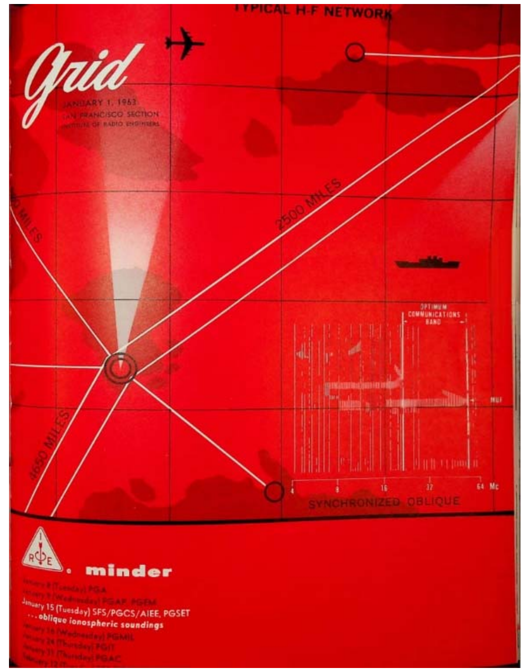
EDITOR'S PROFILE of this issue

from a historical perspective …

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



January, 1963:

Cover: As we learn more about HF propagation, the performance of HF networks can be optimized. More on page 8.

Page 7: Stanford's dean of engineering, Joseph Pettit, writes an op-ed on the 4-year nationwide drop in freshman engineering enrollments. The same drop is felt at Stanford, though graduate engineering enrolment is increasing (the school ranks first in PhDs). Turns out that I joined Stanford in September 1962 as a declared electrical engineering student. Pettit goes on to become president of Georgia Tech.

Page 17: Eimac gets the contract to build the large klystrons for Stanford's 2-mile linear accelerator (SLAC). These are the 50 kW driver klystrons; the final klystron amplifiers will have an output of 25 MW. The total cost of the accelerator should be $114 million.

Grid

JANUARY 1, 1963
SAN FRANCISCO SECTION
INSTITUTE OF RADIO ENGINEERS

IRE • **minder**

January 8 (Tuesday) PGA
January 9 (Wednesday) PGAP, PGEM
January 15 (Tuesday) SFS/PGCS/AIEE, PGSET
. . . oblique ionospheric soundings
January 16 (Wednesday) PGMIL
January 24 (Thursday) PGIT
January 31 (Thursday) PGAC
February 12

Grid volume 9, number 9 January 1, 1963

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contents

cover

Typical HF network is the stock in trade of Granger Associates and its advanced communications manager, Dr. R. D. Egan, who will address another joint meeting of SFS/PGCS/AIEE on January 15. For more on "Oblique Ionosphere Soundings," see the calendar and story—p. 8. Our thanks to Granger and West Assoc. for cover.

section officers

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Grid *reporters*

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MEETING CALENDAR

SAN FRANCISCO SECTION
7:30 P.M. • Tuesday, January 15

(Joint meeting with PGCS and AIEE)
"Oblique Ionosphere Soundings and Radio Propagation"
Speaker: Raymond D. Egan, manager, advanced communications, Granger Associates
Place: Auditorium, Crown Zellerbach Bldg., Market and Sansome, San Francisco
Dinner: 6:00 P.M., Mirror Room, 2nd Floor, Veneto Restaurant, Mason and Bay, San Francisco
Reservations: Mrs. Doris Gould, DA 1-1332
(Parking available at restaurant and Zellerbach Bldg.)

SAN FRANCISCO SECTION
6:30 P.M. • Tuesday, February 12

(Joint meeting with PGED, SFS, AIEE, and IRE-AIEE student branch, San Francisco State College)
"Electronic Engineering Support of a Weapons Test Program"
Speaker: Edward H. Hulse, head, electronic engineering dept., UC Lawrence Rad Lab, Livermore
Dinner-Meeting: 6:30 P.M., Cafeteria, San Francisco State College
Reservations: Mrs. Doris Gould, Section Office, DA 1-1332, for information and reservations

PROFESSIONAL GROUPS

Antennas & Propagation
8:00 P.M. • Wednesday, January 9

"Space Research Program from the Point of View of Education"
Speaker: Professor Samuel Silver, University of California, Berkeley
Place: Room 277, Cory Hall, University of California campus (Hearst Ave., NE corner of campus, off-campus parking recommended)
Dinner: 6:00 P.M., Men's Faculty Club, University of California campus
Reservations: East Bay—Ellen Fitzmorris, TH 5-6000, Ext. 3539; Peninsula—Darlene Wheeler, DA 6-6200, Ext. 2695

Audio
8:00 P.M. • Tuesday, January 8

(Joint Meeting with SMPTE and AES)
"New Techniques and Equipment for Sound Reinforcement"
Speaker: R. A. Isberg, chief engineer, television office, University of California, Berkeley
Place: 155 Dwinelle Hall, inside and left of Sather Gate, Berkeley campus
Dinner: 6:30 P.M., Golden Bear Restaurant, Room B, near Telegraph Avenue and Bancroft Way (left of Sather Gate), Berkeley, approx. cost: $2.00
Reservations: Call Menlo Park, DA 6-6200, Ext. 3584 or Berkeley, 845-6000, Ext. 25-35, by January 7

Automatic Control
8:00 P.M. • Thursday, January 31

"A Convex Programming Solution of Optimal Control Problems"
Speaker: Prof. J. B. Rosen, Visiting Professor, Stanford University
Place: Electrical Engineering 126, Stanford University
Dinner: 6:30 P.M. Place to be announced
Reservations: Mrs. Pauline Eckman, DA 1-3300, Ext. 268, by noon Wednesday, January 30, 1963

MEETING CALENDAR

Communications Systems — 7:30 P.M. • Tuesday, January 15
(Joint meeting with San Francisco Section, IRE and AIEE, see above)

Electron Devices — 6:30 P.M. • Tuesday, February 12
(Joint meeting with SFS, AIEE, and IRE-AIEE student branch, San Francisco State College, see above)

Engineering Management — 8:00 P.M. • Wednesday, January 9
"Developing Our Human Resources"
Speaker: Harold Barrett, Jr., Bureau of Apprenticeship and Training, U.S. Department of Labor
Place: Stanford Room, Rickey's Hyatt House, 4219 El Camino Real, Palo Alto
Dinner: 7:00 P.M., Stanford Room, Rickey's Hyatt House
Reservations: Mrs. Doris Gould, DA 1-1332, by Friday, January 4

Information Theory — 8:00 P.M. • Thursday, January 24
"Some Theory on Communication Through Unspecified Additive Noise"
Speaker: Dr. William L. Root, University of Michigan
Place: Philco Auditorium, Bldg. 56, 3825 Fabian Way, Palo Alto
Dinner: 6:00 P.M., Sakura Gardens, 2116 N. El Camino Real, Mountain View
Reservations: Mrs. Radl, YO 8-6211, Ext. 2460, 2522, or 2244

Military Electronics — 8 P.M. • Wednesday, January 16
"Non-Space Application for Space Computer Technology" (nonclassified meeting)
Speaker: Capt. John H. Van Dusen, U.S. Air Force, staff, Space Research Directorate, Los Angeles
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:00 P.M., Red Shack, 4085 El Camino Way, Palo Alto
Reservations: General Victor Conrad's office, DA 6-4000, Ext. 2212

