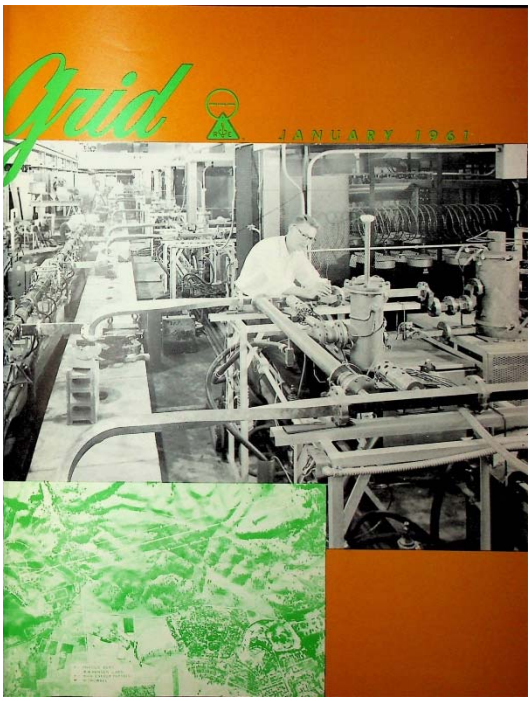
# EDITOR'S PROFILE of this issue

*from a historical perspective …*

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




JANUARY, 1961:

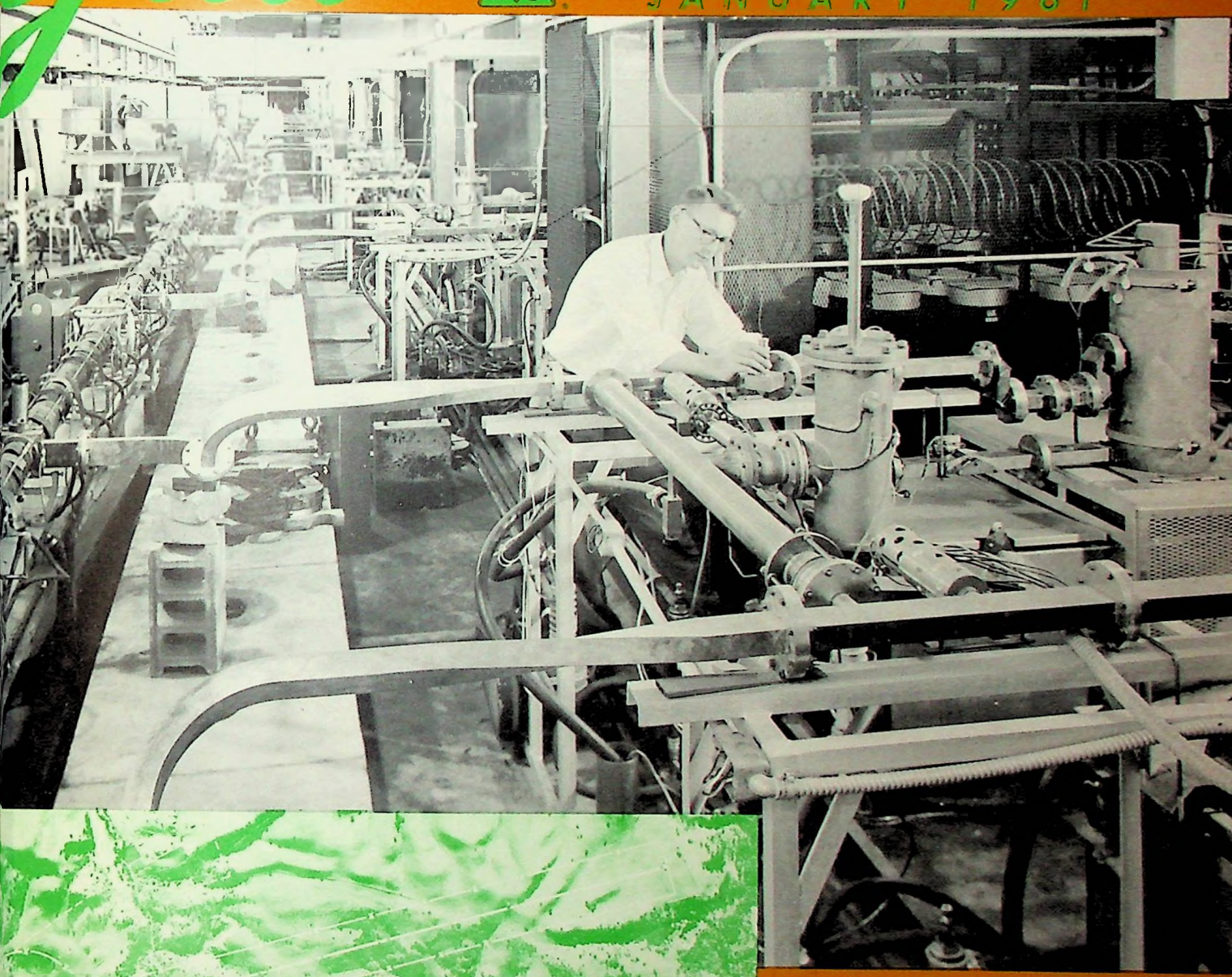
Cover: We get the first introduction to Stanford's Project M ("microwave" or "monster") – the $150 million development of what becomes the Stanford Linear Accelerator (Center) – SLAC. The dream started in 1955 and was approved by President Eisenhower in 1959. It had to be placed parallel to the San Andreas earthquake fault. Shown is the Mark III Linear Accelerator, at the Hansen Labs, with the prominent waveguides that feed the klystron energy into the accelerator itself. The inset shows the low hills behind the campus with a diagram of the accelerator/end-station footprint. More coverage on pp. 10-12.

p. 22: The East Bay Subsection's meeting was "LARC: The Fastest Computer in Operation Today". The Livermore Advanced Research Computer, from Univac, is optimized for computing and data input/output, with a cycle time of 4 microseconds. It has 60,000 transistors, with another 20,000 in memory.

p. 30: A photo shows Fred Terman and his wife Sibyl at an open house for a new Watkins Johnson building in the Stanford Industrial Park; Dean Watkins is also shown.

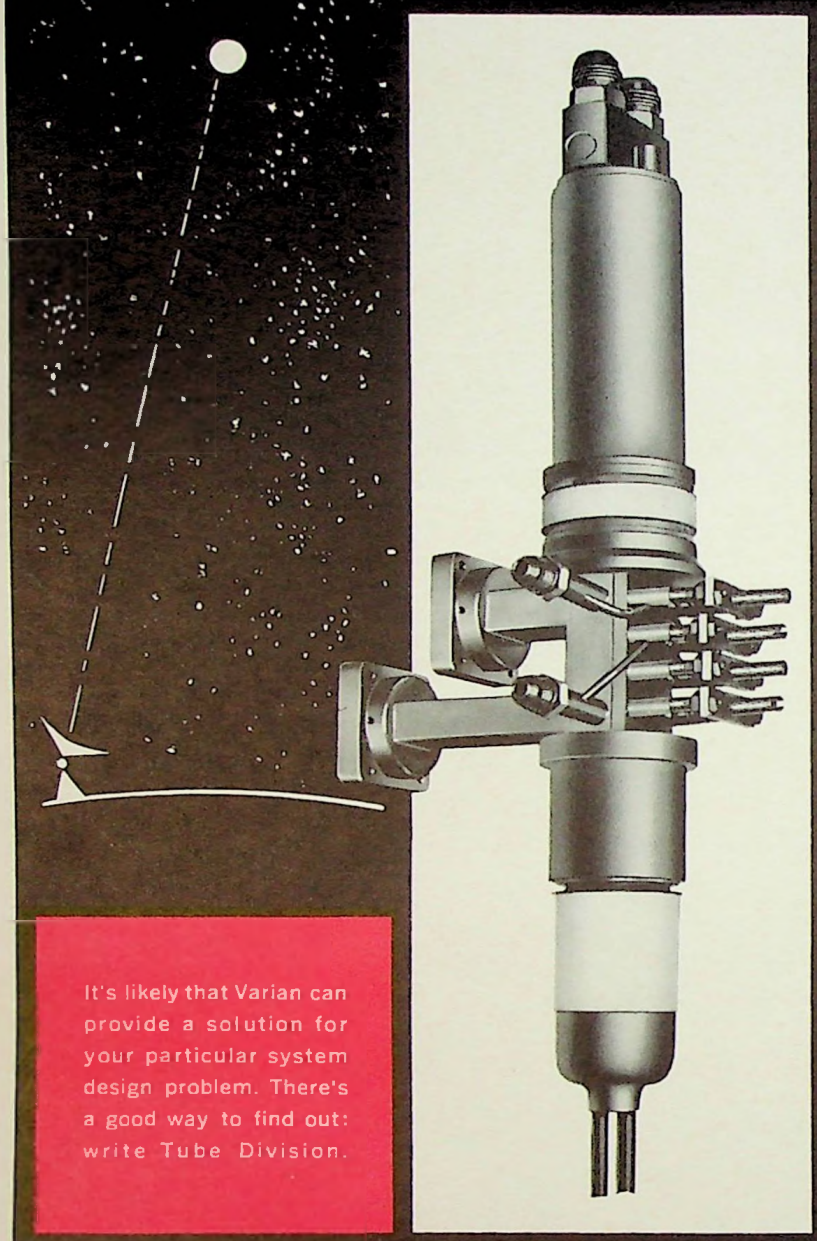
# Grid

JANUARY 1961



# for space systems

# 20kW CW at X-band



**Varian's new VA-849 amplifier klystrons are rated to deliver higher CW power at X-band than any existing tube in the world . . . 20kW!**

Varian's new VA-849 power klystron opens up a variety of new design approaches to space systems. Possible applications exist in communication concepts such as repeater satellites, moon-bounce signalling, or in reflections from clouds of tiny orbiting needles. Radio astronomers, too, will welcome the VA-849.

Immediate applications include CW radar and illuminator service. Low incidental noise. Water cooling. Electromagnet focusing. Another significant advance in microwave components from Varian's broad experience and research in super-power tubes.

**FEATURES**

- **7.125 to 8.5 kMc**
- **20 kW CW**
- **50 db Gain.**
- **30 Mc Minimum Bandwidth**
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# NEW!
# DIRECT READING FREQUENCY METER

## a full octave and beyond

**3.95 to 11.0 KMc**

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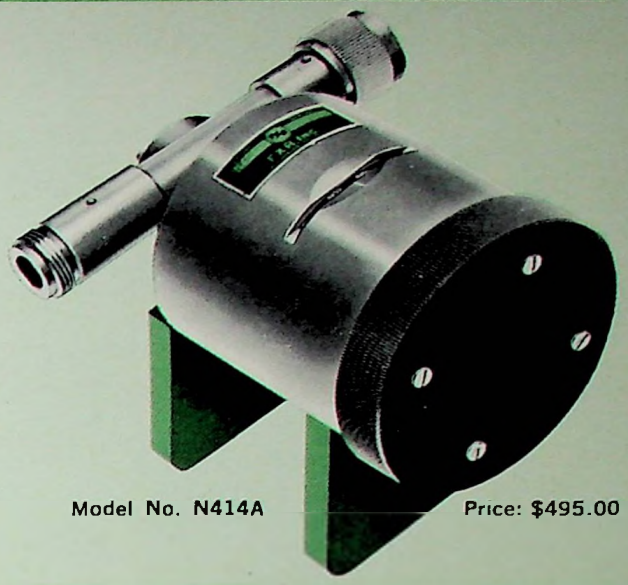


Model No. N414A — Price: $495.00

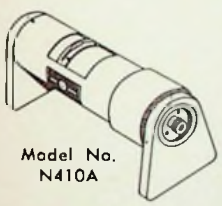
- **Direct reading from 3.95 to 11.0 KMc**
- **Covers a full octave and beyond**
- **Reaction type with 0.1% absolute accuracy**
- **Non-contacting choke for long life and high Q**
- **Standard Type N Connectors for universal utilization**

Meet the newest member of the FXR "family" of direct reading frequency meters. This coaxial type, Model No. N414A, has a range from 3.95 KMc to 11.0 KMc and by use of FXR Series 601 coax to waveguide adapters converts to waveguide set-ups. The unit covers "a full octave and beyond" with an absolute accuracy of 0.1% throughout its range. It is a perfect companion for the FXR Models No. C772 and X772 signal sources.

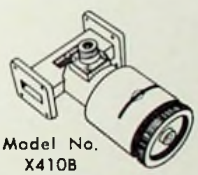
This newest direct reading frequency meter augments FXR's existing line, recognized as the largest in the industry. Direct reading, reaction type units are available for use up to 39.5 KMc while micrometer types extend FXR's coverage up to 220 KMc.

*Write or call now for data sheets on Model No. N414A and other units in the integrated FXR family of precision frequency meters.*

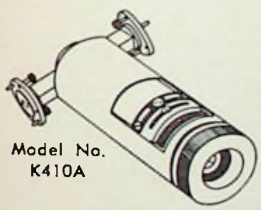
## FXR "FAMILY" OF DIRECT READING REACTION TYPE FREQUENCY METERS



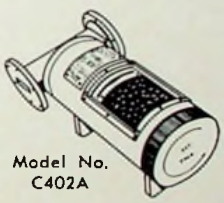
Model No. N410A



Model No. X410B



Model No. K410A



Model No. C402A

| Model No. | Frequency Range (KMc) | Absolute Accuracy (%) | Approx. Q | Waveguide Type RG-( )/U | Flange Type UG-( )/U | Price (F.O.B. Woodside) |
|---|---|---|---|---|---|---|
| **COAXIAL TYPES** | | | | | | |
| N410A | 1.00- 4.00 | 0.10 | 3000 | (3/8" Coax Type N) | | $495.00 |
| N414A | 3.95-11.0 | 0.10 | 500 to 1500 | (3/8" Coax Type N) | | 495.00 |
| **WAVEGUIDE TYPES** | | | | | | |
| *H410B | 3.95- 5.85 | 0.08 | 8000 | 49 | 149A | 250.00 |
| *C410B | 5.85- 8.20 | 0.08 | 8000 | 50 | 344 | 180.00 |
| *W410B | 7.05-10.00 | 0.08 | 8000 | 51 | 51 | 165.00 |
| *X410B | 8.20-12.40 | 0.08 | 8000 | 52 | 39 | 150.00 |
| Y410A | 12.40-18.00 | 0.10 | 4500 | 91 | 419 | 210.00 |
| K410A | 18.00-26.50 | 0.10 | 4000 | 53 | 425 | 230.00 |
| U410A | 26.50-39.50 | 0.10 | 3000 | 96 | 381 | 250.00 |
| C402A | 5.85- 8.20 | 0.03 | 8000 | 50 | 344 | 1275.00 |
| X402A | 8.20-12.40 | 0.03 | 8000 | 52 | 39 | 1275.00 |

* With transmission coupling probe.

