JEFFERS, JR.

meeting review

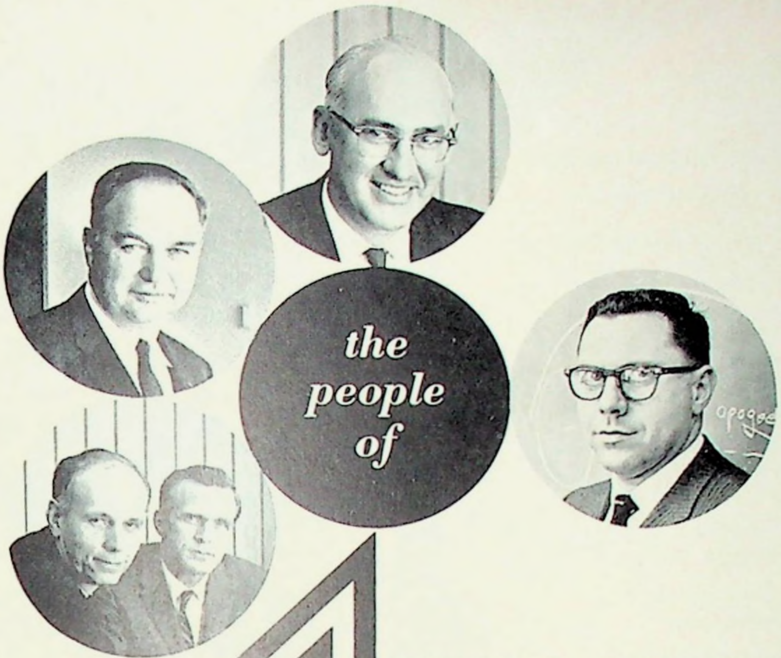
UNCERTAIN NOISE

The lowest noise figure that can be obtained, using perfect components, was the subject considered by Professor Tony Siegman at the second of three current PGED-PGMTT meetings relating to noise in amplifiers. The sixty-two members and guests gathered at the Stanford Physics Lecture Hall were presented with a very clear and informative discussion by Dr. Siegman of some of his recent thoughts on the topic "Getting Close to the Ultimate Noise Limit."

In largely classical terms, the limitations imposed by quantum phenomena on low-noise amplification were given under the following subtopics: (1) The noise limit from the uncertainty principle, (2) The maser, as an example which will just reach this limit, (3) The same limit obtained from consideration of zero point energy, (4) "Noiseless amplifiers," and (5) The effects on channel capacity and information rate. Before considering these topics further they may be summarized by giving the primary result; namely that the minimum amplifier noise temperature is given by the product of the signal frequency and Planck's constant divided by Boltzman's constant. At 10 kilomegacycles this is one half degree Kelvin, a figure which masers are currently approaching. In the visible light or laser frequency region the figure reaches the rather high value of 25,000 degrees K.

The discussion based on the Heisenburg uncertainty principle proceeded as follows. An equivalent form of the uncertainty principle for the amplitude (or number of quanta) and phase

(Continued on page 16)


the
people
of

of a signal was determined. This is $\Delta n\,\Delta\phi \geq 1/2$, where Δn is the uncertainty in amplitude and $\Delta\phi$ the uncertainty in phase. It can then be shown that under optimum conditions the rms values are given by $\overline{\Delta n^2}\,\overline{\Delta\phi^2} = \overline{\Delta v^2}/(hfB)^2$ where Δv is the uncertainty in signal amplitude and B is the receiver bandwidth.

Applying the uncertainty relation we find $\overline{\Delta v^2} \geq hfB/2$ which is equivalent to a noise power of $P_n = hfB$. The temperature corresponding to this noise is $T_a = P_n/kB$ or as stated earlier $T_a \geq hf/k$. The question arose at this point whether this could properly be called the noise temperature of an amplifier since it seems to be a function only of the signal. It appears this is largely a matter of interpretation, i.e., the fluctuations can be considered as properties of the amplifier. Furthermore, consideration of a high gain maser amplifier leads to the same result.