Space Electronics & Telemetry — 8 P.M. • Tuesday, January 15
"LASERS"
Speaker: Dr. Anthony Siegman, associate professor of electrical engineering, Stanford
Place: Lockheed Auditorium, Bldg. 202, 3251 Hanover Street, Palo Alto
Dinner: 6:15 P.M., Sakura Gardens, 2226 N. El Camino Real, Mountain View
Reservations: Tom Linders, RE 9-4321, Ext. 28394 by noon January 15

SAN FRANCISCO SECTION OF AIEE

Communications Division — 7:30 P.M. • Tuesday, January 15
(Joint meeting with San Francisco Section, IRE and PGCS, see above)

SAN FRANCISCO SECTION OF AIEE — 6:30 P.M. • Tuesday, February 12
(Joint meeting with SFS, PGED, and IRE-AIEE student branch, San Francisco State College, see above)

feature

J. M. Pettit

the worried deans

THE CANDIDATE LAG

First in a series of articles contributed by deans of Bay Area engineering schools on a problem of increasing concern to the profession. Dr. Pettit is a fellow of IRE and was chairman of the Palo Alto Subsection in 1952.

Your editor has asked me to comment on the national phenomenon of declining engineering enrollments, as a member of a group of supposedly "worried deans." I should like to commence by distinguishing between the national situation and the local one.

Nationally, it appears that the freshman enrollments in engineering are down about 2 percent compared to last year. This is a shrinkage in absolute numbers, in the face of an expanding population of college-age young people, and of an enlarging fraction of these who are going to college. Hence the decline in percentage of the college population is really continuing its four-year decline. Offsetting this, there appears to be a substantial increase in physical science and mathematics enrollments, although the impression I have gained from the statistics available is that the total of engineering, physical science, and mathematics is also declining as a fraction of the college-age population.

(Continued on page 12)

R. D. Egan

meeting ahead

THE VARIABLE IONOSPHERE

One of the many problems facing operators of high-frequency communications systems is the difficulty of predicting the state of the ionosphere, according to Dr. Raymond D. Egan, manager, advanced communications systems, Granger Associates, who will address a joint meeting of the San Francisco Section, PGCS, and Communications Division of AIEE on January 15.

Currently used predictions are made three months in advance. They are necessarily monthly mean values which cannot take into account the normal day-to-day variations of the ionosphere. Variations in the maximum usable frequency (MUF) may be two-to-one or more within one month. This problem is particularly significant to the military services, government agencies, and to commercial operators of high-volume long-distance network.

A recent innovation has been the technique of synchronized oblique step frequency sounding. An outgrowth of experiments conducted during the International Geophysical Year (IGY) to new sounding technique has been implemented in equipment which is now in operation in a number of government and privately operated research laboratories and in U.S. military operational installation throughout the Western World.

This new approach to frequency management will be described with motion pictures of ionograms showing real time presentations of propagation conditions along the Hawaii-California path. The film shows how the prediction conditions change over a dawn-to-dusk cycle, how the maximum availability frequency moves up and down within the H-F range, and how these movements compare with the predicted MUF.

meeting ahead

ADDITIVE NOISE

On January 24, Dr. William L. Root will address PGIT on "Some Theory on Communication Through Unspecified Additive Noise."

When the noise added by a communication channel is completely unspecified except that its energy content over a signaling interval is bounded, the concept of a maximum likelihood receiver cannot be used. However, a decision rule can be formulated from game theory concepts which will ensure a minimum receiver performance level regardless of the noise actually present. This is a maximum approach to detection theory.

Dr. Root received his B.S. in electrical engineering from Iowa State in 1940, his S.M. in electrical engineering from MIT in 1943, and his Ph.D. in mathematics from MIT in 1952. After active duty in the Marine Corps and fifteen years' association with MIT and Lincoln Laboratory, Dr. Root became professor of instrumentation engineering at the University of Michigan in 1961. He is a member of the American Mathematical Society and the Society for Industrial and Applied Mathematics, and a senior member of IRE.

Dr. Egan joined Granger Associates' engineering staff in January 1962, after serving as consultant to the firm since 1958 while on the staff of the radio science laboratory at Stanford University. As research associate since 1960, he has been engaged in ionosphere research directed primarily toward auroral effects on high-frequency radio wave propagation, as well as studying the solar-terrestrial relationships influencing these effects.

From 1955 to 1960, Dr. Egan was a research assistant in the laboratory, initially engaged in the design and development of fixed-frequency backscatter sounder instrumentation for the IGY ionospheric physics program. Following the installation of these ionospheric sounders, he was responsible for the analysis and interpretation of the vast amount of data collected. From 1959 to the present, Dr. Egan has supervised projects concerning transpolar radio propagation, ionospheric absorption, forward-oblique step-frequency sounding, as well as continued backscatter research.

H. Barrett, Jr.

meeting ahead

TECHNICAL MANPOWER SHORTAGE

"Developing Our Human Resources—The Challenge of the Future" will be the subject of the January 9 meeting of PGEM.

The speaker, Harold Barrett, Jr., is the San Francisco representative of the Bureau of Apprenticeship and Training, U.S. Department of Labor. He reports that "the United States is facing a competitive future, outmatched in manpower by all of its major international rivals; full development of our human resources is imperative; four million jobless workers are a luxury we cannot afford, now or in the future."

Many of the jobless could be employed had their early training been adequate. But industrial skill needs are becoming more sophisticated. Future high-school and college graduates will find the job-knowledge barrier increasingly restrictive. New industries, such as electronics, must create manpower development traditions. The input of graduates and other potentially competent workers is falling off in relation to expanding needs.

The current electronics training situation is "catch as catch can." A rational, coordinated, industry-wide program for manpower development within the industry is essential.

The speaker is an alumnus of Occidental College and American University and formerly worked for the U.S. Naval Ordnance Test Station, China Lake and Pasadena. For five years he was national representative for District 44, International Association of Machinists. From 1960 to 1962 he was with the international division, Bureau of Apprenticeship and Training, U.S. Department of Labor, as program manager for AID-ILO-UN technical exchange trainees. He has been assigned to San Francisco since June 1962.

R. A. Isberg

meeting ahead

MORE db FOR AUDIENCES

Sound reinforcement, an increasing concern in the design and remodeling of auditoriums, theaters, and classrooms as the population explosion calls for larger and larger facilities, will be the subject of the January 8 meeting of PGA, meeting jointly with SMPTE and AES.

R. A. Isberg, chief engineer, television office, University of California at Berkeley, will discuss new techniques and equipment in the field of audio systems. Demonstrations will be given of directional linear array loudspeakers, frequency shift feedback stabilizers, and the new RCA directional microphone developed by Rettinger, the latter the partial subject of a presentation last year in San Francisco before the same societies.