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| Model No. | Frequency Range KMc | Price (F.O.B. Woodside) |
|---|---|---|
| Q410X | 33-50 | $325.00 |
| M410X | 50-75 | 300.00 |
| E410X | 60-90 | 500.00 |
| F412A | 90-140 | 750.00 |
| G412A | 140-220 | 750.00 |

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volume 7
number 5

# Grid

January 1961

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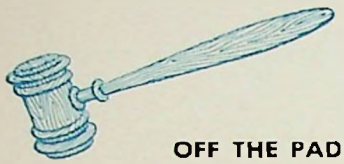
## contents



## about the cover

Linear electron accelerators are expected to make big news in the early New Year with authorization of the $150 million first stage of Stanford University's Project M, the plan view of which appears on the cover, superimposed on an aerial view of the campus foothill region that was the initially proposed site. Forerunner of the projected "world's largest scientific instrument" is the present Mark III accelerator now operative in the W. W. Hansen Laboratories of Physics, a facility named to honor the true father of these machines. Mark III, sans shielding, also appears on the cover. On page 10 is further information on meetings relating to Project M.

*from the chairs*



**OFF THE PAD**

*Nicholas L. Pappas*

The raison d'etre of your new local PGI chapter is dissemination of information using the medium of San Francisco Section sponsored meetings. Presentation of a successful series of meetings depends upon many factors, membership participation being dominant. Given this, how can we turn all factors to advantage?

The chapter's administrative committee, working within the framework of the chapter bylaws, has made the transition from the organizational to the intial operational phase of existence. We have held monthly meetings with an average attendance of 25. Topics covered have included electronic standards, magnetic recording, and missile-range instrumentation.

This average attendance is apparently a typical value for pg chapter meetings heareabouts—however, it seems very low considering the 400 plus PGI members within the Section. How can this figure be improved?

Basically, we must offer topics that are interesting, with possibly just a dash of controversy added, and helpful to most of the members. Easy to state, difficult to fulfill. Difficult, since the membership is largely silent except for the few who call after a meeting to present their views. May we take this opportunity to thank you one and all.

Also, it has been alleged that our non-unique problem stems from a dearth of people who really have something to communicate and who can, at the same time, make an interesting presentation. Intuitively we reject this allegation because all fascinating developments are not kept deep, dark secrets forever and anon and because at least some English-speaking people have emerged from our universities. Anyway, most universities field a football team.

While we are making obvious remarks, let us go for one more: spectators and players react upon each other. The chicken-and-egg problem is manifest and so should be the analogy to pg chapter meetings.

A good friend of ours has observed that function theory is like life: it is the singularities that count! We can hardly infer that any chapter meeting can be all that outstanding; however, we do feel that each meeting participated in as spectator or player can constructively contribute to one's professional esprit de corps, practical and/or theoretical knowledge, and awareness.

We always feel that the "next" meeting will be bigger and better (if only to support Parkinson) for we have learned a little more about this art of promotion from the last one.

On paper the future is bright for PGI considering the strong emphasis on instrumentation in this area.

Nicholas L. Pappas

NICHOLAS PAPPAS, CHAIRMAN, PGI

# DELAY LINES, INDUCTORS, FILTERS AND CHOKES... ARNOLD IRON POWDER CORES CUT COSTS

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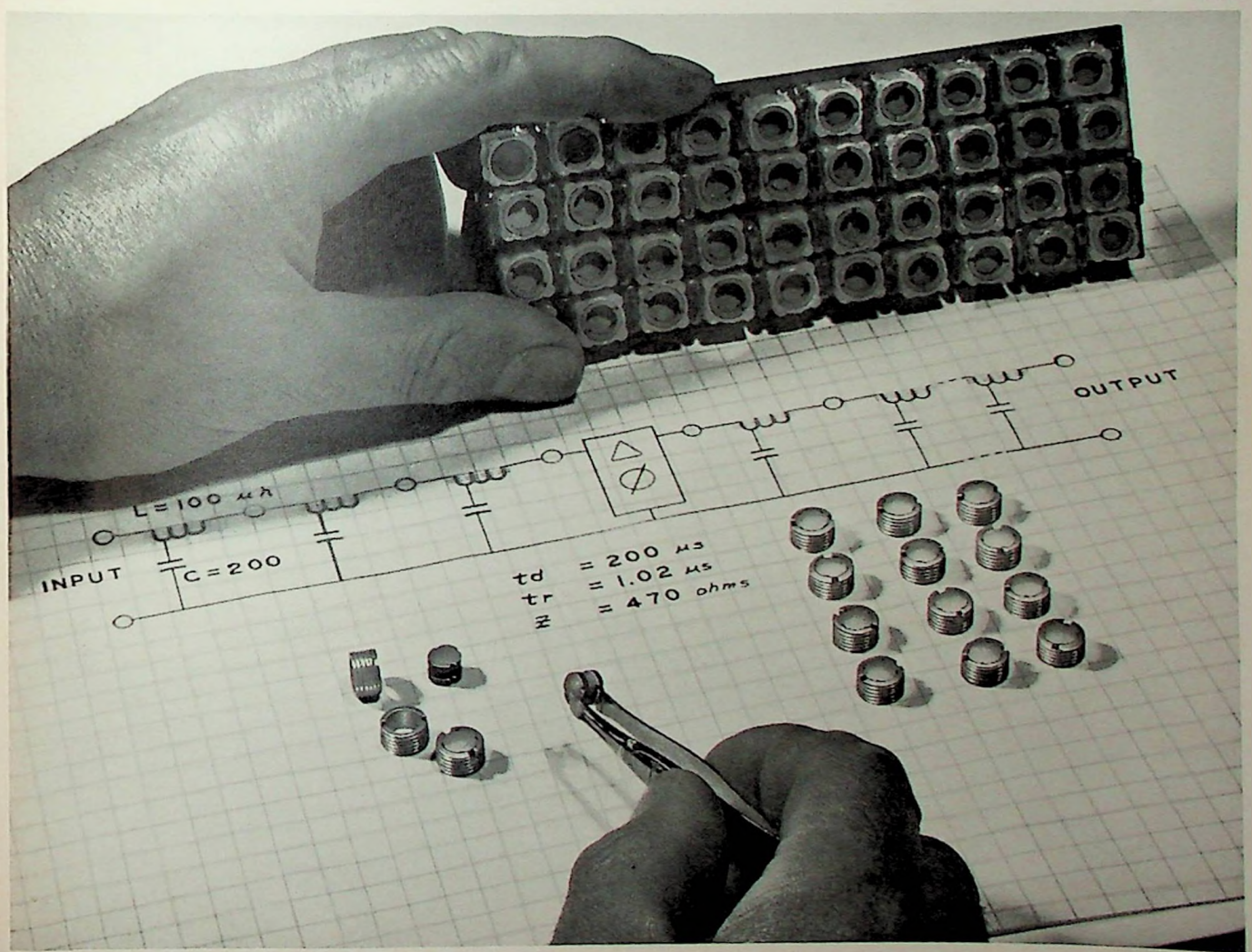

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# MEETING CALENDAR

## EAST BAY SUBSECTION

**8:00 P.M. • Monday, Jan. 23**

(Joint meeting with PGEM and PGRQC)
"Component Approach to Reliability"
Speaker: John T. Lavrischeff, reliability engineer, Lawrence Radiation Laboratory, Berkeley
Place: The Cottage, 9925 E. 14th Street, Oakland
Dinner: 7:00 P.M., The Cottage
Reservations: Maryanne Cook, HIlltop 7-1100, Ext. 84203; Virginia Cherniak, THornwall 3-2740, Ext. 5434; or Marilyan Holland, YOrkshire 8-6211, Ext. 2165, by Jan. 20

## PROFESSIONAL GROUPS

### Bio-Medical Electronics

**8:00 P.M. • Wednesday, Jan. 18**

"Hospital Automation—Progress and Prospects"
Speaker: Mark S. Blumberg, M.D., senior health economist, Stanford Research Institute
Place: Room M-112, Medical School Building of Palo Alto-Stanford University Medical Center. Room M-112 is located in the courtyard of the wing in the Center nearest Hoover Tower. Approach from Palm Drive on Stanford Campus, which is the extension of University Avenue, Palo Alto
Dinner: 6:00 P.M., Red Cottage Restaurant, 1706 El Camino Real, Menlo Park
Reservations: Ken Gardiner, DAvenport 6-6200, Ext. 2659 (or by mail: Stanford Research Institute, Menlo Park)

### Electron Devices

**8:00 P.M. • Wednesday, Jan. 25**

"The Application of Mass Spectrometry and Emission Spectroscopy to the Manufacture of Vacuum Tubes"
Speaker: Robert Culbertson, manager, processes and materials development lab, Eitel-McCullough, Inc., San Bruno plant
Place: Room 100, Physics Lecture Hall, Stanford University

### Electron Devices

**8:00 P.M. • Wednesday, Feb. 15**

(Joint meeting with PGMTT, see next column)
"Project M"
Speaker: Gregory A. Loew, research associate, Stanford University
Place: Room 320, Geology Building, Stanford University
Dinner: 6:30 P.M., The Red Shack, 4085 El Camino Way, Palo Alto
Reservations: Odette Moore, DAvenport 6-6200, Ext. 2414

### Electronic Computers

**8:00 P.M. • Tuesday, Jan. 24**

"Finite State Machines and What's Behind Them"
Speaker: Arthur Gill, assistant professor, electronics research laboratory, University of California, Berkeley
Place: Building 202, Lockheed Auditorium, 3251 Hanover Street, Palo Alto
Dinner: 6:00 P.M., The Red Shack, 4085 El Camino Way, Palo Alto
Reservations: None required

*Y. P. Yu*

*meeting ahead*

**OF TIME AND PHASE**

Early in the month, the first of two February PGI meetings will feature Dr. Y. P. Yu, president and chief engineer of Ad-Yu Electronics Laboratories, Inc., Passaic, N.J.

The paper will describe phase measuring instruments capable of operation up to 2000 mc with accuracy of 0.1 degree or 1 per cent. The operating principle is based on comparing phase delay with a continuously variable de-

# MEETING CALENDAR

**Engineering Management** 8:00 P.M. • Monday, Jan. 23
(Joint meeting with EBSS and PGRQC, see above)

**Engineering Writing & Speech** 8:00 P.M. • Tuesday, Jan. 17
"The Preparation and Writing of Successful Proposals"
Speaker: to be announced
Place: Conference Room, Building 3, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto

**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: Cubberley Auditorium, Stanford University
Dinner: "Meet-the-Speaker"; 6:00 P.M., Red Cottage Restaurant, 1706 El Camino Real, Menlo Park
Reservations: H. A. Kazanjian, EMerson 9-1226

**Instrumentation** 8:00 P.M. • Tuesday, Feb. 28
"Large Scale Data Handling Concepts"
Speaker: Robert L. Sink, associate director, Datalab Division, Consolidated Electrodynamics Corp.
Place: Cubberley Auditorium, Stanford University

**Microwave Theory & Techniques** 8:00 P.M. • Wednesday, Feb. 15
Joint meeting with PGED)

**Product Engineering & Production** 8:00 P.M. • Tuesday, Jan. 24

**Reliability & Quality Control** 8:00 P.M. • Monday, Jan. 23
(Joint meeting with EBSS and PGEM, see above)

**CHRONOLOGICAL RECAP**

January 17—Engineering Writing & Speech, Space Electronics & Telemetry
January 18—Bio-Medical Electronics
January 23—East Bay Subsection/Engineering Management/ Reliability & Quality Control
January 24—Electronic Computers, Product Engineering & Production
January 25—Electron Devices
February 7—Instrumentation
February 15—Electron Devices/Microwave Theory & Techniques
February 28—Instrumentation

*Robert L. Sink*

*meeting ahead*

**THE COMING DATA DELUGE**

What to do with great amounts of data will be the problem considered by R. L. Sink at the later of two PGI meetings in February. See the Calendar for details.

Many interesting and important programs require automatic systems for data gathering, processing, editing, display, and storage. The sheer volume of data that must be handled has resulted in design and construction of data-handling systems which are capable of making measurements at a higher rate and with higher accuracy than would have been considered desirable or possible only a few years ago. This paper will concern itself first with a discussion of the current state-of-the-art in equipment used for handling large quantities of data and then cover some of the plans for coping with the overwhelming stream of data which it is possible to generate.

Large-scale systems are based upon time-division-multiplexing methods using analog-to-digital converters to achieve resolution, accuracy, and storage capability in an advantageous fashion. Characteristics (and the reason for their selection) of specific systems will be covered. Experiences in their use will be reported.

Some results of fundamental studies aimed at reducing the amount of information actually transmitted or stored to only that portion which contains preestablished criteria of significance will be presented. The effect on system character of the philosophy of elimination of redundant data at the site will be discussed. Characteristics of a complete system designed for missile or space-probe applications will be discussed in terms of the characteristics, size, power, weight, resolution, accuracy, reliability, etc.

*(Continued on page 10)*

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lay standard which is constructed coaxially from input to output.

Special circuits have been developed for these instruments. These circuits include: (1) a coherent detector capable of measuring phase angle up to several thousand megacycles, and (2) a differential tuned amplifier capable of increasing both sensitivity and selectivity, yet producing no phase error due to drift of signal frequency or improper tuning. In addition, a direct reading phase meter for operation at lower frequencies is included for discussing the art of phase measurement.

Yu founded Ad-Yu in 1952 and, as its president, has guided the research and development of numerous instruments in the field of precision phase and time measurements. He is a prolific writer and the holder of several U. S. patents.

His discussion will be based on an original presentation at the 1960 National Electronic Conference. He will cover new methods and devices for rapid phase measurements with digital readout from a fraction of a cycle per second to over 5,000 megacycles.

*Robert D. Culbertson*

*meeting ahead*

**WHAT'S IN A GAS**

Mass and emission spectroscopy as used in the manufacture of electron tubes will form the core of the presentation by Robert D. Culbertson of Eitel-McCullough at the January PGED meeting. See the page 8 Calendar for time, place, etc.

His presentation will include the application of each of the two instruments with notes on how they are used in problem solving. He will also touch on new developments in techniques.

For example, residual gases in a high-power klystron have been monitored with a portable mass spectrometer, from the exhaust stage through an actual life test. Culbertson will show slides of some of the spectrographs, as well as of the equipment.

Culbertson obtained his BS degree in chemistry at San Jose State College in 1950, and worked as a chemist with a food processing firm prior to his association with Eitel-McCullough, Inc.

He joined the research and development division of Eitel-McCullough, Inc., in 1952 as a chemist and served two years as an assistant group leader. Thereafter, he transferred to the manufacturing division as chief factory chemist, and later was made director of factory engineering. At present, he is the manager of the processes and materials development laboratory.

His work at Eimac is in the field of high power tube techniques, and processes. Culbertson has applied for three patents—two for improvements in oxide-coated cathodes, and one for a heater package.

*meeting ahead*

**DOWN THE TUBE**

Now that the East Bay Subsection of the San Francisco Section has had the latest word on Stanford's Project M, PGMTT and PGED will take up the subject with a meeting on February 15 with Gregory Loew as principal speaker. Complete attendance details are in the calendar, page 9.