The noise figure of a two-level cavity maser was next determined. The noise introduced by the amplifier is that expressed by the familiar Johnson noise law which gives a positive noise voltage whether the equivalent circuit resistance is positive or negative (the latter being required for maser action). The noise output from the maser is found to be $N_O = (G-1)\,hfB/1 - \exp.\,(-hf/kT_m)$, where G is the power gain of the maser and T_m is its temperature. This noise power may be said to result from spontaneous decays from the higher to lower energy level in the maser. For $T_m \gg hf/k$ this gives $T_m = P_n/(G-1)\,kB$. Now as T_m is allowed to approach zero we obtain $P_n = (G-1)\,kB\,(hf/k)$. Thus the limiting value for the noise at zero temperature is equivalent to a temperature of hf/k, the result obtained previously.

Siegman next considered the application of zero point energy concepts to the problem. These require an input to the amplifier of $hfB/2$. The resulting output power, N_O, for high gain is the same as that given in the previous paragraph. A possible interpretation here is that the amplifier does not introduce noise but does amplify the zero point energy.

There followed an interesting consideration of so-called quantum counters as noiseless amplifiers. An example here is the phototube operated at zero temperature and thus with zero dark current. This device counts incoming quanta perfectly. However, while there is no ambiguity in the amplitude of the signal, all phase information is lost and we appear to be satisfying an uncertainty principle. If one attempts to incorporate a separate phase detector the principle is still not violated be-

(Continued on page 18)

Audio, telemetry and low frequency oscillators

Pictured here are six of the most widely used oscillators in electronics. All employ the highly stable, dependable, accurate resistance-capacity circuit. They require no zero setting. Output is constant, distortion is low and frequency range is wide. Scales are logarithmic for easy reading; all are compact, rugged and broadly useful basic instruments. Brief specifications are given below; call your hp rep for demonstration or write direct for complete data on any instrument.

Model	Frequency Range	Calibration Accuracy	Output to 600 ohms	Recommended Load	Maximum Distortion	Max. Hum & Noise ¶	Input Power	Price
200AB	20 cps to 40KC (4 bands)	±2%	1 watt (24.5 v)	600 ohms	1% 20 cps to 20 KC 2% 20 KC to 40 KC	0.05%	70 watts	$150.00
200CD	5 cps to 600 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5% below 500 KC 1% 500 KC and above	0.1%	75 watts	$170.00
200J	6 cps to 6 KC (6 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.1%	110 watts	$300.00
200T	250 cps to 100 KC (5 bands)	±1%†	160 mw 10 volts	600 ohms*	0.5%	0.03%	160 watts	$450.00
201C	20 cps to 20 KC (3 bands)	±1%†	3 watts (42.5 v)	600 ohms**	0.5%‡	0.03%	75 watts	$225.00
202C	1 cps to 100 KC (5 bands)	±2%	160 mw 10 volts	600 ohms*	0.5%§	0.1%	75 watts	$300.00

*Internal impedance is 600 ohms. Frequency and distortion unaffected by load resistance. Balanced output with amplitude control at 100. Use line matching transformer for other control settings. **Internal impedance approximately 600 ohms with output attenuator at 10 db or more. Approximately 75 ohms below 5000 cps with attenuator at zero. †Internal, non-operating controls permit precise calibration of each band. ‡0.5%, 50 cps to 20 KC at 1 watt output. 1.0% over full range at 3 watts output. §0.5%, 10 cps to 100 KC. 1.0%, 5 to 10 cps. 2.0% at 2 cps. 3.0% at 1 cps. ¶Measured with respect to full rated output.

hp 200AB Audio Oscillator

hp 200CD Wide Range Oscillator

hp 200J Interpolation Oscillator

hp 200T Telemetry Oscillator

hp 201C Audio Oscillator

hp 202C Low Frequency Oscillator

HEWLETT-PACKARD COMPANY

CONTACT OUR ENGINEERING REPRESENTATIVES, NEELY ENTERPRISES, FOR INFORMATION — Los Angeles, 3939 Lankershim Blvd., North H'wd., TR 7-0721; San Carlos, 501 Laurel St., LY 1-2626; Sacramento, 1317 Fifteenth St., GI 2-8901; San Diego, 1055 Shafter St., AC 3-8106; Phoenix, 641 E. Missouri Ave., CR 4-5431; Tucson, 232 So. Tucson Blvd., MA 3-2564; Albuquerque, 6501 Lomas Blvd., N.E., AL 5-5586; Las Cruces, 114 S. Water St., JA 6-2486. 6036

hp pioneered the world-famous resistance-capacity oscillator circuit

MORE NOISE

cause of an uncertainty which must be introduced by the partition of the signal.