The frequency shift feedback stabilizer was designed by Schroeder of Bell Telephone Laboratories and is now manufactured by a firm in Detroit. This equipment shifts the frequency of the audio signal fed to the loud-speaker by approximately 5 cycles, thereby overcoming some feedback resonances between the speaker and microphone. The resulting over-all benefit permits approximately 6 db greater sound volume than without feedback. The linear array loud-speaker, or line radiator, essentially compresses sound in the vertical plane and radiates the energy directly toward the listening audience.

meeting review

THIN-FILM COMPUTER

A. S. Zukin of the Hughes Aircraft Company delivered an interesting and well-documented talk on the HCM-202 thin-film computer at the September meeting of PGEC.

The computer is fabricated from circuit boards which use thin-film deposited resistors, capacitors, and "wire."

The HCM-202 computer is a parallel and highly modular computer system which is capable of using a number of different memories. These include magnetic drums, cores, and thin-film memories. The memory cycle is six microseconds. The basic circuit component used in the fabrication of the system was a diode transistor "nor." Each 3" by 4" circuit board contains 32 "nor" elements. The resistors and capacitors used were deposited on a substrate by using photomask techniques.

Although the use of deposited passive circuit elements greatly reduced the system size, the main advantage claimed for the technique was that it greatly increased the reliability of the system and would ultimately reduce the fabrication cost.

W. H. DAVIDOW

meeting review

SECOND-HAND SATELLITE

Dr. D. A. Chisholm, member of the technical staff of Bell Telephone Laboratories, addressed the November 27 joint meeting of PGCS, PGAP, and Communications Division of AIEE on the Telstar experiment, introducing his talk with a description of the kind of experiment Telstar is designed to be.

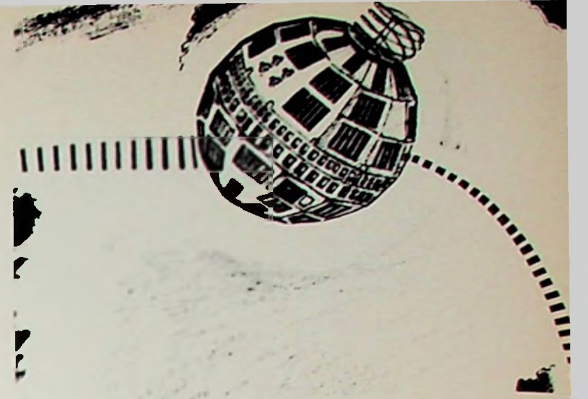
He developed the reasons why the Bell Telephone Labs chose the particular kind of satellite for this experiment and pointed out that this means of communication would be the most attractive to transmit bulk traffic across the Atlantic. The satellite was designed to remain in orbit for at least three years, and all component parts were developed to optimize this objective.

Dr. Chisholm made the statement that only "used" components were put into orbit; by this, meaning, of course, that all parts were preaged to detect and remove any that might be marginal. By doing this, the component reliability was improved by about two orders of magnitude.

Because of the success of Telstar and the abundance of information that has been returned via telemetry, plans for launching a second satellite have been indefinitely postponed. Van Allen radiation has not seriously affected component life; however, at the present time the satellite fails to respond to commands to turn on its communications system. The telemetry equipment is still operating normally, and it is expected that information derived from this channel will offer a clue as to the type of trouble in the communication circuit.

Dr. Chisholm concluded his talk with descriptions of both the ground equipment and the space craft itself. He and his staff at Bell developed the highly sensitive amplifiers used at the ground stations at Andover, Maine, and near Bordeaux, France. In addition, they produced the traveling wave tube used in the satellite itself.

MAURICE H. KEBBY



meeting review

DETECTING FOULED-UP SIGNALS

On November 29, Dr. Robert Price, visiting professor at the University of California, Berkeley, addressed a PGIT audience of forty in the Philco auditorium on the optimum detection, in the presence of strong white noise, of a pulsed signal that has been corrupted by passage through a fluctuating multipath medium.

Here "detection" refers to determining whether the signal is present or absent, given the form of the transmitted signal, the noise level, and the statistics of the medium. This is the radar-astronomical problem or the problem of on-off telegraphy through a tropospherically scattering link.

The optimum decision as to the presence of the signal turns out, under a wide variety of criteria of optimality, to depend on whether some functional of the received waveform exceeds an appropriate theshold. The optimum detector, then, is a device that computes this functional—or any monotonic function of it. Determining its form is a difficult problem, but the leading term of the solution of an in-

(Continued on page 10)

Cazanjian, PGRQC *Johnson, PGEM* *L. L. Schneider, Minuteman*

meeting review

RELIABLE MINUTEMAN

At the November joint meeting of PGEM and PGRQC, L. L. Schneider, associate reliability manager, Minuteman Program, Space Technology Laboratory, Los Angeles, discussed management control for the Minuteman reliability program.

The goal was assurance that the 1.5 million dollars per day being spent would result in a reliable system. Criteria of the reliability program were:

- Heavy emphasis on reliability at the outset of the program, rather than an "after the fact" evaluation
- An easily understood program status summary that pointed to potential problems in organization, parts selection and approval, design, review, etc.
- A positive corrective action follow-up system
- Definitive reliability requirements and what constitutes having met them
- A well-defined reliability management organization, both at STL and the contractor organizations, with clear policy and direction
- Management visibility and feedback
- A parts reliability improvement program

Results of such a program were an initial successful firing, continued flight test success, the ability to demonstrate rocket motor reliability based on static tests, improved industry standards, and an order of magnitude of improvement in parts reliability.

Mr. Schneider concluded that through such a positive program Minuteman has been able to advance the reliability state of the art. He reiterated the most important aspects of the program as:

- Early emphasis
- Improved definition and direction
- Improved management methodology.

W. WAHRHAFTIG

MORE REVIEW

tegral equation gives a good approximation to the optimum, viz.,

$$D = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \overline{z(s)z(t)}w(s)w(t)ds\, dt,$$

where $w(t)$ is the received waveform, $z(t)$ is the received signal, assumed zero-mean nonstationary Gaussian, and the bar denotes the mathematical expectation. This expression can be described as the cross-correlation between the true and the observed correlation functions.

When the received signal is known exactly for amplitude, i.e., when the medium does not fluctuate in time, D becomes simply the square of the cross-correlation between the received signal and the received waveform, in agreement with Woodward's solution for that case. At the opposite extreme, where the received signal is stationary and the (fictitious) transmitted signal is a sinusoid, as in the radio-astronomical case, D becomes simply a measure of received energy, with each frequency in the spectrum weighted in proportion to the received signal's expected spectrum.

The best fixed-energy waveform to transmit, subject to certain reservations, can be found by maximizing the output signal-to-noise ratio. In a simple case, it turns out that the optimum pulse length is the geometric mean of the multipath spread and coherence time (reciprocal of bandwidth). It can then be shown that the detectability deteriorates as the ratio of multipath spread to coherence time increases.

Much of Price's talk is based on work appearing in his MIT Lincoln Laboratory technical report No. 234 and in a chapter he has contributed to the forthcoming book on radar astronomy in the McGraw-Hill Lincoln Laboratory series.

NELSON M. BLACHMAN

professional education notes

CAL EXTENSION SPRING CLASSES

Several new courses of interest to electronic and electrical engineers will be offered by Engineering and Sciences Extension, University of California, beginning in February.

Transform calculus, a credit course offered in Palo Alto, develops the definition and basic properties of Fourier transforms with applications to analysis of linear time-invarient systems. Included are the LaPlace transform and generalized harmonic analysis.