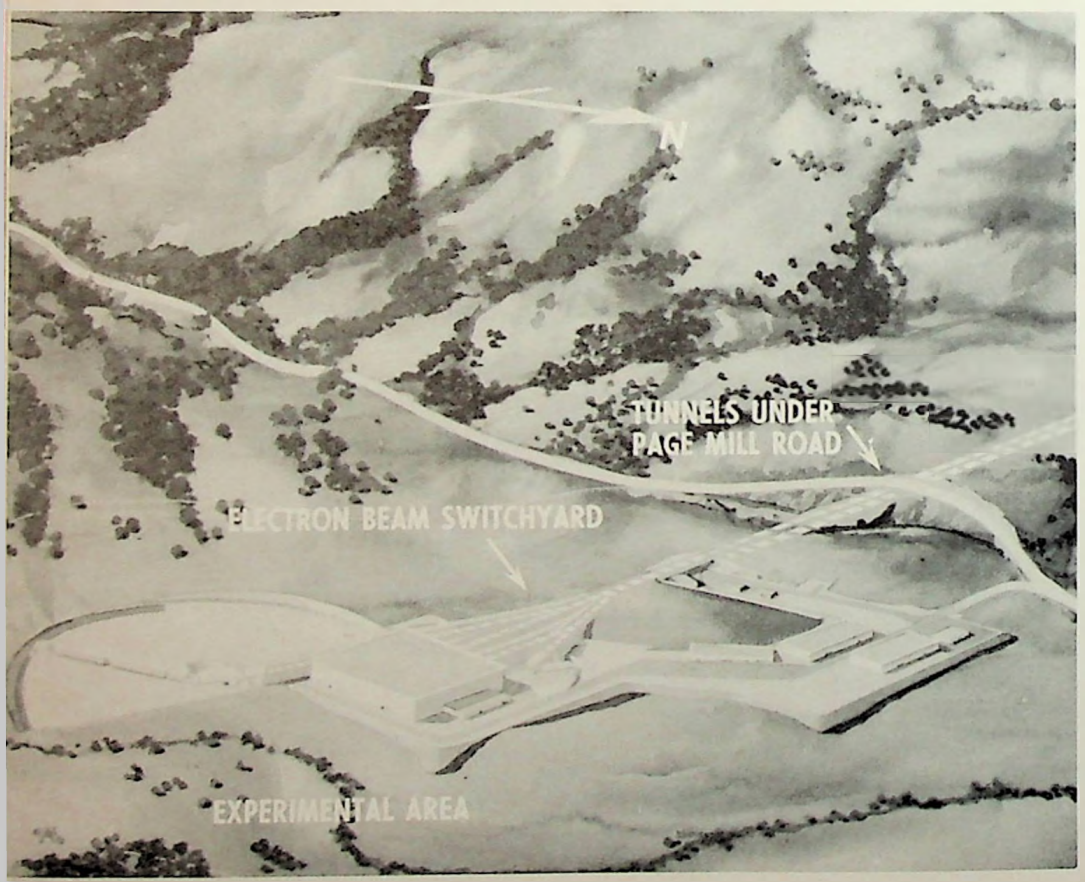
See also meeting review, "Rapid Transit," below.

Although complete authorization of Stanford's Project M was still pending as of January 1, 1961, development work and planning have been actively pursued during the past year. During this talk, an attempt will be made to describe the design and research objectives of the Stanford two-mile linear electron accelerator. Following a brief comparison of this machine with other types of particle accelerators regarding physics research, emphasis will be placed on the present status of the project with particular reference to accelerator operation, microwave techniques, and associated problems.

Gregory A. Loew was born in Vienna in 1930 and brought up in France and Argentina. His university training includes the equivalent of a bachelor's degree in physics and chemistry from the University of Paris (Sorbonne), 1952; an MS in EE from CalTech, 1954; and a PhD in electrical engineering from Stanford, 1958.

His thesis subject was "External-Circuit Traveling-Wave Amplifiers." He has worked in the linear electron accelerator field at Stanford since his graduation.

*Marshaling yard will take charge of 15-bev electrons (later, 45) coming from Stanford linac, and direct the beam magnetically to specific experiment desired*




*meeting review*

**RAPID TRANSIT**

The Stanford University two-mile electron linear accelerator was the subject of a November East Bay Subsection meeting with Omar E. Snyder, research assistant at the W. W. Hansen Laboratory of Physics as principal speaker.

The Stanford two-mile linear accelerator (LINAC) has been nicknamed project M (for monster) right from its start

*(Continued on page 12)*

MORE DATA DELUGE

Robert L. Sink, associate director of Datalab, a division of Consolidated Electrodynamics Corporation, joined CEC in 1945 as chief electrical engineer and for a number of years before the company divisionalized its operations he was assistant director of engineering. Earlier, he held engineering posts with Litton Engineering, Hewlett-Packard Co., and the General Electric Company.

Sink is a member of the technical advisory group for the Air Force armament center at Eglin Air Force Base, Florida. He is a Fellow and former national director of the Institute of Radio Engineers, a past chairman of PGI, a member of the Instrument Society of America, and a registered electrical engineer in the State of California.

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MORE ACCELERATOR

in 1955. The $150-million price tag compares with 140 million for the Bay Bridge and 125 million for three miles of downtown Boston freeway, both thought to be "monstrous" projects.

The electrical characteristics of Project M are as staggering as the price tag. For example, the Brookhaven National Laboratory's alternating gradient synchrotron and the Lawrence Radiation Laboratory's bevatron both are operating machines producing about 100 watts of beam power. Most electron accelerators produce a few hundred watts of beam power. The MURA colliding beam machine may produce 10 bev at 0.6 megawatts. What about Project M? It is designed to produce 45 bev at 2.4 megawatts of power—certainly the most powerful design under construction.

The thinking, begun five years ago, led to the request for construction signed by the President in 1959. The contract was let in November, 1960, and subcontracts are now being negotiated.

Why build such an expensive machine? Powerful beams are needed for nuclear research and the LINAC has potentially more power than circular machines. The circular machines are limited to about 4.5 mev per turn due to stray radiation. Shooting along a straight line, even though it may be a long straight line, allows 4.5 mev per foot with much less stray radiation. An additional advantage of the LINAC is that the field can be removed and the beam will coast without getting out of the area intended to contain it. The machine essentially consists of a long evacuated waveguide excited with r-f. The electrons ride the peak of the traveling wave. Loading disks slow the velocity of propagation. A klystron will be needed every ten feet to provide a total r-f power of 23,000 megawatts.

The operating frequency was chosen to be 2,856 mc. S-band (10 cm) klystrons are needed which can handle up to 250 kv at 250 amp input power. Both Sperry and RCA are developing tubes for Project M. The cost will be about $5,000 per tube for tubes with an average life of 2,000 hours. When Project M is in full swing it may require 12 tubes a day to keep going.

A running discussion developed with the speaker mostly being called upon to answer questions concerning tolerances. The most popular question concerned how straight the 2 miles of waveguide had to be. The allowable tolerance is plus or minus ⅛ inch in the total length. (The curvature of the earth is about 2 inches in two miles.) This allows the electron beam to thread ⅞-inch-diameter holes in the loading disks all the way. The mechanical tolerances are generally 0.0002 inch. The waveguide is made up of 10-foot sections, each made by electroforming copper around aluminum forms to a ⅜-inch thickness. What is the price of misalignment? Probably a melted LINAC because the temperature rise if the beam hits the guide would be about 40 deg C per pulse and there are 360 pulses per second. (This machine, obviously, must be laid out parallel to the San Andreas fault.)

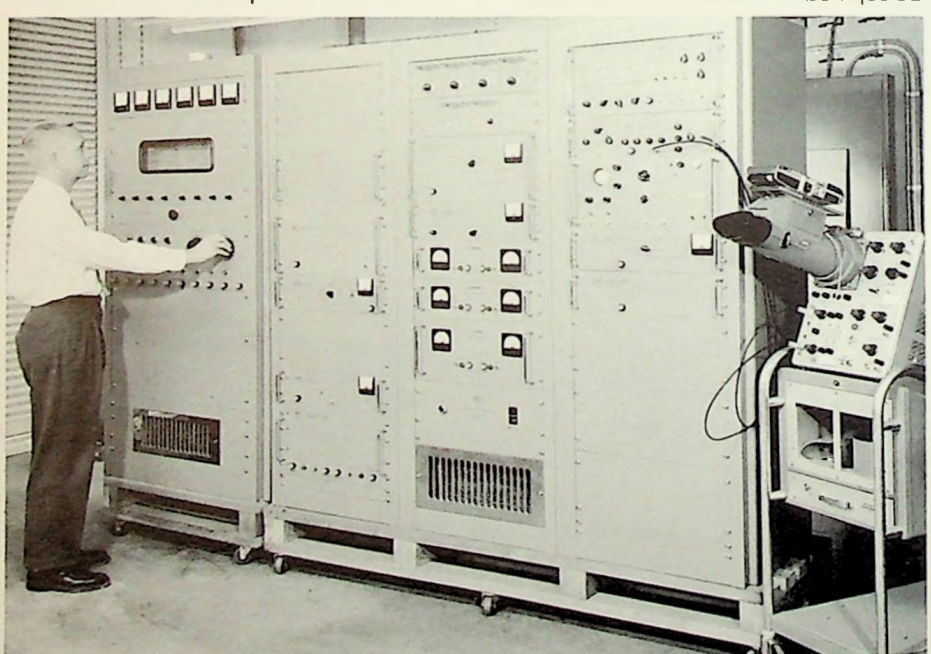
Electrical tolerances were not neglected in the discussion. The beam pulses are to be held to plus or minus ½ per cent ripple and plus or minus ¼ per cent absolute amplitude.

What kind of beam has to be injected into the Project M LINAC? Electrons will be injected at 80 kev. Protons would have to be injected at 7 bev. The injected pulses would be 1.6 microseconds long and the r-f pulses in the machine would be 2.5 microseconds. The peak injected beam current needs to be about 100 ma with the average current about 60 microamps.

Project M produces such a powerful beam that the input power must be staggering. What is PG&E going to provide? A 110 kv, 150 megawatt, 60 cps line is planned. It may have to be split up into 64 phases in order to filter so much power economically.

With the contract let only the week before, the speaker would not hazard a guess as to the completion date of the most powerful, most monstrous of the nuclear particle accelerators under construction today.

—JOHN T. LAVRISCHEFF



*Len Seader, one of the November PGCS speakers, adjusts a Granger-Associates step-frequency sounder of the type described at the meeting*

*meeting review*

**STEPPING THROUGH THE IONOSPHERE**

The Professional Group on Communications Systems opened its season with a presentation on ionosphere sounding techniques. The November meeting had Dr. Raymond Egan and Leonard Seader, both of Granger Associates, as speakers.

Egan led off with an interesting and informative commentary on ionosphere physics and solar emissions. He noted how the solar flares apparently caused ultraviolet emission which created a SID on the sunlit side of the earth due to the D-region absorption. Following this solar-generated difficulty, the slower-moving corpuscular emission hits the earth in about 24 hours, and is not limited to the sunlit side as particles stream in on the geomagnetic field. These ionospheric and magnetic disturbances often are of large magnitude.

Even though the disruptions relating to solar flares are predictable in general, they are fortuitous with respect to fine-scale time. To utilize the available spectrum to the fullest, there has long been a need for rapid determination of the openings which occur in the "blackout" periods.

Seader discussed the step-frequency sounder developed and produced by Granger Associates. He outlined the technique of automatically, and nearly instantaneously, picking the optimum frequency for presentation to the operators at both ends of the circuit. The equipment is capable of sweeping the band from 4 to 64 mc in as many as 160 steps at rates up to 50 steps per second. Partial sweeps may be also programmed as required. Since the communication circuit may be down when the sounder is commanded, accurate clock drives at each end are used for synchronization.

*(Continued on page 14)*


Progress of the Hughes Infrared Systems and Guidance Heads Department reflects Hughes' overall growth. In the past ten years, employment has risen from under 2,000 to over 30,000 in semi-autonomous divisions concerned with Engineering, Research, Commercial Products, Ground Systems, Communications and Manufacturing. The infrared activity includes these typical projects:

1. **Air-To-Air Missiles**
2. **AICBM**
3. **Air-To-Air Detection Search Sets**
4. **Satellite Detection & Identification**
5. **Infrared Range Measurement**
6. **Detection Cryogenics**
7. **Detector Application Physics**
8. **Optical Systems Design**

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.

You are invited to investigate these openings if you have several years of applicable experience in infrared, optics or electronics, and can assume responsibility for systems analysis and preliminary design.

The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

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MORE IONOSPHERE

The speakers illustrated their talks with slides and speeded-sequence stills on motion-picture film. The latter shots, taken at five-minute intervals, dramatically pictured the oblique incidence sounder results. The sporadic E and the F zones really hopped in and out during the periods shown!

—KEN PATTERSON

*meeting review*

**MAN DOGS BITS**

Frank F. Stucki of Lockheed addressed a meeting of the PGEC in December at the Lockheed MSD auditorium. His subject was the random-access ferrite-sheet store which he had worked on at the Bell Telephone Laboratories before his recent move to California.

Stucki described the design, characterization, and operation of a randomly addressable, bit-organized ferrite-sheet store having a capacity of 704 words, each 16 bits long. A new type of ferrite sheet produced by BTL was used. It consisted of a 16 x 16 array with 25 mil holes. The memory was built with 44 active sheets.

Such properties as peak switching voltage, peaking time of the switching voltage, switching time, disturbed zero-output, half select output, and delta noise were measured on a single sheet and on different sheets of the linear memory array. In addition, the homogeneity of an individual sheet and the sheets in the memory array were investigated. All tests were performed at temperatures ranging from −10 C to +95 C. For comparison purposes, a commercially available RCA ferrite sheet was tested.

A highly reliable store system was described, using ferrite sheets as the memory elements and a magnetic T-type access switch for translating the incoming address, and for supplying the load currents. A read-write cycle time of 10 microseconds was easily attained. A considerable decrease in the cycle time could have been achieved by using high-speed transistor logic circuitry to drive the magnetic access switch.

Stucki received his education at the Swiss Federal Institute of Technology, Zurich, Switzerland, where he obtained the MSEE in 1951. He has been employed by the Bell Telephone Company of Canada and the Bell Telephone Laboratories in New Jersey. Since November 1960 he has been employed by Lockheed MSD to do research in magnetic logic.

—J. A. BOYSEN

*meeting review*

**HEAVYWEIGHT AUDIO?**

Stan Hose, senior design engineer at the Triad Transformer Corp. in Venice, Calif., journeyed into the Bay Area to give an interesting talk on "Audio Transformer Design Considerations" to a November joint PGA-AES meeting held at the Stanford Research Institute. Inasmuch as audio transformer specifications published by various manufacturers are seldom either complete or uniform, listeners at the meeting found the presentation especially informative in two respects: firstly, with respect to understanding and/or formulating audio transformer specifications and secondly, with respect to selecting an appropriate transformer for use in a specific circuit.

Hose introduced the group to basic transformer design considerations relating to transformer size, wide frequency range operation, operating voltages, source and load impedances and source and load inductances. For instance, the low-frequency end of a wideband transformer operating range is determined chiefly by the transformer open-circuit inductance The high-frequency end is governed by the leakage inductance and distributed capacitance.