The effects on channel capacity or loss of information are not yet fully determined. While some estimates of information loss have been made much work remains to be done.

—RICHARD P. BORGHI

meeting review

THE 17-YEAR ITCH

The content and organizational requirements of patents were reviewed by John F. Lawler, patent attorney for Sylvania's Mountain View operations, at the November meeting of the Professional Group on Engineering Writing & Speech. The meeting was held at a conference room of Hewlett-Packard Company in Palo Alto and was conducted by Chairman Arthur Walters.

Lawler, introduced by Vice Chairman James Weldon, holds a BS degree in mechanical engineering from Case Institute of Technology and earned his LLB at Western Reserve University. He entered the electronics field from service as a radar officer in the Army during World War II.

The word "patent" originated in the practice of English kings of issuing privilege-granting "letters patent" or open letters to select subjects. The modern patent is a form of barter or exchange between an inventor and the public at large, represented by the government. In exchange for exclusive proprietary rights to his invention for a period of seventeen years, the inventor provides a complete "disclosure" of the construction, operation, and application of his invention.

The government agrees to provide its judicial facilities to assure the prohibition of others from using an invention. In return, any person may obtain the complete disclosure of the invention for his information and education for the nominal fee of twenty-five cents.

The patent itself consists of three parts: drawings, specifications, and claims. The first page or pages of the patent contain as many figures as necessary to illustrate completely the principles, construction, and component parts of the invention. Each part and group of parts to be described or referred to in the patent is accompanied by an index "call-out" number for ease of reference.

The first portion of the text material in the patent is the specifications, in effect a complete description of the invention. Here are presented statements of the purpose of the invention, the problem area, the object of the invention in detail, and a summary of the invention. These statements are followed by an identification and descrip-

(Continued on page 21)

A rose by any other name . . . etc., etc., etc. Shakespeare, we finally realized, was right. In the depths of the night quite recently, we recalled, with not a modicum of horror, those first disastrous days when we were trying to put a name to the corporation now known as Rantec. "It's gotta have 'micro' in it," an officer high on the echelon (there were three of us at the time) claimed, "without 'micro' we just ain't in the electronics business." "Well, we're not, really," some wretched iconoclast put forth, "has anybody seen a contract around here yet?"

Having gotten rid of *him*, we settled down to facts, or some semblance thereof. R for radomes, ANT for antennas, EC for electronic components. RANTEC. Fabulous. Meaningful. Easy to say with your mouth full. And it was truly valid for about three and a half days. Although we still make antennas (and quite a number, if the truth be known), Rantec is now involved up to its neck in ferrite devices, multiplexers, waveguide components and microwave sub-systems. See what we mean.

The upshot of this entire thing has been a little game called "Pin the Tail on the Electronic Firm" which has succeeded in pulling our senior research engineers away from the ping pong table and our technicians away from the chessboard. The amazing thing is that the game has no prizes and nobody wins. Of course, nobody loses either which might or might not mean something. The rules are simple: name a fictional electronic firm. Although, as we said, there are no prizes, no one can deny us the right of picking our favorites. Try these on for size. (1) HydroPeptic, manufacturers of irrigation equipment; (2) Macroneurotic and its wholly-owned subsidiary, Frustronics, which provide problems instead of solutions; and (3) Myoptics, Inc. which designs and develops complete systems with equally complete obsolescence.

If first prize there were to be, it must be awarded to one of our brilliant electronic engineers who thought it might be wise to open up a second-hand hardware company in Culver City, California, and call it the Used Tool Company.

Any engineer on the outside who might have a smattering of knowledge about microwave theory or antennas or electronics of various orders and who might or might not want a job can join in the fun. Send your answer to Rantec Corporation, Calabasas, California. Rantec. That's pretty funny, right there.

MORE PATENTS

tion of the figures included in the patent. Finally, the specifications include a complete detailed description of the invention, referring to the figures.