Electrical engineering courses to be taught on the Peninsula include: electromagnetic fields and waves; linear systems analysis; microwave antenna design—reflector design theory; solid-state energy conversion; magnetic memory and logic circuits; transients in linear systems; physical phenomena in transistors; switching theory and logical design; and pulse techniques.

Network analysis, to be offered in Berkeley, is a review of direct- and alternating-current principles; introduction of the newer concepts of network analysis; LaPlace transformation and transformation between time and frequency domain.

Information on courses in other areas and the scheduling and description of these courses can be found in the complete engineering and sciences catalogue which is available on request from Engineering and Sciences Extension, University of California, Berkeley 4, California, or TH 5-6000, Ext. 4151.

rep conference news

ERA CONVENES JAN. 22-26

"The Gate to Electronic Marketing in the '60s" is the theme of the fourth annual ERA national convention to be held in San Francisco, January 22-26, at the Mark Hopkins Hotel. The entire program will follow the workshop format to insure those attending a practical approach to such subjects as sales forecasting, determining market trends, etc. As in past years, one of the convention highlights will be awards to outstanding sales managers in each of the audio, distributor, industrial components, and instrumentation divisions. Registration will be held in the lobby from noon on January 22.

MORE DEANS

This decline persists in spite of evidence on all sides of expanding employment opportunities, and presumably, therefore, in an economy in which supply and demand can operate, the problem should correct itself in time. Much is being done by employers, engineering societies, etc., to shift the tide by appropriate (though in some cases inept) publicity. Whether these efforts are really responsive to the as-yet-undiagnosed sociological phenomenon which is taking place, and whether they will be effective, is certainly not yet clear.

It does appear that we may have to get along for some time with fewer engineers, which is certainly possible if the quality is good. There is no evidence as yet that the quality is in any way declining. We will also have to get along with a larger fraction of pure scientists compared to engineers, which may also be appropriate to the national needs for the years just ahead.

Locally, now, as far as Stanford is concerned, our freshman engineering enrollment has been declining at a greater rate than the national trend, although our percentage of freshman men in engineering is about twice the national percentage. The quality is better every year. Part of the loss is going into science, particularly mathematics, and another part is going into an increasing fraction of the freshman class who are not initially declaring their major field of interest. At Stanford we admit a fixed number of freshmen without regard to field of interest, nor do they have to declare their major until the end of the sophomore year. We have at the same time a steadily growing graduate enrollment in engineering, which last year overtook the undergraduate enrollment.

As I would see our future, we will continue to turn out a small group of top-quality undergraduates who will have had the experience of four years at a moderate-sized residential university. Hopefully, this will be a leadership group, but not one which will be numerically significant in the state or national scene. At the graduate level, however, we will continue to grow, and will strive to be a significant producer in both quality and quantity. We are already in the top five U.S. schools in output of graduate degrees, particularly at the Ph.D. level, where in electrical engineering we rank first.

There is one troublesome aspect, nevertheless. The concern is not that we are losing undergraduates to mathematics, for instance, when the need for more mathematicians is obvious, but whether students are deciding against engineering for inadequate or incorrect reasons. I think we must continue to try to reach the high-school students with an adequate picture of the diverse opportunities in engineering. The years just ahead should increase the attractiveness of engineering if the projected scarcity results in substantial improvements in salaries and other aspects of employment.

J. M. PETTIT
DEAN, SCHOOL OF ENGINEERING
STANFORD UNIVERSITY

grid returns

Editor, the **Grid**:

You may find it interesting to learn an indirect effect of a **Grid** story, which may indicate its readership effectiveness.

The March 15, 1962, issue of **Grid** reported the results of a meeting of the Professional Group on Military Electronics in a review entitled "PERT for the Engineer." In a sense, this was a "scoop" story which directly resulted in many inquiries about PERT and the PERT-O-GRAPH which I had designed for helping implement PERT for the smaller industrial programs typical of the electronics industry.

Since then, the story has spread to many other publications, including "Electronic News," "Aviation Week," and "Business Week." The resulting thousands of requests indicated that (1) many of the industries have similar problems in "program management," and that (2) they want to learn of the practical newer techniques such as the scaled-down version of PERT.

All this has opened up a fabulous new opportunity to share the knowledge and experience of "PERT for the Engineer" now as a management consultant. My thanks to the **Grid** for that original story which indirectly helped launch a broad new career for me.

JAMES HALCOMB
JAMES HALCOMB ASSOCIATES
495 CALIFORNIA AVE.
PALO ALTO, CALIF.

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Specifications

SWEEP

- Width... Single control for continuous adjustment from a few megacycles to the entire frequency range of the instrument. Center frequency selected with single continuously adjustable control. Vernier controls enable precise adjustment of both sweep width and center frequency.
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- Selector... Recurrent, Single or External.
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- External . . . Programmable sweep, 200 volts negative required for full sweep width. Dc to 10 Kc/s response. Stable —300 volt rear panel output provided for use with external voltage divider for programming or remote control.
- Output... Both constant amplitude and proportional amplitude linear sawtooth voltages provided for synchronized scope or recorder presentation.
- Oscilloscope Blanking... +50 volts pulse provided blanking oscilloscope during retrace.
- RF Blanking... Switch selects RF ON or RF OFF du retrace. RF ON position, desirable for recorder operat allows normal RF output during retrace. RF OFF posit desirable for oscilloscope operation, provides zero RF out during retrace.
- **CW Mode... Continuously adjustable or five fixed preset frequencies.**

AMPLITUDE MODULATION

- Internal Square Wave... RF output is alternately 0 unmodulated CW value, adjustable from 800 to 1200 cps
- External... +100 volts maximum signal decreases RF put from maximum to zero. Response: dc to approxim 500 Kc/s.
- **Residual FM**... Typically less than .0025% peak.
- **Size**... 7" rack panel for 850 series
  12" rack panel for 851 series
  20" rack panel for 852-858 series

851 Series

Internally Leveled Signal Sources

- Excellent Leveling Characteristics
- Available With or Without Microwave Sampling Components

852-858 Series

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- **1-10 Watts Leveled Output**
- Excellent Leveling Characteristics

PM Focused TWT AMPLIFIERS

- Gain... 30 db minimum
- Noise Figure... 35 db nominal
- Modulation . . . focusing element capacitatively coupled to front panel "BNC" jack
- **For Closed Loop Applications... optional modulation, from dc to approx. 500 Kc/s on control grid, available.**
- Size... 5¼" relay rack panel
- Weight... 45 lb.

LOW POWER

Model No.*	Frequency (Gc/s)	Min. Power Output (MW)	Price
L972A	1.0-2.0	15	$1,950
S972A	2.0-4.0	10	1,950
C972A	4.0-8.0	10	2,225
H972A	7.0-12.4	10	2,650
X972A	8.0-12.4	10	2,225
U972A	12.4-18.0	10	4,700

MEDIUM POWER

Model No.*	Frequency (Gc/s)	Min. Power Output (Watts)	Price
L975A	1.0-2.0	1.0	$1,950
S975A	2.0-4.0	1.0	1,950
C975A	4.0-8.0	1.0	2,850
H975A	7.0-12.4	1.0	2,990
X975A	8.0-12.4	1.0	2,850
U975A	12.4-18.0	1.0	5,400

*Specifications and prices of custom TWT Amplifiers in other frequency ranges and at various power levels available on request.