To obtain an audio transformer of optimum design one must juggle various factors such as core size and material, the type or geometry of the transformer windings, the type of d-c or a-c insulation required, and the proper use of feedback principles. Harmonic distortion in audio transformers, a little understood subject, can be minimized by the proper selection of new materials such as a special grade of silicon steel.

Hose concluded with the caution that the widespread practice of selecting a good output audio transformer of given power-handling capacity merely on the basis of size or weight can be in error since a host of other design features contribute to transformer efficiency and frequency response.

—STANLEY K. OLESON

*meeting review*

**CURTAIN ON NOISE**

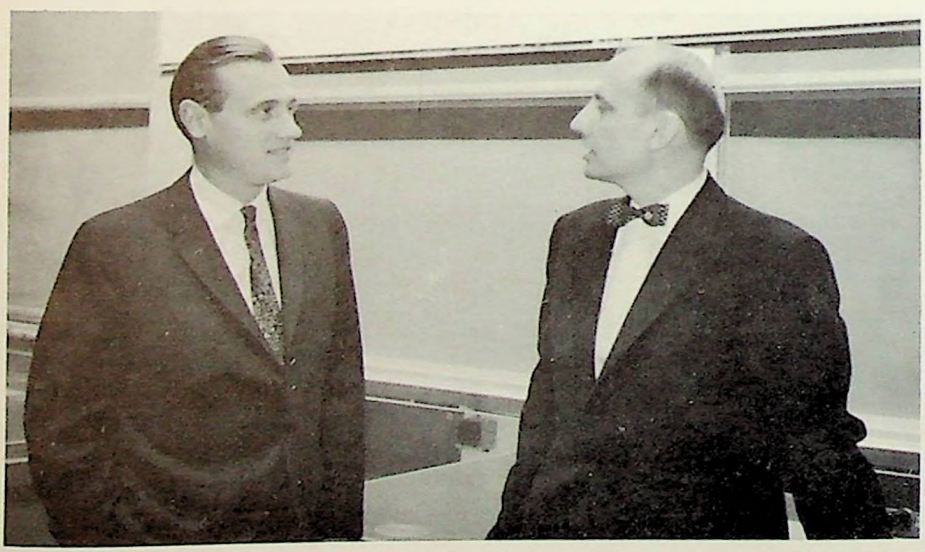
A survey of the low-noise performance of traveling-wave tubes, parametric amplifiers, masers and tunnel-diode amplifiers was presented by Dean Watkins and Glen Wade at a double-feature meeting of PGED/PGMTT on November 30 at Stanford. This final meeting, in a series of three on low noise, played to a packed house.

Dean Watkins described the current status of low noise traveling-wave tubes and gave a brief account of previous developments. He feels that low-noise traveling-wave tubes and other low-noise devices give performance that is sufficiently good to cause other characteristics such as bandwidth, gain, reliability, weight, etc., to be the deciding ones in determining the choice for a particular system. (It is interesting to note that this conclusion concurs with the remarks of Dr. Ewen in the first of these talks regarding radiometric applications.)

Glen Wade briefly described parametric amplifiers, masers and tunnel diodes. Their noise temperatures were tabulated and a comparison made. While pointing out that devices other than the traveling-wave tube have demonstrated the lowest noise figures, he felt that each had its limitations and would find its appropriate place.

Starting with noise figures of 18-20 db in 1948, the noise figure of traveling-wave tubes presently reaches lows between 2 and 3 db for the frequency range 2-4 gc. This has been accomplished by reducing both interception or partition noise and shot noise. Interception noise has been virtually eliminated by improving transmission through the helix, particularly at the

*(Continued on page 16)*

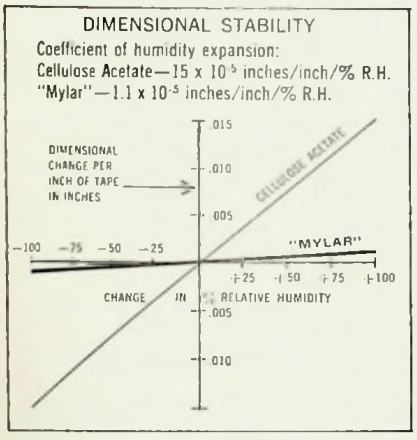


*Dean A. Watkins and Glen Wade at the last-of-November PGED/PGMTT meeting reviewed at right*

# Magnetic tapes of "Mylar"® insure reliability of recording and playback

Much information recorded on magnetic tapes can never be replaced because of the tremendous cost of duplicating test conditions. You can protect your investment in such valuable data with tapes of "Mylar"* polyester film. Their small additional cost is negligible compared to the cost of the data they contain. Here's why they provide higher reliability than any other tapes:

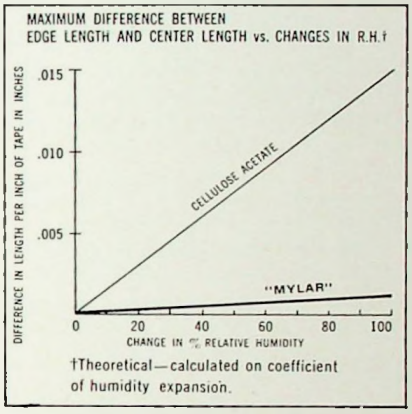
CHART NO. 1




## Less signal dropout.

Chart 1 shows that dimensional change in "Mylar" with humidity change is negligible compared to acetate. This exceptional stability prevents tape shrinking, swelling or cupping that could result in shifting of tracks or loss of contact with the recording or playback head. Possibility of signal dropout or garbled or weak signals are minimized and reliability of recorded data is assured.

CHART NO. 2



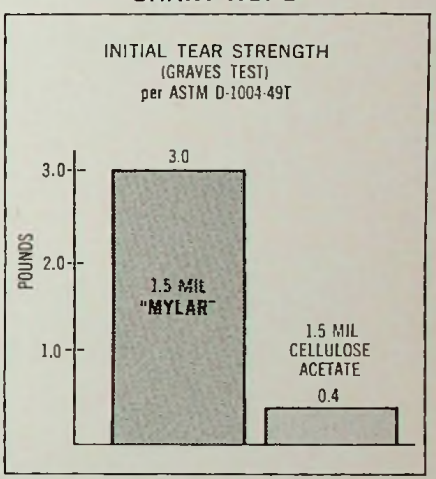

## Fewer garbled signals.

If magnetic tape picks up or loses moisture unequally across the tape width there will be a difference in length between the edges and center. Chart 2 compares this effect for "Mylar" and cellulose acetate tapes. Because "Mylar" is virtually non-hygroscopic there is no dimensional difference between edges and center to cause poor registration of timing across adjacent tracks on the tape.

## Less tape breakage.

Since most breaks start as edge nicks, the high initial tear strength of "Mylar" reduces chance of breakage and subsequent failure to record critical information. Chart 3 compares initial tear strength of "Mylar" and acetate. In addition, "Mylar" has the highest tensile strength of any instrumentation tape base. And "Mylar" does not lose its toughness with age, repeated playbacks or storage because it has no plasticizer to dry out.

CHART NO. 3

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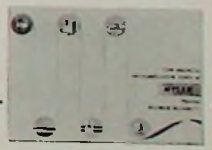

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MORE NOISE

input. Shot noise has been reduced by two mechanisms; transformation of noise waves by velocity jump guns, and by introducing correlation between current and velocity fluctuations.

The velocity jump technique permitted noise figures to be brought near their theoretical minimum for this case of about 6 db. The theory, however, neglected what happened in very low potential regions and did not predict the lower noise results, first observed by Currie, in experiments with backward-wave amplifiers. The guns used were found to have essentially hollow beams and a low potential region following the cathode. Improvements which have led to lower noise figures are: the introduction of more electrodes adjacent to the cathode for better control of the potential, use of a ring cathode to eliminate residual surface current from the central region, a disc cathode with a chamfered corner whose operation is not entirely agreed on, but appears to function by enhancing edge emission. The results which have been obtained thus far are lows of 4 to 4½ db, about 9 gc; to under 2½ db, about 1 gc. Gain is typically 20 to 25 db and life is good.

In the future we may expect these low noise techniques to be applied to K band and the 3 and 4 millimeter region. We may expect to achieve noise figures of 10 db as high as 100 gc.

Wade included in his discussion parametric amplifiers of the three major types (diode, electron-beam, ferrite), masers, and tunnel diodes. Since his data was in terms of noise temperature, Wade began by converting the 20 db to 2.7 db improvement in noise figure of low noise traveling-wave tubes to an equivalent noise temperature improvement of 30,000 K to 250 K. The noise temperature of an amplifier he defined as the temperature of a corresponding source which when used with that amplifier gives an overall noise figure (total noise to load divided by noise of source to load) of two. The noise temperatures quoted are for double-channel, synchronously-pumped operation including a circulator. If the system is double-channel but not synchronously pumped, 1½ db must be added to the corresponding noise figure. If only one channel can be used, 3 db must be added.

The electron beam parametric amplifier consists of an input and output coupler with an exponential growth region between. The couplers serve as circulators, with the input coupling the noise out of the beam and the signal in. The output coupler couples the signal from the beam to the load. Noise and reflections from the load are coupled onto the beam and disposed of. Noise temperatures of 40 K have been obtained below 1 gc.

Diode parametric amplifiers are limited in performance primarily by thermal noise. At room temperature these have obtained double-channel performance of 75 K at 3 gc, 80 K at 6 gc, 300 K at 9.6 gc.

The tunnel diode is similar to an ordinary p-n junction except that the doping concentration is higher. This results in the position probability for electrons in one material extending appreciably over the potential barrier permitting a negative dynamic resistance for proper bias values. Noise figures of less than 5 db at 0 K have been predicted with the conflicting requirements of decreasing noise figure with decreased doping. The best doping concentration has been found to be just below that giving maximum negative resistance. On the basis of noise figure alone, the tunnel diode is not yet competitive, yielding 1000 K at 3 gc and 200 K at 400 mc.

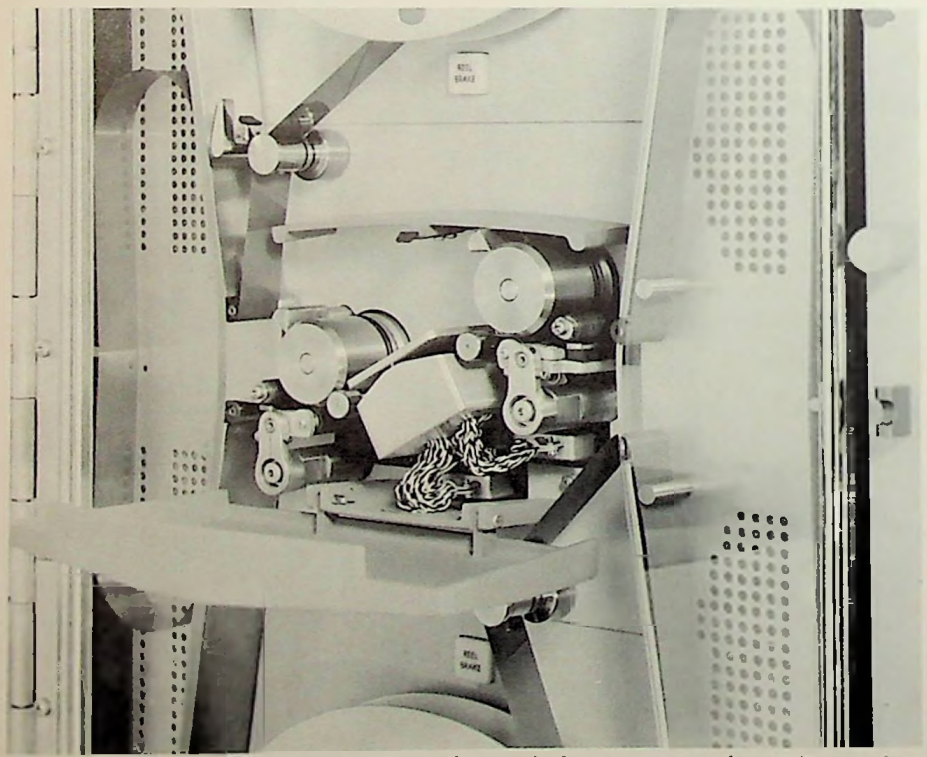
Ferrite parametric amplifiers apparently are not yet in contention. Noise figures of 12 db at 5 gc have been reported.

The maser is the ultimate in low noise amplifiers approaching noise figures limitations determined by the uncertainty relations (as discussed at the previous meeting). As an interesting example, Wade chose the project Echo traveling wave maser of DeGrasse. This operated at 5.65 gc with a bandwidth of 25 mc and a gain of 35 db. The overall system noise temperature was 18.5 K with the maser itself giving 2.8 K.

A traveling-wave tube in the same system would have given a temperature of 277 K. This represents a factor of 4 in range advantage in echo applications and a factor of 2 in radar range advantage for the maser.

A lively discussion followed. Some of the comments have been included in the body of the report.

—RICHARD P. BORGHI



*Instrumentation magnetic recording, subject of the late November PGI meeting, is typified by this myopic insight into the heart of the Ampex FR-300 machine*

*meeting review*

**HOW IS IT WITH IMR?**

Meeting for the second session of the month late in November, the Professional Group on Instrumentation took up the subject: State of the Art—Instrumentation Magnetic Recording. The speaker, Winfried B. Heinz, chief engineer of instrumentation in the Ampex Data Products Company, showed slides of the latest instrumentation recorders which have carried the virtues of increased accuracy into smaller package sizes.

As he pointed out, developments are continually in process to advance the state of the art and the performance of the machines. For example, improved tape coatings and even generally new concepts are under development.