The last portion of the patent contains all the claims presented. These define the area of the monopoly granted the inventor. A patent usually contains a number of claims, each succeeding claim describing a broader scope of the application of the inventor. A narrow claim, presenting a precise description and specific application is least susceptible to attack by previous patents. Broader claims, describing the principles and applications of the invention in more general form, provide the invention with a much more all-inclusive monopoly.

To illustrate his presentation, Lawler distributed amongst the members several patents illustrative of the points covered. —DOUGLAS WM. DUPEN

meeting review

PIDGIN MACHINE

In November, the Professional Group on Electronic Computers met at the SRI Auditorium to listen to John Griffith of IBM speak on "Table Look-Up and Language Translation."

Griffith introduced the topic of table look-up by discussing the classic paper on the Turing Machine. Turing described his machine in the form of tables as opposed to the flow charts ordinarily used today. The structure of this machine is almost entirely contained in the memory. Turing's requirement of "scratch paper" is still a requirement of machines today in the use of temporary storage, index counter, etc. Most machines today use extrinsic addressing instead of intrinsic as used in the Turing Machine. Extrinsic addressing is the usual type where items are in a definite order and their address is either known by the item or can be computed. Intrinsic addressing is without order and an item is found by searching.

Earlier this year IBM announced a language translation machine built under contract for the Air Force. This machine, named Mark II, has some of the features of the Turing Machine—intrinsic addressing, very large memory, table look-up, etc. The use for which this machine was built was to translate Russian into English. It could also be used to translate other foreign languages and unnatural languages such as braille, stenotype, character codes, etc. Although there is no arithmetic hardware within the machine, arithmetic operations could be performed by the proper use of tables in the memory.

Some of the features of the machine mentioned by Griffith were a 10-inch-

(Continued on page 22)

IT IS REPORTED

Levinthal

Morris

Dr. **Elliott C. Levinthal,** chairman of the board of directors of **Levinthal Electronic Products, Inc.,** a subsidiary of **Radiation Incorporated,** and formerly president and general manager, has announced the election of **Albert J. Morris** as president and general manager. Morris has been serving as senior vice president for engineering. Levinthal, in addition to serving as a member of the Board of Directors of Radiation, Incorporated, will serve as a staff vice president of Radiation Incorporated.

Harry Heard, formerly chief engineer, is elected to the position of vice president and chief engineer of the r-f systems division; **Meryl Burns,** formerly chief engineer of Radiation's space communications division in Mountain View, is elected to vice president and chief engineer of the space communications division, and **Eldon Anderson** is elected to vice president and production manager of Levinthal Electronic Producs, Inc.

Building expansions are currently being announced, or completed and dedicated, by the following: **Beckman/Spinco** has a 43,000-sq-ft addition under construction in Palo Alto; **Lockheed missiles and space division** plans a four-million-dollar expansion consisting of a 172,800-sq-ft engineering and laboratory building in Sunnyvale, to begin January, for occupancy by June; **Philco Corporation,** whose president, **James M. Skinner, Jr.,** appeared in Menlo Park for the formal dedication of a **Sierra Electronic Corp.** division expansion of 50,000 sq ft to their basic 35,000 sq ft, also announced a five million dollar building program to add 250,000 sq ft to the western development laboratories in Palo Alto; **Shell Development Company,** has completed a multi-million dollar expansion program at its Emeryville research center through conversion of a 5-story warehouse adjacent to the existing research facility; and **Western Scientific Instrument Co., Inc.** announced the start of construction on a new building on Warrington Street near Bay Road in Redwood City—the completed facility to include the first commercial primary-standards laboratory in Northern California.

Arthur H. Hausman has been appointed vice president and director of research at **Ampex Corporation,** succeeding Walter T. Selsted, who was recently appointed vice president, engineering, for the Corporation.

For the past 12 years, Hausman has been with the U.S. Government in research and development. His most recent position was in the Department of Defense, Washington.

Hausman

Myers

William D. Myers, who has been with **Hewlett-Packard Co.** for 16 years, has been named manager of a new precision components division. Myers was formerly manager of the electrical engineering section of the company's manufacturing engineering department.