Solenoid Focused TWT AMPLIFIERS

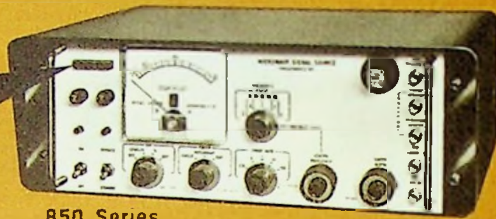
- Noise Figures to 4.0 db
- Output Power to 10 Watts

MODEL 812

MICROWAVE INSTRU

SWEPT SIGNAL SOURCES

Exclusive...1000 hour
Wave Tube Warranty for most models ... indicated by built-in Elapsed Time Meter


850 Series

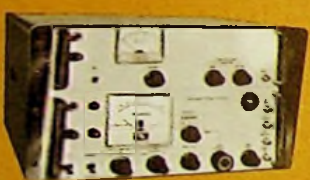
Specifications

SWEEP

- **Width** ... Single control for continuous adjustment from a few megacycles to the entire frequency range of the instrument. Center frequency selected with single continuously adjustable control. Vernier controls enable precise adjustment of both sweep width and center frequency.
- **Rate** ... 0.01 to 100 cps, continuously variable. Sweep Rate Range Extender provides additional slow sweep rates to hours. Wide range permits flicker-free scope presentation or graphic recording.
- **Selector** ... Recurrent, Single or External.
- **Single Sweep Control** ... Triggered by front panel button or external signal >20 volts.
- **External** ... Programmable sweep, 200 volts negative required for full sweep width. Dc to 10 Kc/s response. Stable —300 volt rear panel output provided for use with external voltage divider for programming or remote control.
- **Output** ... Both constant amplitude and proportional amplitude linear sawtooth voltages provided for synchronized scope or recorder presentation.
- Oscilloscope Blanking ... +50 volts pulse provided f blanking oscilloscope during retrace.
- RF Blanking ... Switch selects RF ON or RF OFF duri retrace. RF ON position, desirable for recorder operatic allows normal RF output during retrace. RF OFF positic desirable for oscilloscope operation, provides zero RF outp during retrace.
- **CW Mode ... Continuously adjustable or five fixed presettab frequencies.**

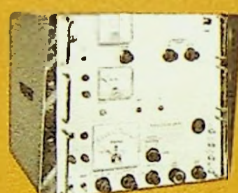
AMPLITUDE MODULATION

- Internal Square Wave ... RF output is alternately 0 a unmodulated CW value, adjustable from 800 to 1200 cps.
- External ... +100 volts maximum signal decreases RF ou put from maximum to zero. Response: dc to approximate 500 Kc/s.
- **Residual FM** ... Typically less than .0025% peak.
- **Size** ... 7" rack panel for 850 series
  12" rack panel for 851 series
  20" rack panel for 852-858 series


851 Series

Internally Leveled Signal Sources

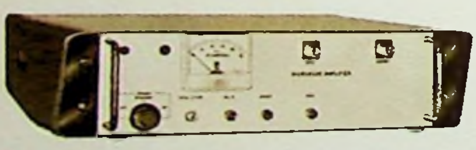
- **Excellent** Leveling Characteristics
- Available With or Without Microwave Sampling Components


852-858 Series

High Power Leveled Signal Sources

- **1-10 Watts Leveled Output**
- Excellent Leveling Characteristics

PM Focused TWT AMPLIFIERS



- Gain ... 30 db minimum
- Noise Figure ... 35 db nominal
- Modulation ... focusing element capacitatively coupled to front panel "BNC" jack
- For **Closed Loop Applications** ... optional **modulation, from dc to approx. 500 Kc/s on control grid, available.**
- Size ... 5¼" relay rack panel
- Weight ... 45 lb.

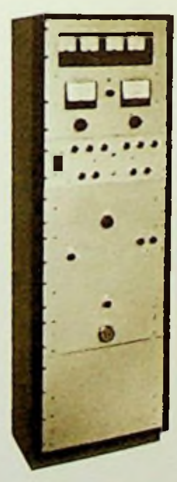
LOW POWER

Model No.*	Frequency (Gc/s)	Min. Power Output (MW)	Price
L972A	1.0-2.0	15	$1,950
S972A	2.0-4.0	10	1,950
C972A	4.0-8.0	10	2,225
H972A	7.0-12.4	10	2,650
X972A	8.0-12.4	10	2,225
U972A	12.4-18.0	10	4,700

MEDIUM POWER

Model No.*	Frequency (Gc/s)	Min. Power Output (Watts)	Price
L975A	1.0-2.0	1.0	$1,950
S975A	2.0-4.0	1.0	1,950
C975A	4.0-8.0	1.0	2,850
H975A	7.0-12.4	1.0	2,990
X975A	8.0-12.4	1.0	2,850
U975A	12.4-18.0	1.0	5,400

*Specifications and prices of custom TWT Amplifiers in other frequency ranges and at various power levels available on request.


MODEL 812

Solenoid Focused TWT AMPLIFIERS

- Noise Figures to 4.0 db
- Output Power to 10 Watts

MENTATION by paradynamics

Frequency Range (Gc/s)	Min. Power Output	Power Output (Leveling) Variation* (±db)	Model No.	Price
0.4-1.2	50 MW	†	P850B	$2950
1.0-2.0	100 MW	†	L850B	2975
	100 MW	0.75	L851B	3350
	1 Watt	0.65	L852B	5975
	2 Watts	0.65	L854B	6500
	10 Watts	0.65	L858B	8950
1.0-2.3	1 Watt	†	B850B	3250
1.6-3.2	80 MW	†	N850B	3750
2.0-4.0	70 MW	†	S850B	2850
	70 MW	0.75	S851B	3250
	1 Watt	0.65	S852B	6500
	2 Watts	0.65	S854B	6900
	10 Watts	0.65	S858B	8850
2.4-4.7	50 MW	†	T850B	3700
3.6-7.2	20 MW	†	W850B	3900
	15 MW	1.0	W851B	4750
4.0-8.0	20 MW	†	C850B	2750
	20 MW	0.75	C851B	3250
	1 Watt	0.75	C852B	6750
	10 Watts	0.75	C858B	8280
7.0-11.0	2 Watts	0.75	H854B	8350
	10 Watts	0.75	H858B	9550

Frequency Range (Gc/s)	Min. Power Output	Power Output (Leveling) Variation* (±db)	Model No.	Price
7.0-12.4	20 MW	†	H850B	$3375
	1 Watt	1.25	H852B	8850
	5 Watts	1.25	H856B	9500
8.0-12.0	5 Watts	0.9	X856B	9250
	10 Watts	0.9	X858B	8885
8.0-12.4	20 MW	†	X850B	2850
	1 Watt	0.9	X852B	7950
	2 Watts	0.9	X854B	8475
8.2-12.4	20 MW	1.15	X851B	3450
10.0-16.0	10 MW	†	D850B	3285
12.4-18.0	10 MW	†	U850B	3250
	8 MW	2.5	U851B	4250
	1 Watt	2.25	U852B	9600
	2 Watts	2.25	U854B	10400
15.0-20.0	10 MW	†	Y850B	3750
18.0-26.5	5 MW	†	K850B	4150
	4 MW	2.5	K851B	5150
26.5-40.0	3 MW	†	V850B	4850
	2 MW	3.0	V851B	5950
40.0-50.0	3 MW	†	Q850B	6900
50.0-60.0	3 MW	†	M850B	6900

†UNLEVELED—EXTERNAL LEVELER AVAILABLE AS ACCESSORY. Paradynamics Levelers consist of a closed loop feedback system containing RF sampling device, detector, and stabilized direct coupled high gain amplifier. (Levelers can also be supplied without RF components).