In an instrumentation recorder, fundamental considerations are speed, delay, storage, monitoring, high-frequency, non-repetitive character, computer feed, and loop feed. To produce good equipment, it is necessary to give attention to mechanical characteristics

*(Continued on page 18)*

# 456A AC CURRENT PROBE

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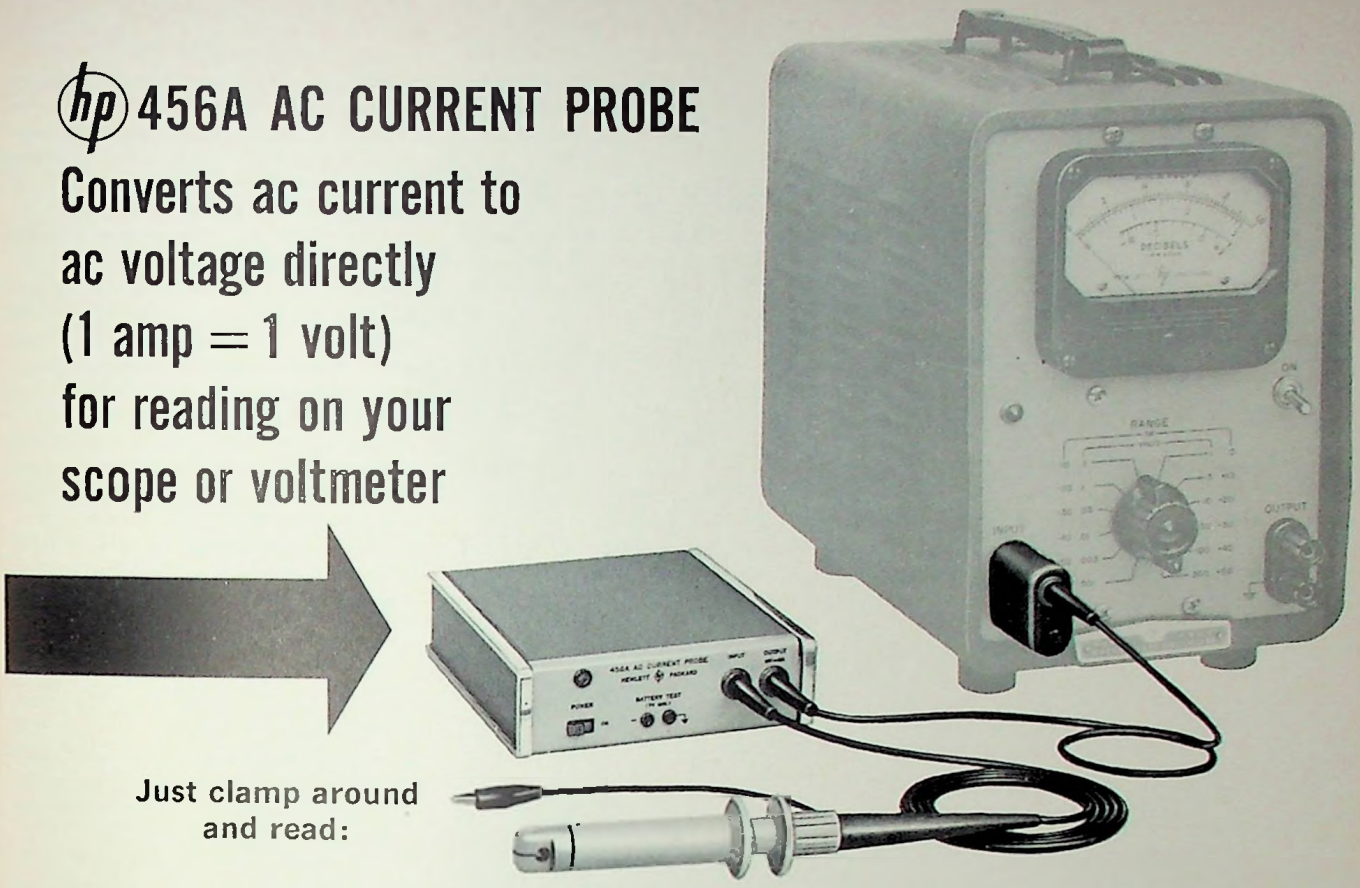

Just clamp around and read:

**Tube circuits** . . . . . view current on your scope or measure it with a VTVM

**Transistor circuits** . . . . . measure small signals dynamically, without clipping leads or circuit loading; study diodes at breakdown

**Logic circuits** . . . . . measure ac current in presence of dc current

**Impedance measuring** . . with a dual-channel scope, measure current, voltage magnitude; phase angle

**Power measuring** . . . . . with dual-channel scope read current, voltage directly, calculate power

**Frequency counting** . . . . use 456A with counter for clip-on frequency access

**And, how about these?** . . phase comparisons of ac carrier waveforms; instrument fuse current ratings; cable identification, response of magnetic cores; magnetic field sensing; silicon rectifier peak currents

### SPECIFICATIONS

**Sensitivity:** 1 mv/ma ±1% at 1 KC
**Frequency Response:** ±2%, 100 cps to 3 MC
±5%, 60 cps to 4 MC
— 3 db at 25 cps and above 20 MC
**Maximum Input:** 1 amp rms; 1.5 amp peak. 100 ma rms above 5 MC
**Maximum dc current:** Dc up to 0.5 amp has no appreciable effect
**Input Impedance:** Probe adds to test circuit only approx. 0.05 ohms in series with 0.05 μh
**Equivalent Input Noise:** Less than 50 μa rms (100 μa ac powered)
**Power:** 10 radio mercury cells; approx. 400 hours service normally supplied. Ac supply available
**Size:** 5" wide, 1½" high, 6" deep, weight 3 lbs.
**Price:** $190.00; for ac operation $210.00.
hp 456-95A ac supply for field installation $32.00
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Just clamp the hp 456A probe around a wire under test and view or read ac current directly on an indicating device. Model 456A's 1 mv to 1 ma unity conversion permits direct readings up to 1 ampere rms. The instrument's wide bandwidth permits use with oscilloscopes to view complex current waveforms with rise times to 0.017 μsec. No direct circuit connection is required; there is no loading, no appreciable impedance change in the circuit under test, and the impedance of the test circuit is immaterial.

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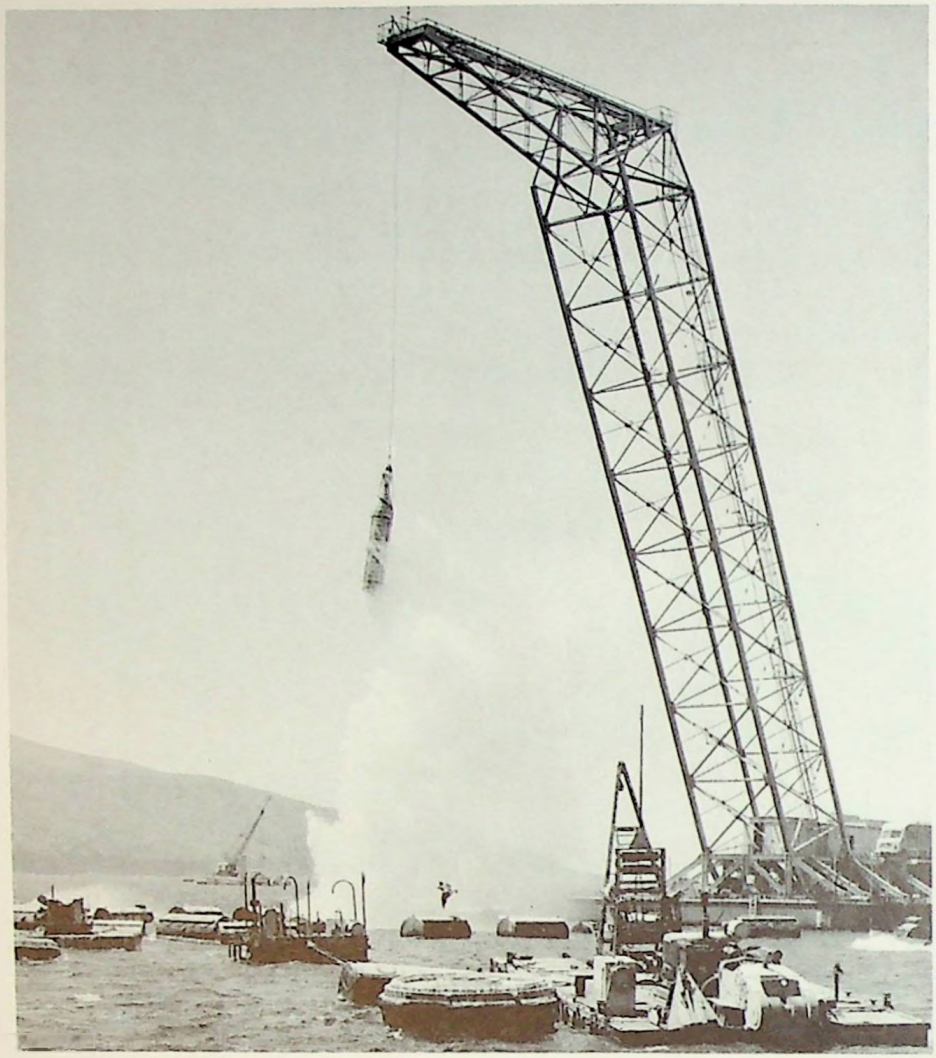

*Back in July 1959 a dummy Polaris was being test launched from underwater, unnerving nearby seagulls, foreground. This December, a report on the Lockheed-managed program was made to the PGMIL*

*meeting review*

**POLARIS STARRED**

Early in December, Commander Nicholas Brango, assistant director, plans and policy division, BUWEPS special project office for the Polaris program, presented to the Professional Group on Military Electronics an extremely interesting talk and film on the Polaris missile and the flight ballistic missile weapon system.

The paper covered a brief history of the Polaris missile and the flight ballistic missile weapons system from its origin to the latest operational tests with special emphasis on the concept of the system and its development into a deterrent force. Over fifty people attended this unclassified talk and it was gratifying to note the special interest displayed by several teenage sons of members in this subject, since these boys do represent tomorrow's scientific community.

—JEROME J. DOVER

*meeting review*

**LOUD AND CLEAR**

In mid-November, the newly formed Professional Group Chapter on Radio Frequency Interference held a pre-organization meeting. Pete Spencer of Filtron has served as interim chairman in organizing the chapter. It was reported that the petition for establishment of the chapter had been acted upon favorably by the San Francisco executive committee and national approval was expected momentarily.

The major item of business was the nomination of officers, as follows: Chairman, Peter F. Spencer, (Filtron); vice chairman, Edward Edison, (Hammett & Edison); and Robert Lathrop; secretary-treasurer, R. G. Davis (Lockheed MSD), Floyd Lewis (Sylvania), and J. P. Booker (Cook Engineering).

The agenda for the next meeting, to be held the second Tuesday in January, includes installation of officers and discussion of the program for 1961.

—R. G. DAVIS

*meeting review*

**THE LATEST DOPE**

Dr. George Dacey of Bell Telephone Laboratories presented an interesting review of recent development in Esaki diodes and their applications to a joint meeting of the PGMTT and PGED on December 7 at Stanford.

Over two years have passed since Esaki first observed and explained theoretically a negative-resistance effect in heavily doped semi-conductor diodes. During this time intensive efforts have been made to develop these diodes as practical devices, both in switching and in microwave applications. In order to understand the potentialities and limitations of the device which these efforts have revealed, a brief review of the theory of its operation is necessary.

When the material on both sides of a p-n junction is sufficiently heavily doped, the conduction band on one side of the junction overlaps the valence

*(Continued on page 20)*

MORE IMR

in regard to linearity and mechanical feedback. Performance is improved if proper care and environment are provided.

Operational emf is proportional to the tape speed. Flux heads are used in slow-speed tapes. Direct recording permits maximum bandwidth, but it is noisy; high-level f-m has been used, but recent developments permit the use of low levels. Redundant recording reduces errors to 1 part in 100,000. A monitor scope used to align the setup prior to operation increases the accuracy.

Predetection recording gives a wide bandwidth, not sensitive to flux change; the amplitude sensitivity is good and it gives greater speed with a better time basis.

Slides were used to show appearance and performance details of the Ampex model FR-600 recorder which is a light, compact, wide-band machine.

A series of attractive meetings was announced for the first quarter of 1961. Some of these already appear in the Meeting Calendar, others will be announced later. There will be two instrumentation workshops in the spring, tentatively devoted to the areas of digital readout and microwave instrumentation.

Program Chairman Kazanjian has issued a call for an individual in the group to serve as a photographer at the meetings and to assist the official reporter. Possession of a camera is desirable but not essential, and volunteers should contact present reporter, Les Burlingame, at LYtell 1-8461.

—LES BURLINGAME & GEORGE RAKONITZ


# Titles

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EQUAL JOB OPPORTUNITY For All Qualified Applicants

*H. John Shaw and George C. Dacey at the December joint PGMTT/PGED meeting*

MORE DIODES

band on the other side. The energy gap then acts as a barrier between states of equal energy on opposite sides of the junction. Under these circumstances conduction can take place by quantum-mechanical tunneling of electrons through the barrier.

When there is no applied voltage the forward and reverse tunnel currents are equal, resulting in no net current. When a small forward voltage is applied, the energy levels on opposite sides of the junction are shifted in such a way that the reverse tunnel current decreases, resulting in a net forward current. This forward current increases with applied voltage until a critical voltage (typically 100 mv) is reached, after which the forward tunnel current also decreases, resulting in a region of negative slope in the I-V characteristic of the diode. After passing through a minimum the forward current again rises at higher voltages due to the normal forward conduction mechanism.

Diodes can be made which exhibit this negative resistance characteristic from d-c to frequencies over $10^{11}$ cps. The small-signal equivalent circuit for a suitably biased diode consists of a negative resistance shunted by a capacitance, the combination being in series with an inductance and a positive resistance. In switching applications the switching time is determined by the product of the negative resistance and its shunting capacitance. This has been made as small as $10^{-10}$ second in practical devices with $10^{-11}$ second as an attainable limit. Work on 1000-mc computers using these switches is currently in progress. One of the most serious problems encountered is that of holding the peak current to close tolerances without excessive expense.

Microwave applications of the Esaki diode appear to be nearer to practical realization than switching applications. Oscillators have been made at frequencies as high as 103,000 mc. At 10,000 mc 1 mw has been obtained with 30 per cent efficiency. At high frequencies the designer is faced with a choice between making the diode very small, with resulting limited power output, or operating at extremely low impedance levels. Efforts have been made to overcome this limitation by making the diode junction in the form of a line instead of a spot.

To obtain stable, broad-band, unilateral gain a strip-line structure has been built with a number of Esaki diodes distributed along its length and with suitably magnetized pieces of ferrite located so as to attenuate waves traveling in the reverse direction. With this device, using five diodes, 10 db of gain has been obtained over a 2-kmc bandwidth centered at frequencies from 2 to 8 kmc.

In the question period following the lecture, Dacey discussed noise in Esaki diode amplifiers. The principle source is shot noise, and the lowest noise figures attained, about 4 db. Other topics discussed included the relative advantages of different semiconductor materials, the radiation resistance of the diodes, and the explanation of the fact that the current minimum in the characteristics of actual diodes is considerably higher than simple theory predicts.

E. F. BARNETT

## *meeting review*

### THE EARS HAD IT

Members and guests of the PGA/IRE and AES met in the Monterey room of the Sir Francis Drake Hotel in San Francisco early in December. There they enjoyed a very informative and stimulating panel discussion on a great number of aspects surrounding the past, present, and future of f-m/f-m multiplex stereo broadcasting. They also enjoyed a spirited question and answer session which threatened to extend into the early morning hours of the next day.

R. S. MacCollister, who acted as panel moderator, is the producer of the Equipment Report program on KPFA, Berkeley, and KPFK, Los Angeles. The panel members were Al Isberg, member of Panel No. 5 of the National Stereo Radio Committee and chief engineer of the office of education, North, University of California; Ed Davis, manager of KDFC-FM, San Francisco, a station now multiplexing; and Erwin Goldsmith, chief engineer of KPFA-FM in Berkeley.

Isberg led the panel discussion by reviewing the recent history of f-m multiplexing and the events leading to the FCC selection of the NSRC Committee, whose purpose is to field test and report upon the many methods of f-m stereo broadcasting that have been developed by various individuals and companies. He then listed the types of American and British stereo broadcast systems that were recently tested at Uniontown, Pa. Then, using the results of these tests, he discussed the relative merits and disadvantages of each system with respect to distortion, channel interference or separation at high frequencies, etc.