International Business Machines Corp., San Jose, has made the following personnel changes: **A. G. Anderson,** manager physics department, research laboratory; **Don V. Couden,** manager of reliability and serviceability program in the general products division development laboratory; **W. A. Gross,** manager, applied mechanics department, research laboratory; **Henry A. Head,** manager of market planning in the advanced systems development division

(Continued on page 24)

MORE LANGUAGE

diameter photo-store of 30 megabits. A high resolution Eastman film was used here. The bit rate of the machine was one megacycle and an average access time from memory was 10-20 milliseconds.

Griffith had some examples of the Mark II translation of the Russian newspaper Pravda. Although the translation was in pidgin English because of the word-for-word translation, the text was still readable and very interesting.

—J. A. BOYSEN

commercial group; **A. S. Hoagland,** manager, special studies department, research laboratory; **Otto Kornei,** manager of magnetics in the advanced technology group of the general products divisions development laboratory; **J. D. Michaelsen,** manager, photo-chemistry department, research laboratory; **R. M. Walker,** manager, magnetic recording department, research laboratory; **E. Rae Wooding,** manager, special systems engineering, general products division development laboratory. Dr. **Gardiner L. Tucker,** manager of the research laboratory, will function as interim manager of a systems-science department under the new organization.

Blachman

Jeffers

Sylvania Electric Products, Inc. welcomed Dr. Nelson M. **Blachman** back to EDL after a two-year assignment with the London branch of the Office

(Continued on page 26)

MORE SWINGS

of Naval Research, promoted **Leonard M. Jeffers** from EDL customer relations to supervisor of technical publications; and appointed **Paul E. Jensen** to head the EDL engineering writing section, from his previous activities in liaison and publications.

Jensen

Moore

Kendric A. Moore has joined **Granger Associates** as manager of aviation products. Moore has been based in New York as manager of communications for Pan American World Airways' overseas division. From 1945 to 1959 he was superintendent of radio engineering for the Pacific-Alaska Division of PAA. Moore has been active in ARINC, AEEC, and airline-industry committees in promoting airline communications improvement and reliability programs.

Barco, Inc., of Milwaukee has appointed **A & P Electronic Sales,** San Francisco, as sales representatives for its line of electrolytic capacitors.

grid return

LETTER TO THE EDITOR

Atherton, California

Dear Sir:

I have the privilege of being a part of the Technical Fellowship of an enterprise — Data International — which was established to improve communications between individual missionaries in the field and competent help at home. All manner of requests for technical inputs are received and replies are prepared by interested members of the technical community.

At this time we have a request for back issues of the IRE Proceedings from William Haney, a technical missionary with Centro Audio Visual Evangelico in Brazil. Other requests like this have depleted our source of supply. It occurred to me that perhaps **Grid** would run a short item directing those who have back issues to donate to this purpose to send word of their availability to William Hoff at Data, 3201 Middlefield Road, Palo Alto, Calif.

Yours very truly,
Paul W. Crapuchettes

Grid editorial offices already have been happily involved in publications clearing-house activities of this general sort. Maintaining lists of "haves" and "have nots" will be a continuing function and members are urged to utilize either aspect.—Ed.

events of interest

IRE MEETINGS SUMMARY

January 8-12—**Symposium on Thermo-electric Energy Conversion.** Statler Hotel, Dallas, Texas. Philip Klein, General Electric Co., Syracuse, New York.

January 9-11—**7th National Symposium on Reliability & Quality Control.** Bellevue-Stratford Hotel, Philadelphia, Penna. Robert L. Schwerin, ACF Electronics Div., ACF Industries, Inc., 11 Park Place, Paramus, New Jersey.

January 16-17—**Symposium on Space Instrumentation.** Washington, D.C. Cancelled.

January — **Conference on Magnetic & Dielectric Devices.** Lockheed Missiles and Space Division, Palo Alto, Calif. A. K. Wing, ITT Labs., Nutley 10, N. J.

NON-IRE EVENTS

On Saturday, December 24, at 4:30 p.m., **KPFA-FM,** 94.1 megacycles (also KPFB-FM, 89.3 mc), Berkeley, will broadcast the regular "Equipment Report" program by R. S. MacCollister. The subject of this program will be the Transis-tronics, Inc. TEC Model S-15 all-transistor integrated output-transformerless stereo power amplifier.