*Maximum variation over complete instrument frequency range. Narrow band leveling typically ±0.1 db.

POWER SUPPLIES

TO POWER BWO'S/CARCINOTRONS ...

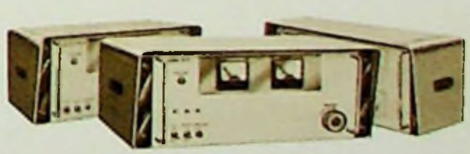
The Model 812 was designed specifically to fulfill the stringent power supply requirements of the American Radio Company (French CSF) carcinotron millimeter oscillators, including the recently developed COE 07. In addition, it finds wide application as a source of power for higher voltage microwave tubes. Logic circuitry provides ultimate in absolute electrical protection for microwave tube.

- **10KV with Unparalleled Tube Protection**
- Line Supply ... 3-10 KVdc, 100 ma, 30 mv rms ripple, ±0.005% regulation
- Anode Supply ... 0.1-3 KVdc, 5 ma, 3 mv rms ripple, ±0.05% regulation
- Grid Supply ... 0-200 Vdc, 10 ma, 1 mv rms ripple, ±0.5% regulation
- Heater Supply ... 0-10 Vdc, 5 amps, 100 mv rms ripple, ±0.5% regulation

$8,800

UNIVERSAL MODULES ...

Highly versatile, individual power supply modules can be combined to operate low and medium power Klystrons, BWO's, TWT's, VTM's and Carcinotrons. All modules insulated to 10 KV.



801 Series

- Line Supply ... 100-4200 Vdc, 200 ma, 1.5 mv rms ripple, ±0.005% regulation **801-1: $1,450**
- Grid 1 and 2 Supply ... 20-2000 Vdc, 50 μa, 500 μv rms ripple, ±0.005% regulation
  Grid 3 Supply ... 200-2000 Vdc fixed, 10 μa, 500 μv rms ripple, ±0.005% regulation **801-2: $650**
- Anode Supply ... −450 Vdc to +450 Vdc, 25 ma, 500 μv rms ripple, ±0.005% regulation **801-3: $650**
- Heater Supply ... 0-15 Vdc, 5 amps, 0.01% rms ripple, ±0.1% regulation **801-4: $435**
- AFC Link ... applied in series with repeller supplies. **801-5: $350**

HIGH POWER
Microwave Signal Source

Model X890A is a versatile source of high power pulsed energy for the popular 8,500 to 9,600 Mc/s frequency spectrum*. It utilizes a tunable magnetron oscillator and hydrogen thyratron line-type modulator.

*Also available for S, C and Ka bands.

- Peak Power Output . . . 5 to 50 KW, continuously variable
- Average Power Output . . . 0 to 50 Watts, continuously variable
- Pulse width . . . 0.6 μsec or 2.1 μsec
- Pulse Repetition Rate . . . 450, 1000, or 1500 pps
- Sync Output . . . +5 to 20 volts
- External Trigger . . . +15 volts, min.
- Modulator . . . type 6587 hydrogen thyratron
- Size . . . 8¾" relay rack panel
- Weight . . . 50 lb. **$2,590**

a paradynamics *Exclusive*

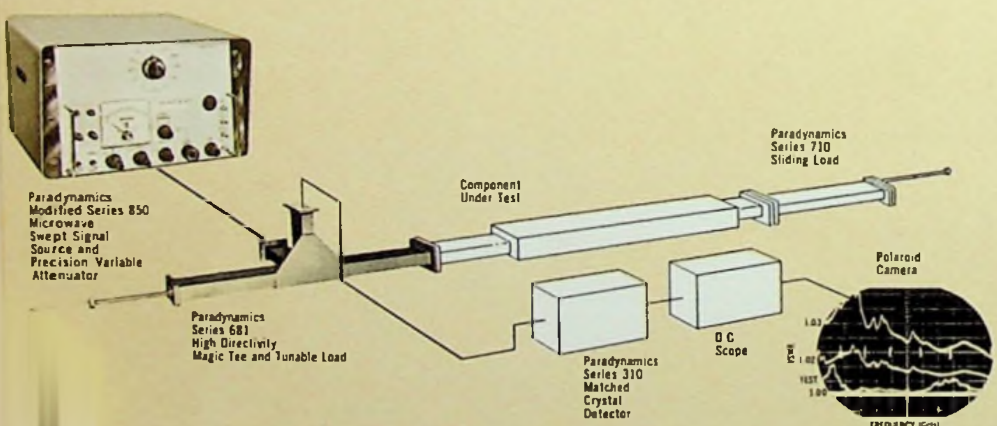
SERIES 273 PRECISION REFLECTOMETER
. . . for VSWRs from 1.01 to 1.1

Paradynamics Precision Microwave Reflectometer utilizes specially modified Series 850 Swept Signal Sources and recently developed broadband 60 db directivity "magic tees" to achieve measurement speed and accuracy hitherto unobtainable in the measurement of extremely low VSWRs.

Slotted line techniques, in addition to yielding only point-to-point data, are relatively slow and inaccurate for measurements of low VSWRs in the range of 1.02. Swept reflectometers using directional couplers, while providing continuous frequency coverage, do not have sufficient directivity to resolve such low values of VSWR. However, with directivities greater than 60 db, accurate VSWR measurements in this range are readily achievable.

By calibrating a dc oscilloscope at desired values of return loss (VSWR) with a precision attenuator, effects of component nonlinearity are made virtually insignificant. With directivity and non-linearity effects so reduced, system accuracy now depends upon such factors as calibration and attenuator accuracy, and the reflection effects of a movable termination. Utilizing readily obtainable 2% accuracy rotary vane attenuators, and high quality, low reflection terminations, it becomes possible, for the first time, to make measurements of extremely low values of VSWR with the same speed and precision previously obtainable for VSWRs above 1.1.

Prices and detailed specifications for the complete instrumentation system, or the individual components, are available on request.



PRECISION MICROWAVE REFLECTOMETER

paradynamics *Specialty*

WAVEGUIDE FEEDER SYSTEMS . . . VSWRs < 1.1

Utilizing novel machining and brazing techniques, coupled with extreme care in fabrication, Paradynamics has produced thousands of feet of precision feeders, with overall waveguide assembly (i.e. 100-400 feet) **VSWRs averaging 1.07*!**

*Measured continuously throughout the waveguide bands with Paradynamics Series 273 Precision Reflectometers.