Isberg then illustrated, with color slides, some of the equipment and personnel involved in the Uniontown tests. The audience also listened to recordings of f-m stereo broadcasts actually received during these tests. It was indicated during the question and answer period that probably a year or two would elapse before an FCC decision could be reached on f-m stereo broadcasts, since the NSRC reports would have to be reviewed by companies involved in the tests and also by FCC subcommittees.

Goldsmith reviewed the local history of broadcast multiplexing and pointed out the many possible ways of multiplexing if one were to consider all the combinations of AM-FM-TV channels. He mentioned some of the problems faced by the earlier f-m/f-m stations, the lack of listener support, the complaints of interference from monophonic listeners and the technical and economic aspects of both the station and the home listener. Goldsmith suggested that part of the multiplex spectrum could be well used for 2-way group communications or remote control for satellite stations.

Davis brought up three objections to the widespread introduction of f-m/f-m stereo broadcasting at this date. Firstly, since stereo system receivers can easily be tuned to frequencies authorized for specialized services, he anticipates many legal entanglements to ensue. Second-

*(Continued on page 22)*

**The first six years** of **S**pace **T**echnology **L**eadership

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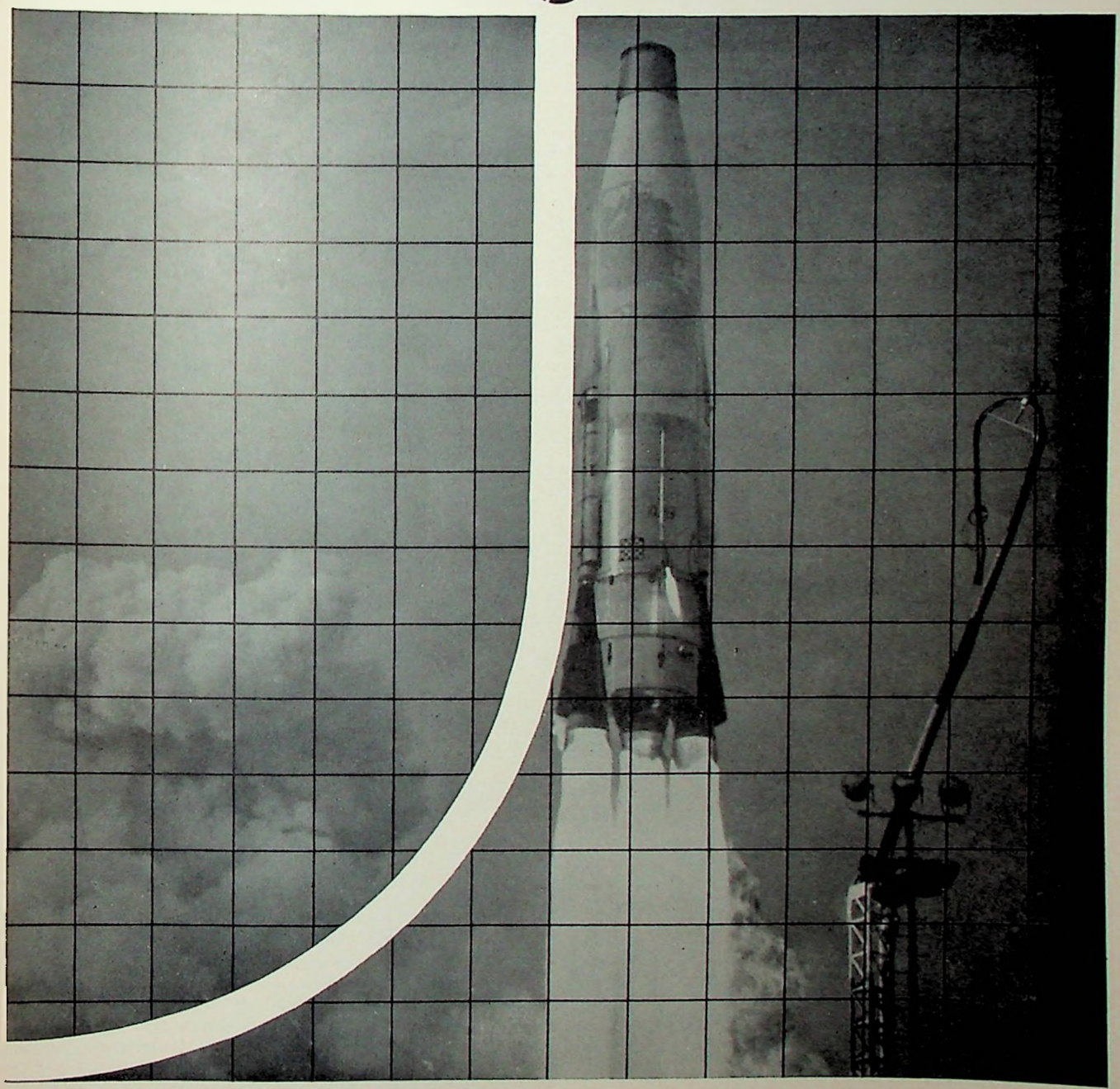

*Robert C. Douthitt*

*meeting review*

**FAST FIGURING**

Back in September, Robert Douthitt, Remington-Rand consultant for Lawrence Radiation Laboratory spoke to the East Bay Subsection on LARC: The Fastest Computer in Operation Today.

The Livermore Advanced Research Computer is considered the most advanced machine ever delivered to a customer. It was built for the University of California's Lawrence Radiation Laboratory at Livermore by the Remington-Rand Univac Division of Sperry-Rand Corporation.

The LARC system consists of two independent digital computers linked by a common high-speed bus to a magnetic-core memory.

The first computer is called the Computing Unit. It has 76 possible operations, 26 of which are addition, subtraction, multiplication, and division.

The other computer is called the Input-Output Processor. It keeps the Computing Unit supplied with new data, and it takes the answers out of the Computing Unit for dispatch to tapes, drums, line printers, cathode-ray to film devices, electronic page recorders, or any other output desired. A Dispatch Unit assists the Input-Output Processor in editing data to a form suitable for the output device selected.

An important feature of the LARC is that the Computing Unit is not slowed by input and output functions. Because the Input-Output Processor can operate independently of the Computing Unit, it can handle input and output functions and editing of raw or final data while the Computing Unit is busy with the main computation. This ability to do different operations simultaneously is one of LARC's important advantages over earlier digital computers. Incidentally, the machine is built so that a second Computing Unit can be added at any time.

How fast is the LARC? The control counter addresses the memory on a 6 microsecond cycle, although the memory has a 4 microsecond cycle time if needed. This allows the LARC to add two 11-digit numbers 125,000 times in a second. It divides two 11-digit numbers 36,000 times per second, so that the slowest function is about 180 microseconds for a divide operation.

The LARC's printer can print answers on paper at the rate of 600 lines per minute. The electronic page recorder can print 8,400 characters in about half a second. Curve plotting can be done at 5,000 points per second.

The high-speed magnetic-core memory stores 2500 words. Auxiliary memory drums can store an additional 3,000,000 words. The machine is decimal, not binary.

The circuitry of the LARC is similar to Athena in the Thor ICBM, but is two and a half times faster in operation. The LARC contains 60,000 transistors in the Computing Unit, Input-Output Processor, and Dispatch, with 20,000 transistors in the memory.

How reliable is this machine? Life test racks were set up for some of the components 4½ years ago. An extensive component evaluation program has provided a machine with parts so constructed that LARC is expected to run at least five years with less than ½ hour down-time per 12 hours operation. The maximum error rate should be three errors in 30 hours of operation during the first five year period. Although delivery of the LARC was a little late it does meet the original performance specifications drawn up five years ago. The machine is altered only ½ per cent from the original specifications.

In spite of the speed of the LARC, by 1965 the scientists of the Lawrence Radiation Laboratory expect to need another computer—one which can attain a speed many hundreds of times as fast as the LARC.

Following the paper, James A. Moore, LARC project engineer, conducted a tour of the facility.

—JOHN T. LAVRISCHEFF

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MORE STEREO

ly, multiplex stereo will not appeal to the woman in the home (the determining factor in the market for home radios) since she is too busy throughout the day to remain at a single location and thus realize the full benefits of stereophonic sound. Thirdly, the potential stereo broadcast listener will rebel at the cost of buying essentially two receivers plus a necessarily elaborate and expensive antenna system.

Bob MacCollister summed up the panel's views on stereo broadcasting, gave a technical description of the various systems which have been proposed and then opened the meeting to questions from the audience. Most of these questions were directed towards the pro and con aspects of broadcast station economics, the acceptance of stereo broadcasts by the public with respect to cost and quality of reception, and whether stereo broadcasting is yet actually technically practicable.

—STAN OLESON

*feedback*

**WESCON TURNS FANS ON**

Two months following the 1960 Western Electronic Show and Convention, a report on an independent survey at the Sports Arena in Los Angeles last August has given executives of WESCON an appraisal of views held by a wide sampling of registered attendees.

Conducted by Facts Consolidated, a well-known national firm specializing in research and market analysis, the survey returns opinions from 730 personal interviews during WESCON and replies from a mailing of 745 questionnaires.

Major findings are in the following statements from the report:

A majority of 89.6 per cent of those interviewed stated that the lectures and technical discussions serve to advance the electronic art, whereas 2.9 per cent stated a negative opinion.

A total of 57.8 per cent of respondents indicated that they either had attended or intended to attend the technical discussions; 36 per cent indicated they hadn't and didn't expect to participate.

Most of those interviewed (93.5%) agreed that the convention had served to advance their knowledge of the industry.

A majority of 89.6 per cent of the respondents stated that they thought the exhibits served to advance the electronic art.

Over 88 per cent stated that they thought the exhibits would help them with their jobs.

The reasons most often stated for the exhibits being of help were: "The introduction of new products/new applications" (33.2%), "They show us equipment we can use in research" (12.5%) and "They show the over-all state of the industry/the general state of the art" (11.9%).

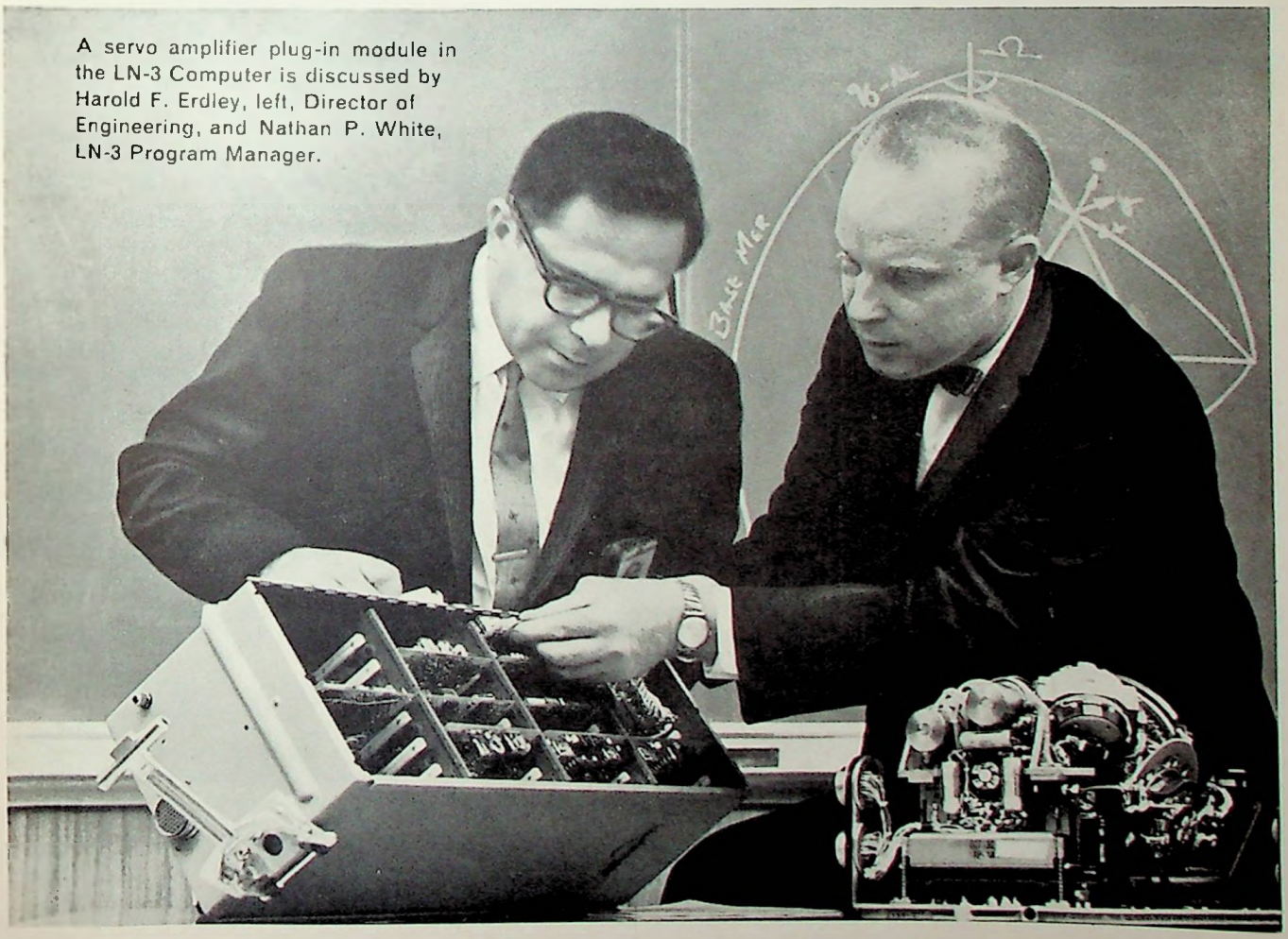
There were 405 replies from the mailing of 745 questionnaires—54.4 per cent and considered high for an elective response. Queried were individuals principally responsible for an exhibit at WESCON, from electronic manufacturers, research and development organizations, and manufacturers representatives.

# INERTIAL ENGINEERING INGENUITY

The Litton LN-3 Inertial Navigation System is a system in being. Production orders for this system to be used in the F-104 are, to the best of our knowledge, larger in number than those for any other inertial guidance system. The LN-3, consisting of a two-gyro, four-gimbal platform, computer, adapter, and controls, weighs less than 80 pounds installed. Even smaller systems, designed for orbital and sub-orbital guidance, are in development. These will weigh less than half as much as systems now in production.

Do you have experience applicable to the integration of developmental inertial guidance and computer sub-systems into functioning prototype systems? Can you evaluate performance in such systems with a view toward increasing system capabilities even further? If so, contact Mr. Donald A. Krause of our Research and Engineering Staff regarding your interests. You can share in generous employee benefits, including stock purchase and tuition-paid education plans. Relocation assistance is provided.

**LITTON SYSTEMS, INC.**
**GUIDANCE & CONTROL SYSTEMS DIVISION**
**Beverly Hills, California**



A servo amplifier plug-in module in the LN-3 Computer is discussed by Harold F. Erdley, left, Director of Engineering, and Nathan P. White, LN-3 Program Manager.

*International IRE President Ronald M cFarlan paid another visit to the San Francisco Section, attending the December OPCOM meeting, and seen here with Treasurer Süsskind, Office Manager Pacak, Region Director Carnahan, Chairman Dunn, and Section Director Morris* —Grid photo

## *grid swings*

### IT IS REPORTED

Chairman of the **WESCON** board of directors for 1961 is **Albert J. Morris,** president and general manager of Radiation at Stanford, Palo Alto. Chairman of the executive committee is **O. H. Brown,** assistant for corporate relations, Eitel-McCullough, Inc., San Carlos.