January 11—Peninsula Chapter, **California Society of Professional Engineers:** "Building for Professional Growth," a special meeting for prospective members to answer their questions about the NSPE. Hillsdale High School (Little Theatre), San Mateo, 8:00 p.m.

IRE PAPERS CALLS

December 20—Complete papers or 200-word abstracts for PIB Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma (New York City, April 4-5, 1961). Send to Symposium Committee, Polytechnic Institute of Brooklyn, 55 Johnson Street, Brooklyn 1, New York.

December 31—Abstracts of approximately 250 words with brief professional record of author, in duplicate, for Fifth National Symposium on Global Communications (GLOBECOM V), Chicago, May 22-24, 1961). Send to: Donald C. Campbell, ITT-Kellogg, 5959 So. Harlem Avenue, Chicago 38, Illinois.

January 1—500-1000-word abstracts for PGIT 1961 Symposium on Transmission and Processing of Information (MIT September 6-8, 1961). Send to Peter Elias, RLE, MIT, Cambridge 39, Mass.

January 1—500-word abstracts, including an original and four copies, for the 1961 7th Regional IRE Technical Conference & Electronic Exhibit (Phoenix, Ariz., April 26-28, 1961). Send to: H. W. Welch, Jr., Motorola, Inc., P.O. Box 1417, Scottsdale, Arizona.

the section

MEMBERSHIP STATUS

Following are the names of IRE members who have recently entered our area, thereby becoming members of the San Francisco Section:

Richard J. Aaron
Jon P. Aasterud
Cardis L. Allen
Jose C. Alvarez
Agostino Arcidiacono
Robert S. Baldwin
Ronald R. Banducci
Barlow Bechtel
Wallis D. Bolton
David E. Bowser
Peter Burger
John Chow
Richard E. Cordray
Thomas F. Crossman
Richard T. Dawson
Norman L. De Noon
Paul J. Dionne
Constantine Dolkas
John C. Eidson
Robert J. Espinosa
Michael O. Felix
Wayne A. Flemming
James A. Forgey
Victor R. Frank
Edward C. Fraser
Jeffrey I. Frey
Gregory Ganifas
Ralph W. Gerchberg
William G. Granat
Colin Hacking
Donald W. Haney
Paul Hodges
John W. Hogg
David A. Hornby
James A. Howard
Howard T. Humphrey
Norman L. Huntington
Claude A. Jackman
Colin M. Jones
Walter V. Jones, Jr.
Russell C. Jouett
D. P. Kanellakos
Allen D. Keimig, Jr.
Raymond G. Kenyon
Norman E. Kerver
Walter A. Koenig
Kyriakos V. Krestas
John R. Largent
James P. Lesniak
Gerald E. Lewis
Herbert E. Lindberg
James B. Lindgren
Darrell H. Liston
George M. Loh
Herman Loopeker
R. Ray Mangold
Robert C. Mason
Bruce A. McElhoe
Donald K. Melvin
Francis N. Miller
William N. Mills
James L. Mongillo
Andrew J. Nichols, III
John A. Nicoletti
Roy E. Olson
E. Kenneth Peterson
Michael L. Pullen
Stanton E. Quail
Zack D. Reynolds
Max A. Richman
Claude Romans
J. Ballard Sampson
Elmer S. Seeley
Eugene B. Sheker
James E. Simpson
Glen H. Smerage
David A. Spaulding
Gerald T. Stillman
James E. Stubbles
George L. Turin
Robert W. Vaughan
David A. Ward
Jack E. Wilson
William L. Wise
Robert J. Wohl
Alan F. Woldow
Thomas W. Wright
Daniel K. Yee
Herbert M. Young
Leo Young
Ralph W. Young
Barry B. Woo

Following are the names of individuals who have been elected to current membership:

Donald W. Baird
David M. Ball
Robert A. Baumheckel
Chris C. Billot
Glenn A. Black
Thomas T. Inouye
Walter W. Jones
John F. Kane
Ray E. Kelo
Harry A. Kline

Following are the names of members who have recently been transferred to a higher grade of membership as noted.