Prices and specifications subject to change without notice.

paradynamics, INCORPORATED

SALES REPRESENTATION

Alabama, Huntsville:
Murphy & Cota
112 Gallatin St. S.W.
Phone: 205-536-9121 or 205-538-8476

Arizona, Phoenix & Tucson:
O'Halloran Associates
Phone: ENterprise 1200

California, Los Angeles:
O'Halloran Associates
11636 Ventura Blvd., N. Hollywood
Phone: 213 TR 7-0173

California, Palo Alto:
O'Halloran Associates
3921 E. Bayshore
Phone: 415 PA-6-1493

California, San Diego:
O'Halloran Associates
1052 Rosecran Street
Phone: ACademy 4-2824

Serving California

Florida, Orlando:
Murphy & Cota
712 W. Vassar Avenue
Phone: GA 4-2167 or 5633
TWX 305-275-0646

Illinois, Chicago:
Berndt & Associates
6322 N. Milwaukee Ave.
Phone: 312-SP 5-3488 or 3393
TWX CG 2608

Massachusetts, Allston: (Boston)
New England Office: Paradynamics, Inc.
Herb Berger
233 Kelton St.
Phone: 617-RE 4-4226

Michigan, Detroit:
WKM Associates
2415 East 7 Mile Rd.
Phone: 313-366-0840

New Jersey, Old Bridge:
Local Office: Paradynamics, Inc.
Vincent Pirro
4 Laurel Avenue
Phone: 201-CL 4-0106

New Jersey, Asbury Park:
Burlingame Associates
Phone: WX 2611

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510 So. Fulton Ave.
Phone: MO 4-7530
TWX 914 699-3671

New York State, Syracuse:
Burlingame Associates
516 University Blvd.
Phone: GR 4-7409

North Carolina, Winston Salem:
Murphy & Cota
1106 Burke St.
Phone: 919-PA-4-0750 or 4-1535

Ohio, Cleveland:
WKM Associates
7710 Wainstead Dr.
Phone: 216-886-5616

Pennsylvania, Canonsburg:
WKM Associates
207 Grandview Dr.
Phone: 412-563-2010

Pennsylvania, Upper Darby: (Philadelphia)
Burlingame Associates
222 Long Lane
Phone: JA 8-6080

Texas, Dallas:
Texas Avionics Company
4515 Prentice Street
Phone: 214-EM 8-3566

Washington State, Seattle:
James J. Backer Co.
221 West Galer, P.O. Box 9077
Phone: 206-AT 3-6470

Canada, Montreal 12, P.Q.:
Glendon Instrument Co., Ltd.
11142 James Morrice St.
Phone: 514-331-5370

Canada, Scarborough, Ontario:
Glendon Instrument Co., Ltd.
46 Crockford Blvd.
Phone: Plymouth 9-6021

EXPORT:
EMEC, Inc.
127 Grace St., Plainview, N. Y.
Phone: 516-WE 1-3700

Printed in U.S.A.

events of interest

IRE MEETING SUMMARY

Feb. 11-15—3rd International Symposium on Quantum Electronics. Unesco Bldg. & Parc de Exposition, Paris, France. Exhibits: Feb. 8-15—Monsieur Foucoult, Fed Nat. des Indus Elec. 23 Rue de Lubeck, Paris 16, France. Program: Madame Cauchy, Secretaire, 3 eme congres d'Electronique quantique, 7 rue de Madrid, Paris 8 eme France. *DL-10-1-62. Proceedings in book form.

Feb. 20-22 — **International Solid State Circuits Conference.** Sheraton Hotel and Univ. of Penn., Philadelphia, Pa. Program: S. K. Ghandi, Philco Scientific Lab., Blue Bell, Pa. *DL-11-1-62. Digest.

NON-IRE

Feb. 18-20 — **American Standards Association.** New York's Biltmore Hotel. Program: ASA Hdqts., 10 East 40th St., New York 16, N.Y.

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accelerating an accelerator

Driver klystrons for the two-mile linear accelerator at the Stanford Linear Accelerator Center (Project M) will be built by Eitel-McCullough. U.S. Atomic Energy Commission has concurred in the award of the contract by Stanford University for the work.

Announcing the initial contract for $170,000, Louis Martin, Eimac marketing director, said the tube firm will deliver the first of the klystrons this year.

Designed to deliver 50 kilowatts peak, 50 watts average power at S-band, the Eimac driver klystrons are of wholly new design. They are unusually light in weight, using periodic permanent magnets for beam focus. They are among the first power klystrons to use the PPM principle.

Martin noted that this is the first production order the university has released for klystrons for the two-mile accelerator. The giant final amplifiers, which will be driven by the Eimac klystrons, will deliver a peak power of 24 megawatts. The linear accelerator, estimated to cost $114,000,000, is being built under Atomic Energy Commission contract.

grid swings

IT IS REPORTED:

John W. Scheck has been appointed to the newly created position of divisional marketing manager of the Donner Division, principal operating division of Systron-Donner Corp.

Richard W. Loren has been named to the new post of advertising and sales promotion manager for Ultek Corp., Palo Alto, after serving as acting advertising manager at Fairchild Semiconductor, Mountain View.

Jefferies

Sprinkle

Robert F. Jefferies has been advanced to controller of Microwave Electronics Corp., Palo Alto, formerly serving as assistant controller, accounting manager, and accountant.

Dr. H. D. Sprinkle has joined the Western operation of Sylvania Electronic Systems as systems technology laboratory manager in its reconnaissance systems laboratories after experience as manager of the advanced systems department of Litton Systems, Inc.

Systems and Standards, Redwood City, has been appointed sales representative in Northern California for Greenray Industries, Inc., manufacturers of frequency standards, oscillators, component ovens, and crystal ovens.

pgrqc news

RQC SF MEET JAN. 22-24

"f(R)=customer • producer • user team" is the theme of the ninth national symposium on reliability and quality control to be held at the Sheraton-Palace Hotel, San Francisco, January 22-24. Technical session topics include general management, research and training, program management, systems analysis, fabrication and assembly, mechanical aspects of electronic design, electronic parts, inspection and screening, statistics, design review, quality assurance, design testing, and maintenance and operation. Symposium headquarters will be located in the French Room on the second floor. Registration will take place in the Ralston Room, 5 to 10 p.m. on January 21, and 8 a.m. to 4:30 p.m. on January 22.

pgmil news

WINTER CONVENTION JAN. 30-FEB. 1

A total of 87 papers in twenty sessions, two of which are classified secret, will comprise the technical program of the fourth annual winter convention on military electronics in Los Angeles, January 30-February 1. The secret sessions will be on guidance and navigation, and antisubmarine warfare. In addition, two confidential sessions on radar and tactical warfare systems will be held, and two invited panel meetings on displays and space environmental simulation and testing will highlight the program. All classified sessions will be held at the Institute of Aerospace Sciences building in Los Angeles, while other sessions and displays will be located at the Ambassador Hotel, convention headquarters.

Winkler

Morcott

Geoffrey C. Winkler has been appointed manager of manufacturing for the tube division of Huggins Laboratories, Inc., Sunnyvale, and will be in charge of planning, administration, and technical direction of all TWT production activities.