Convention director is Dr. **John V. N. Granger,** president of Granger Associates, Palo Alto, and show director is **Calvin K. Townsend,** vice-president of Jennings Radio Manufacturing Corp:, San Jose.

**Win W. Tompkins & Co.,** 3944 El Camino Real, Palo Alto, has been named technical sales reppresentatives for **National Beryllia Corporation.**

**Fred A. Speaks** has been named director of the marketing division of **Eitel-McCullough, Inc.,** San Carlos. Prior to his present appointment, Speaks served as assistant director of marketing. He joined Eimac in 1954 in research and development.

**Ross H. Snyder** has been appointed staff assistant to Speaks. Before joining Eimac, Snyder was manager of the video products department of the Ampex Professional Products Co. He is a graduate of the University of California.

*Speaks* *Snyder*

Included among the new items of business transacted in the area during December were the following: **Radiation at Stanford** (formerly Levinthal Electronic Products) received a 1.2 million dollar contract from Varian Associates for a high-power tube-testing facility to be used in connection with a new high-power klystron; **Caswell Electronics Corp.** and the **University of Michigan Research Institute** have a joint study program under sponsorship of the Rome Air Development Center to investigate possible uses of ferro-electric materials in microwave devices; **Eitel-McCullough, Inc.** has received new orders totaling 1.3 million dollars from the Air Force for delivery over the next eight months from both San Carlos and Salt Lake City plants; **Fairchild Semiconductor Corp.** has a 1.4 million dollar order for high-reliability transistors from Autonetics Division of North American Aviation; and **Ampex Data Products Company** has orders for $600,000 worth of digital tape handling equipment from Ferranti of England and $552,000 worth from Olivetti of Italy.

**Alfred Electronics,** now located at 897 Commercial St., has started a new 32,000 sq ft factory and administration building on a four-acre site in Stanford Industrial Park, Palo Alto.

Promotion of **Clarence E. Elkins** to senior project engineer for **Lynch Communications Systems Inc.,** has been announced. Elkins joined Lynch after receiving his BSEE degree in 1958 from the University of California.

Dr. **E. Ackerlind** has joined the research and development staff of Lynch. He is an electronics design engineer and consultant who has held positions in Radio Corporation of America, Jet Propulsion Laboratory of the California Institute of Technology, Northrop Aircraft, and the Naval Research Lab.

**Radiation Incorporated** has announced a change in the name of its subsidiary, **Levinthal Electronic Products, Inc.,** to **Radiation at Stanford,** which will remain a subsidiary of the parent company. It will combine the activities of Levinthal Electronic Products, Inc. of Palo Alto and Radiation's space communications division presently at Mountain View. The company's Palo Alto facilities will be expanded to accommodate the Mountain View division, as well as increased Western operations.

**Varian Associates** has created a new department to concentrate on military applications of magnetometry, called the military magnetics department. The new unit will be managed by **Norman Hiestand,** formerly chief product engineer for Varian's instrument division. In addition, several experienced Varian scientists will have key roles. These include Dr. **James Arnold,** applied research; Dr. **Jean Rabier,** systems engineering; and **T. L. Allen,** magnetometer engineering.

**Weinschel Engineering,** Kensington, Maryland, has appointed **Kelly Byler** of **Astroel, Inc.,** 755 Mercy Street, Mountain View, as engineering representative.

**James F. Campbell, Jr.,** has joined **Fairchild Semiconductor Corp.** after receiving a PhD in physics from the Massachusetts Institute of Technology. He is a member of the research and development technical staff in the micrologic section.

**L. J. Kabell** has joined Fairchild to head a new section on electro-optical devices. Kabell came to Fairchild from Stanford Research Institute in Menlo Park, where he was a senior research engineer in the graphic sciences lab.

**Arjun N. Saxena** joined the research and development laboratories as a member of the physics section's technical staff. Saxena, a native of Lucknow, India, received his BS in physics, chemistry and mathematics from Lucknow University in 1950, and an MS in physics from the same University in 1952.

The Boards of Directors of **Varian Associates** and **Eastern Industries, Inc.** have announced the preliminary basis for a merger of Eastern into Varian. The plan is that one share of Varian would be issued in exchange for three shares of Eastern.

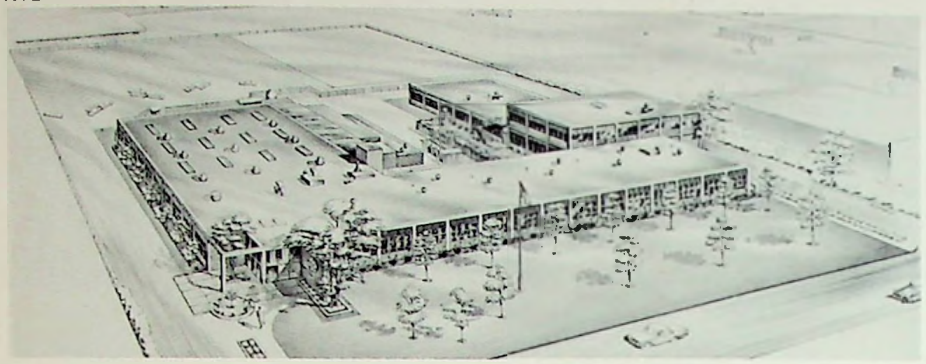
In San Francisco, SMPTE (Society of Motion Picture and Television Engineers) has elected new officers: **Donald E. Anderson,** KRON-TV, chairman; **Clifton R. Skinner,** Skinner, Hirsch & Kaye, San Francisco, secretary-treasurer; and members of the board of managers: **W. A. High,** Oakland Junior College; **Stewart A. Macondray** and W. A. **Palmer,** both W. A. Palmer Films.

**Components for Research, Inc.,** Palo Alto manufacturer of ultra-high-voltage insulating components, announces the appointment of **Harold Deck** to the post of design engineer for specialty transformers.

Most recently active in the design and construction of specialized geophysical equipment, Deck has, in the past, been employed by Hill Transformer Co., Engineered Instruments, Inc., Imperial Geophysical Survey, and General Electric Company.

*(Continued on page 26)*

*Harold Deck*



*This is how the GE Stanford Industrial Park plant will look on completion of building program*





**General Electric Co.** has announced that it has awarded a $141,000 contract to Howard J. White, Inc., Palo Alto, for construction of an 8,000 sq ft single-story addition to its electronics plant at 601 California Avenue. Completion is scheduled for May, 1961.

**Bernard L. Pfefer,** previously manager of product planning in the light military electronics department, Utica, New York, becomes head of a new product sales planning operation for microwave tubes and devices in Palo Alto.

In a major reorganization of the laboratory, which was formerly an engineering section of the company's power tube department based in Schenectady, the facility has been made a separate product section of the department and renamed the traveling-wave tube product section. Dr. **Chester G. Lob** has been named manager. Lob, a native of New Orleans, first joined General Electric in 1951, having been a development engineer with RCA and a research associate at the University of Illinois, while studying for his doctorate.

*Lob* *Evans*

**John T. (Jack) Evans** has been named sales manager of the **Delcon Corporation.** He has been with the Alpha Corporation, a division of Collins Radio; Minnesota Mining and Manufacturing Corp.; and Beech Aircraft Corp.

At **Microwave Electronics Corporation** two new engineering section heads have been appointed: Dr. **Robert W. De Grasse** and Dr. **William E. Waters.** De Grasse came recently from Murray Hill, N.J. where he was a member of the technical staff of Bell Telephone Laboratory and associated with the Echo I program. A graduate in EE from CalTech, he spent two years with JPL and was a research assistant in the electronics research laboratories at Stanford, where his MS and PhD degrees were awarded. He is a member of Sigma Xi.

Waters has been with the National Bureau of Standards where he did research and development on microwave tubes for use in guided missiles, and Diamond Ordnance Fuze Laboratories where he was active in the development of microwave oscillators for proximity-fuze transmitters. A native Kentuckian,

Waters has a BS in electrical engineering and an MS in physics from the University of Kentucky. His doctorate is from the University of Maryland. His memberships include the American Physical Society, the American Association for the Advancement of Science and the Federation of Atomic Scientists.

Scheduled for participation in a symposium on Thermoelectric Energy Conversion in Dallas, Texas, January 9-12 were **Kurt Hubner** and **William Shockley** of Shockley Transistor; and **William Parker,** USNRDL, San Francisco.

Financial matters reported by members of our local industrial community include the following: **Beckman Instruments, Inc.** reported record sales and earnings of $54,257,282 and $3,092,915 respectively for the fiscal year ending last June 30, compared with sales of $44,872,768 and earnings of $1,771,689 for fiscal 1959, and per-share earnings up to $2.24 from $1.30; **Litton Industries'** first quarter sales came to $52,111,000 from $36,435,000 for the same period last year—a 43 per cent increase, with a 40 per cent increase in net earnings — $2,150,000 compared to $1,537,000 and per-share earnings up to 50 cents from 40 cents; **Varian Associates** showed a sales increase of 21 per cent and an earnings increase of 11 per cent from figures of the fiscal year ending September 30—sales $46,482,031 from $38,483,543 and income $2,861,886 from $2,580,340, and per-share income up to 85 cents from 82 cents.

The **Van Groos Co.,** Los Altos, announced the recent staff addition of **Bob DeLapp,** a specialist in electronic test instrumentation, and most recently supervisor at the Lockheed-Sunnyvale measurements standard laboratory. He is membership committee chairman of the Precision Measurement Society in the Bay Area.

**Chemprint Corporation** has begun production of printed circuits at its 23,000-sq-ft Menlo Park headquarters plant. Chemprint Corporation, operating with a staff of 25, expects to have a full staff of 120 within the next few months.

Before founding Chemprint Corporation, **G. M. Howard,** president, was owner and manager of G. M. Howard & Associates of San Francisco. **Richard J. Kuri,** vice president and general manager, was with Litton Industries in Los Angeles.

**Willis M. Hawkins,** who had a major part in the design and development of some of America's most important missile and space programs, has been

*(Continued on page 28)*

MORE SWINGS

appointed a vice president of **Lockheed Aircraft Corporation,** the second corporate officer assigned to Lockheed's missiles and space division in Sunnyvale.

Dr. **Francis S. Johnson, Lockheed missiles and space division** physicist, was among 25 scientists recently appointed as consultants to the National Aeronautics and Space Administration. Johnson, manager of Lockheed's space physics research, was the only scientist selected from private industry. He will serve on the ionospheric physics panel.

**Neely Enterprises** has added **Peter W. Bauer,** assigned as staff engineer, to its San Carlos office. Bauer holds a BA degree from San Jose State College and a BS degree in electrical engineering from California State Polytechnic. **Benjamin L. Holmes,** holder of a BS in applied physics from the University of California at Los Angeles, has been assigned to handle the Neely Mobile Lab activity.

**Philco Corporation** has established two special departments for space-age activities. One, the surface electronics department, headed by **Frederic N. Barry,** is intended expressly to design and fabricate ground equipment for satellite programs; while the other, the vehicle electronics department, headed by **Louis A. G. ter Veen** is to specialize in the design and development of spaceborne electronic equipment. Barry was in charge of the original development and design programs which administered the Courier satellite program at the Western Development Laboratories, while ter Veen has been for the past four years a consulting scientist and manager of automatic data processing and checkout equipment development for Lockheed Aircraft missiles and space division.

Other personnel appointments at Philco's Palo Alto facilities include **John A. Blickensderfer** appointed as an engineering specialist, **Edward C. Buurma** as northwest regional manager, and **Richard H. Tibbits** as engineering specialist. Blickensderfer has a BE in electrical engineering from the University of Southern California and MS and PhD degrees from Stanford in electrical engineering. He has been a research associate at Stanford and has been with Stanford Research Institute and General Electric Co. Buurma is a native of Chicago, holding a BS degree from the University of Illinois. He has been associated with TWA, RCA, MMM, and Anaconda Wire and Cable. Tibbits attended UCLA receiving an MA in mathematics. He has been with Northrop Corp. until this year.

**Ernest Iufer,** one of the U.S. Navy's experts in the field of degaussing, has joined the electronic systems division of **Dalmo Victor Co.** He brings to the position of senior project engineer nine years' experience as chief engineer of the Naval Degaussing Station, Kingston, Washington. He attended Oregon State College and University of Basle, Switzerland. He is a member of the National Association of Naval Technical Supervisors.

**Sylvania Electric Products, Inc.** made several new appointments in the electronic defense laboratories, Mountain View. They were: **Raymond E. Franks** from advanced development engineer to engineering specialist (broadband antennas); **Harold A. Judy,** formerly an engineer-in-charge, to head of the receiver section (advanced receivers for electronic countermeasure systems); and Colonel **Francis N. Miller,** U.S. Army Signal Corps, (ret), formerly chief of staff at the U. S. Army Proving Ground, Fort Huachuca, Arizona, to head of the field engineering section.

*Franks*

*Judy*

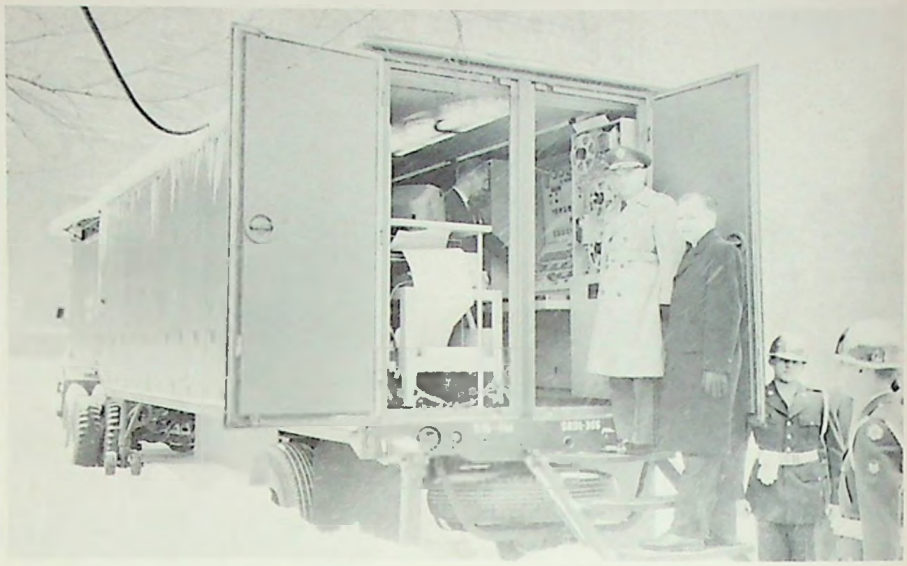
*Miller*

*Brooks*

Election of **Rex E. Brooks,** formerly national sales manager, to the newly created position of vice president for sales and advertising at **Electro Engineering Works** has been announced. Brooks joined Electro Engineering Works in 1951 after graduating from the University of California.