SENIOR MEMBER
Thomas J. King

MEMBER
Bruno W. Barchenger
Glenn P. Barney
George J. Bertuccelli
Mel H. Breitsprecher
Richard E. Brownlie
Philip F. Chew
Ted J. Crowther
Anthony D. Ferrari
Robert J. Hansen
Morimi Iwama
Berlen A. Kanady
James P. Lesniak
Fred A. Loewy
Charles T. Markee
Emory W. Meeker
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Robert P. Rumble
Per S. Skullestad
Theodore Van Duzer

ASSOCIATE MEMBER
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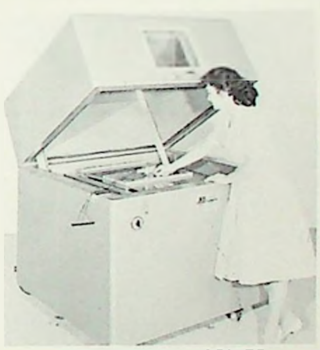

VIBRATION EXCITER

Rotocon is a complex-wave vibration exciter, designed for rapid checkout of production-line items.

Designed by Convair-Astronautics and manufactured under exclusive license by Rototest Laboratories, Lynwood, California, Rotocon supplies wide-band complex vibration to payloads up to 120 pounds without the need for complicated control or monitoring systems.

Single switch control and automatic shutoff allows reliable operation by production line personnel. Nuisance noise is negligible, and the unit may be operated in production areas.

Available now, Rotocon sells for $3,850. Rototest Laboratories, Inc., 2803 Los Flores Blvd., Lynwood, California.

Wanted!

Sr. Electronics Engineer

High-speed research and instrumentation cameras and meteorological instruments are the activities of our instrument division. A versatile man with a BS or MS in either electrical engineering or physics, a good grasp of circuitry and systems, an analytical approach, and the ability to take responsible, decisive action, will find an interesting and unusual career in this division.

Beckman & Whitley is a well established concern in both of these fields as well as in missile components.

It will be this man's primary task to see that the latest concepts and techniques of electronics are kept constantly applied to the camera and meteorological activity. For this, he must have a wide range of technical interests and 5 years of electronic instrumentation design or development.

If you are interested please forward resume or call the Personnel Department at LYtell 1-8241.

Beckman & Whitley

San Carlos, California

MANUFACTURERS INDEX

Manufacturer	Representative
Ace Engineering & Mch. Co.	Premmco, Inc.
Accurate Instrument Co.	Jay Stone & Assoc.
Acton Laboratories	White and Co.
Adage, Inc.	J. T. Hill Co.
Airflow Company	Premmco, Inc.
Ameray-Nuclear Shielding Prod. Div.	White & Co.
American Mach. & Fdry.	McCarthy Assoc.
American Optical Co., Instrument Div.	J. T. Hill Co.
Analab Instrument Corp.	V. T. Rupp Co.
Antlab, Inc.	Jay Stone & Assoc.
Baldwin-Lima-Hamilton Corp.	Neely Ent.
Beckman/Berkeley Division	V. T. Rupp Co.
Behlman Engineering Co.	T. Louis Snitzer Co.
Bogart Microwave	Jay Stone & Assoc.
Bomac Laboratories, Inc.	Neely Ent.
Boonton Electronic Products, Inc.	O'Halloran Assoc.
Consolidated Electrodynamics Corp.	Jack Kaufman
Data Instr., Tele.	T. Louis Snitzer Co.
Datafilter Corp.	Jay Stone & Assoc.
Daytronic Corp.	McCarthy Associates
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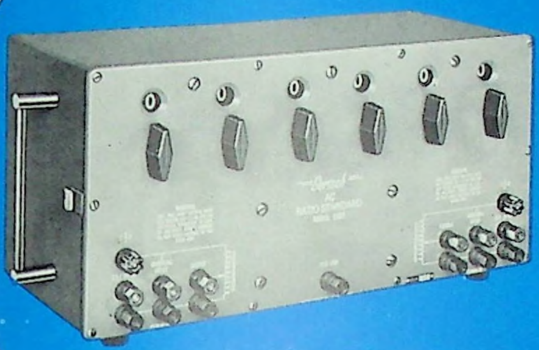

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