Tod Morcott has been appointed chief engineer of Moore Associates, Inc., San Carlos, and will be responsible for all engineering activities, including new-product development, in a long-range product research and development program, continuing the scientific work of Laurence Moore, chief scientist.

grid returns

Editor, the **GRID**:

All of us involved in planning the recent sixth national conference of PGPEP wish to express our appreciation to you and the **Grid** for the excellent coverage given to this event. The October 1 special issue was especially valuable. The comprehensive treatment of PGPEP background and field of activities was very helpful in placing the conference program in proper perspective.

The **Grid** was distributed to exhibitors and others who attended. These included the national PGPEP chairmen and representatives from the Boston chapter who will host next year's conference. Their reaction can be summed up by the latter's statement, "The Boston section will be hard pressed to match this fine issue of the **Grid**."

I feel the **Grid** was our most useful publicity medium and contributed materially to the conference's success.

A. P. KROMER
GENERAL CHAIRMAN
SIXTH NATIONAL CONFERENCE

MANUFACTURER/REPRESENTATIVE INDEX

Manufacturer	Representative
Accurate Instrument Co.	Jay E. Stone & Assoc.
Ace Engineering & Machine Co.	R. W. Thompson Assoc.
Adcom Corporation	W. K. Geist Company
Ad-Yu Electronics Labs, Inc.	Peninsula Associates
Aircom, Inc.	Components Sales California, Inc.
Airflow Company	Richard A. Strassner Co.
Alan Electronics	Tech-Ser, Inc.
Alfred Electronics	Moxon Electronics
Ammon Instruments, Inc.	Tech-Ser, Inc.
Antlab, Inc.	Jay E. Stone & Assoc.
Applied Research, Inc.	Jay E. Stone & Assoc.
Applied Technology, Inc.	Moxon Electronics
Astrodata, Inc.	Moxon Electronics
Astron (Skottie Electronics) Corp.	Long & Assoc., Inc.
Avnet Instrument Corp.	W. K. Geist Co.
Baldwin-Lima-Hamilton, Electr. Div.	Neely Enterprises
Ballantine Labs, Inc.	Carl A. Stone Assoc., Inc.
Barnes Engineering Company	Costello & Co.
Basler Electric Company	Tom G. Maier Company
Bausch & Lomb, Inc.	Perlmuth Electronics
Bay State Electronics Corp.	Perlmuth Electronics
Beckman/Berkeley Division	V. T. Rupp Co.
Behlman/Invar Electronics Corp.	T. Louis Snitzer Co.
Block Associates, Inc.	W. K. Geist Co.
Bogart Mfg. Corp.	Jay E. Stone & Assoc.
Boonshaft & Fuchs, Inc.	W. K. Geist Co.
Boonton Electronics Corp.	O'Halloran Associates
Boonton Radio Corp.	Neely Enterprises
Burr-Brown Research Corp.	W. K. Geist Co.
Burroughs Corp., ECD	Tech-Ser, Inc.
California Technical Industries	Perlmuth Electronics
Cascade Research	Moxon Electronics
Chalco Engineering Corp.	Walter Associates
Cimron Corporation	Ault Associates
CircuitDyne Corp.	T. Louis Snitzer Co.
Clairex Corp.	Moxon Electronics
Clary Arithmetic Centers	American Wireless
Components Engineering & Mfg. Co.	Premmco
Computer Instruments Corp.	Components Sales Calif.
Computer Measurements Co.	Moxon Electronics
Consolidated Ceramics & Metalizing	Artwel Electric, Inc.
Continental Connector Co.	J. Logan & Assoc.
Continental Sensing, Inc.	Birnbaum Sales Co. Inc.
Continental-Wirt Electronics Corporation	Tom G. Maier Company
Control Logic, Inc.	Jay E. Stone & Assoc.
Control Switch Div., Controls Co. of America	Belsco
Coopertronix, Inc.	T. Louis Snitzer Co.
CTS Corp.	J. Logan & Assoc.
Dage Div., Thompson Ramo Wooldridge	Neely Enterprises
Dale Electronics	James S. Heaton Co.
Datamec Corporation	Moxon Electronics
Datapulse, Inc.	O'Halloran Associates
Dielectric Products	O'Halloran Associates
Diginamics Corp.	O'Halloran Assoc.
Digital Devices	Moxon Electronics
Digital Equipment Company	Peninsula Associates
Digitronics Corp.	Components Sales California, Inc.
Duncan Electronics, Inc.	Birnbaum Sales Co. Inc.
Dymec, Division of Hewlett-Packard	Neely Enterprises
Dynatran Electronics Corp.	G. H. Vaughan
Eastern Air Devices	James S. Heaton Co.
E-H Research Laboratories, Inc.	V. T. Rupp Co.
Elco Corporation	James S. Heaton Co.
Elcor, Inc.	T. Whychell Company
Eldema Corporation	James S. Heaton Co.
Electra Manufacturing Co.	Birnbaum Sales Co. Inc.
Electro Assemblies, Inc.	Birnbaum Sales Co. Inc.
Electro Cords Company	Tom G. Maier Company
Electronic Measurements Co.	O'Halloran Associates
Electronic Modules Corp.	Walter Associates
Electronic Production & Development, Inc.	Belsco
Electronic Research Assoc., Inc.	Tech-Ser, Inc.
Elgin-Advance	James S. Heaton Co.
Emcor, Ingersoll Products Div.	T. Louis Snitzer Co.
Empire Devices, Inc.	Carl A. Stone Assoc., Inc.
Eppley Laboratory, Inc.	W. K. Geist Co.
Erie/Eldorado	O'Halloran Assoc.
Etchomatic, Inc.	James S. Heaton Co.
Fabri-Tek, Inc.	Costello & Co.
Fairchild/Dumont Labs	R. W. Thompson Associates
Ferrotan Power Supply Company	Peninsula Associates
Fil-Shield Div. of Filtron, Inc.	Carl A. Stone Assoc., Inc.
Filtors, Inc.	Compar San Francisco
Flow Corporation	G. H. Vaughan Co.
Fluke Mfg. Co., John	McCarthy Associates
Forbes and Wagner, Inc.	James S. Heaton Co.
Franklin Systems, Inc.	Carl A. Stone Assoc., Inc.
General Instrument, Capacitor Div.	J. Logan & Assoc.
General Instrument, Semiconductor Div.	J. Logan & Assoc.
General Meters, Inc.	Long & Assoc., Inc.
Genistron, Inc.	James S. Heaton Co.
Globe Industries	Long & Assoc., Inc.
Gruenberg Electric Company	Peninsula Associates
Hammarlund Manufacturing Co.	R. W. Thompson Assoc.
Hamner Electronics	McCarthy Associates
Harrison Labs., Div., H-P	Neely Enterprises
Heli-Coil Corp.	Premmco, Inc.
Hewlett-Packard Company	Neely Enterprises
Hitemp Wires	James S. Heaton Co
Holt Instruments Laboratories	W. K. Geist Co.
Hudson Tool & Die Co., Inc.	John E. Striker Co.
Hughes Aircraft Co., Instruments	Walter Associates
Hughes Vacuum Tube Products Division	Belsco
IMC Magnetics Corp.	Richard A. Strassner Co.
Industrial Instruments, Inc.	G. H. Vaughan
Inland Motor Corp.	Costello & Co.
International Resistance Co.	J. Logan & Assoc
Jerrold Electronics Corp.	Instruments for Measurements
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