**Carad Corporation** of Redwood City has moved its headquarters to a new building in Stanford Industrial Park, Palo Alto. In addition to serving as home office of the corporation, the new facility will provide 20,000 sq ft of production space.

*(Continued on page 30)*



*For any eastern expatriates, this is what the December New York blizzard looked like, appropriately swirling about the Sylvania mobidic mobile digital computer—ruggedized for severe environmental operation. Entering, Brig. Gen. J. C. Monahan, chief of the Signal Corps research and development division; and Henry Lehne, Sylvania vice president*

**Deere Electronics, Inc.** 1575 Laurel Street, San Carlos, has been appointed representative for PCA Electronics, Inc. The representative firm is headed by **Jerry Deere** and **Dan Smith.**

**Lenkurt Electric Co., Inc.** has sent **Gerd D. Wallenstein,** vice president, product planning, to the second plenary meeting of the International Telegraph and Telephone Consultative Committee (CCITT) at New Delhi, India, where he will represent GT&E's U. S. telephone operations. Lenkurt and VHM Corp. of Oakland have signed a license agreement under which the latter will manufacture and market six different types of advanced electronic test equipment developed by Lenkurt.

**Herbert K. Krengel** has been appointed commercial marketing manager of Lenkurt, San Carlos. Krengel has been with the firm since 1950, when he was appointed as an applications engineer.

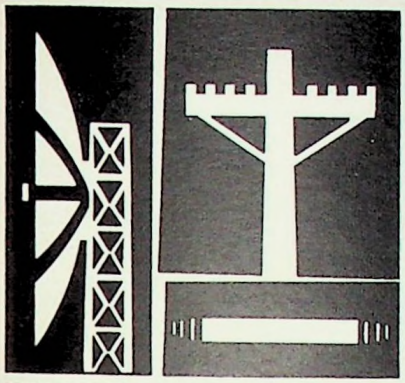
**Berton E. Dotter, Jr.,** has joined Lenkurt Electric in San Carlos as a senior electrical engineer in government systems engineering.

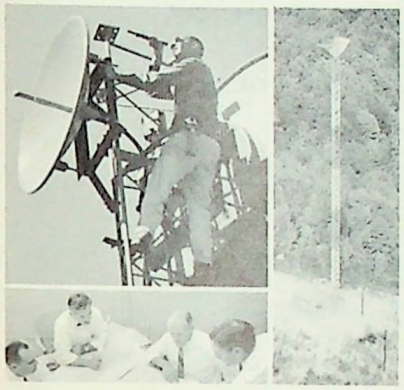
He formerly was with General Telephone Co. of California, Los Angeles. Both firms are subsidiaries of General Telephone & Electronics.

*(Continued on page 32)*

*Dean Watkins, Provost Terman, Mrs. Terman, Bill Hewlett, and Richard Johnson engage in earnest conversation at a recent open house celebrating completion of unit two of the Watkins-Johnson plant in Stanford Industrial Park*

# COMMUNICATIONS ENGINEERS





Lenkurt Electric Company, Inc., the world's major specialist in multiplexing and microwave radio systems for telephone, telegraph, and high speed data transmission offers outstanding opportunities for microwave engineers. Communication in the microwave spectrum is playing a greater and greater part in long distance transmission. If you have experience in video amplifiers, broadband IF circuits, microwave test and design techniques, an understanding of semi-conductor applications in the microwave region, and a B.S. degree or higher, Lenkurt, the recognized leader in long distance transmission invites you to join its family of communications experts. Top salary, liberal fringe benefits, including stock purchase plan and outstanding education refund plan, and relocation expenses are guaranteed for selected engineers. Lenkurt's modern engineering labs are located on the sunny San Francisco Peninsula.

Of further interest to us are mechanical engineers who have had experience with the mechanical design of microwave components and the latest processes for the fabrication of such devices. New production techniques play a prominent part in the overall program.

Also, other engineering open. Send resume or call collect.

**E. Jack Shannahan, Employment Manager • Lenkurt Electric Co., Inc.**
**1105 County Road • San Carlos, California • LY 1-8461, ext. 281**

## *LENKURT ELECTRIC*

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MORE SWINGS

**John C. Beckett** has become general manager and chief engineer of **Palo Alto Engineering Company**. Prior to this Beckett was chief engineer for Wesix Electric Heater Company in San Francisco, a post he had held since 1945.

**Harold Lakin** has joined the staff of **Litton Industries'** electron tube division as a production engineer in the crossed-field department. Lakin has 11 years experience in the design, development, and production of microwave tubes. He most recently was head of fabrication design for Eitel-McCullough, Inc.

**Roy E. Woenne,** who has been manufacturing director of the division, has been named vice-president and technical director of Litton World Trade Corp., with headquarters in Zurich, Switzerland. Woenne joined the original company bearing the Litton name as its first employee on May 1, 1935, while a student at San Mateo College.

Dr. **Gerald E. Pokorny** has joined the San Carlos staff as a senior scientist in the research laboratory. For the last seven years, Pokorny has been section chief of the United States Army Signal Corps microwave research section, Fort Monmouth, N.J.

**Don O. Horning** of Berkeley has been appointed general chairman of the 1961 Bay Area Committee for Engineers' Week, the San Francisco Engineering Council has announced.

Ten high school science and mathematics students will compete for the Engineers' Week scholarships, drafting sets, and slide rules—winners to be announced at the annual Engineers' Week banquet at the Sheraton-Palace Hotel, February 23. Contestants are as follows: Tamalpais Union High School, **Dean Bandes;** Lowell High School, **David W. Kuperstein;** San Mateo High School, **Thomas F. Mitchell;** Carlmont High School, **Douglas M. Campbell;** Tennyson High School, **George F. Ray;** Piedmont High School, **Stephen H. Garrison;** Oakland High School, **David Weinstein;** Las Lomas High School, **Don Cook Jensen;** Benicia High School, **Charles Edward Kimble;** De Anza High School, **David L. Corl.** Selections were made by the following zone chairmen of the scholarship committee for Engineers' Week.

Mill Valley, Novato, Petaluma — **Dion Ramsey-Raisin;** San Francisco — **Robert C. Peterson;** San Mateo, Burlingame, Half Moon Bay—**D. E. Callis;** San Carlos, East Palo Alto—**Allen Lee;** Livermore, Fremont, Castro Valley — **Professor L. London;** Alameda, Hayward —**James Wilson;** Oakland—**J. Elmer;** Orinda, Walnut Creek—**Roger R. Riley;** Antioch, Pittsburgh, Martinez—**G. Borna;** and Berkeley, Richmond — **Wilson S. Pritchett.**

*events of interest*

## IRE MEETINGS SUMMARY

February 1-3—**1961 Winter Convention on Military Electronics.** Biltmore Hotel, Los Angeles, Calif. Dr. John Myers, Hoffman Electronics Corp., 3717 S. Grand Ave., Los Angeles, Calif. Local participants include Dr. William Shockley, Shockley Transistor Corp.

February 15-17—**1961 International Solid-State Circuits Conference.** University of Pennsylvania—Sheraton Hotel, Philadelphia, Penna. Lewis Winner, 152 West 42 Street, New York, N.Y. (Local participants include: David F. Allison, Robert H. Beeson, Victor H. Grinich, David Hilbiber, James Nall, Robert Schultz, and Robert L. Trent, Fairchild Semiconductor Corp.; Russell B. Riley, Hewlett-Packard Co.; Hewitt D. Crane and Edwin K. Van De Riet, Stanford Research Institute; and J. Gibbons and M. M. McWhorter, Stanford University.)

March 20-23—**1961 IRE International Convention.** Waldorf-Astoria Hotel and New York Coliseum, New York City.

## NON-IRE EVENTS

January 19—Northern California Section, **American Society of Lubrication Engineers:** "What and Why of Ashless Detergent in Motor Oil," by F. A. Christiansen, California Research Corporation, Richmond. Spengers Fish Grotto, foot of University Avenue, Berkeley. Social hour, 6:00 P.M., dinner 7:00 P.M.

January 24—Peninsula Chapter, **California Society of Professional Engineers:** "An Eyewitness Account of the Chilean Earthquake Damage," an illustrated report on behalf of the National Science Foundation, by Karl V. Steinbrugge, P.E., chief structural engineer, Pacific Fire Rating Bureau. Benjamin Franklin Hotel, San Mateo. Dinner 7:00 p.m. (no reservations required); program 8:00.

January 28-30—**The University of California's Medical Center and University Extension and the Schering Foundation:** "Control of the Mind," a symposium of the world's foremost medical scientists and men of letters. Participants will include Aldous Huxley, Arthur Koestler, H. Stuart Hughes, Harold D. Lasswell, and others. Further information may be obtained from the Department of Continuing Education in Medicine, University of California Medical Center, San Francisco 22, California.

## IRE PAPERS CALLS

**January 30**—100-word abstracts on Electronic Data Processing and Space Technology for 15th Annual Spring Technical Conference, Cincinnati Section IRE and American Rocket Society (Cincinnati, Ohio, April 12-13, 1961).

Send to: C. Farrell Winder, Papers Chairman, Cincinnati Section IRE, Baldwin Piano Company, 1801 Gilbert Ave., Cincinnati 2, Ohio.

**February 1**—750-word abstracts with biographical sketch of the author, both in triplicate, for the 5th National Convention on Military Electronics (MIL-E-CON 1961, Washington, D.C., June 26-28, 1961). Send to: Harry Davis, SAFRD, the Pentagon, Washington 25.

**February 15**—50 to 100-word summaries of approximately 2500-word papers (the latter not required until time of presentation), in triplicate, for the Chicago Spring Conference on Broadcast and Television Receivers (Des Plaines, Illinois, June 15-16, 1961). Send to: Neil Frihart, Motorola, Inc., 4545 W. Augusta Blvd., Chicago 51.

## *advanced education*

### BACK TO SCHOOL

A broad range of courses offered by University of California Extension will be available to electrical engineers beginning in February. Professional level courses will include Wide-Band Amplifiers, Feedback Control Systems, Analysis of Transistor Circuits, Design and Components of Digital Computers, and Infrared Systems.

Microwave Antenna Design—Reflector Design Theory, a revised version of an earlier course, will be offered for the first time with professional-level credit.

New mathematics and statistics courses include Partial Differential Equations, Matrices and Vector Spaces, and Methods of Probability Theory, a systematic development of the concepts and facts of probability theory needed for the technical treatment of statistical communications problems. Topics will include continuous-time stochastic processes and spectral analysis.

Other courses in electrical engineering will include: Electromagnetic Fields and Waves, Linear Systems Analysis, Microwave Measurements, Basic Transistor Analysis and Circuitry, Engineering Electronics, Solid-State Electronic Devices and Microsecond-Pulse Techniques. A related physics course will be Introduction to Atomic Structure.

These and numerous other courses will be offered in Bay area locations including Mountain View, Redwood City, San Francisco, and Berkeley. Details of their scheduling may be obtained from the Engineering and Sciences publication for Peninsula classes, or the Engineering and Sciences catalogue. For additional information, contact Engineering and Sciences Extension, University of California, 2451 Bancroft Way, Berkeley 4, TH 5-6000, Ext. 2251.

*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:

Rudi E. Albrecht
William W. Anderson
Erling N. Bellond
Larry M. Cohen
Joseph A. Conn
George R. Cook
Donald J. R. Cormier
Sterling W. Davis
Richard O. Fimmel
Lionel L. Fray
John H. Gamble
Henry C. Gammell
Bernard R. Gandler
William Halpern
Georg M. Herzfeld
Kay Mane L. Hing
Dale Horelick
Ronald B. Keeney
Richard T. Lacoss
John R. Lake
Alan E. Lebel
Billy G. Link
Gary E. Lykins
Julian P. Masterson
Warwick D. Musson
Willard F. Palmer
Dayle A. Parkes
Robert H. Pfeil
Lloyd L. Philipson
David E. Reynolds
Robert G. Rose
Douglas H. Turner
George W. Washburn
Iram J. Weinstein
Le Roy D. Yancey

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

Alexander F. Amberson
Robert L. Annett
Jeff R. Bailey, Jr.
Robert B. Barnett
Otto Biscevic
Gene D. Blauder
Mark S. Blumberg
Dimitry A. Bobrott
Jean F. Bodine
William N. Bogle
Arthur J. Brodersen
James A. Brush
Fletcher J. Buckley
John H. Buerfeind
William W. Bullard
Steven J. Burks
Jerome L. Burroughs
Joseph V. Campagna
Mark D. Capitolo
Wayne Carey
Lee W. Carrier
Frank W. Cervenka
Robert L. Chang
Philip W. Cheney
Hua-Thye Chua
William A. Clark
David A. Coats
Wm. N. Compagno, Jr.
John N. Cooper
Gerald A. Coquin
Gary E. Cromer
William C. Cutler
Vytautas J. Danis
Stephen J. De Armond
William E. Devereau
John T. Donohue
John S. Dour
James H. Eaton
Thomas F. Egan
David K. Fibush
Lyle W. Finn
Donald J. Flynn
Barry L. Foley
Kuey Fong
George F. Fredrick
Joseph F. Fry
Michael D. Gainey
James B. Gambrell
Michael J. Gans
Carl W. Geist, Jr.
Michael Gemperle
Ronald C. Given
Frederick W. Glaeser
Kurt E. Golden
Pong N. Lem
Gordon K. K. Leong
Robert Leong
Thomas H. Le Vasseur
Robert S. Lewis
Wesley N. Lindsay
Alec G. Little
Robert W. Lotz
Francis Lum
Noel P. Lyons
Bill A. Maasberg, Jr.
Frederick W. Macondray
James M. Maley
Gene R. Marcum
Francis Mark, Jr.
Robert L. Martin, Jr.
Raynard E. McCormick
Joseph D. Meurrens
Robert J. Millord
Stanley K. Miyashiro
Thos. O. Monaghan, Jr.
William W. Moulden
Larry E. Mullinix
Hiroyuki Nagata
Sadaaki Nanai
Thomas C. Nelson
Bruce H. Nesbit
Junji Nishikawa
Toshimitsu Nishimura
William F. Oliver
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Takao Ozawa
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William A. Rawlings
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*(Continued on page 38)*

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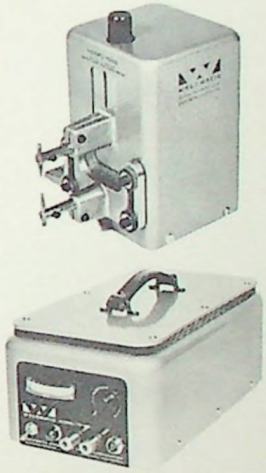

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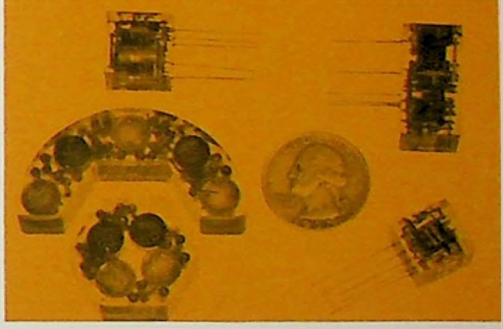

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| Leland E. Leisz | Harvey Yee |

Paul P. J. Yeh

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

### MEMBER

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| Richard C. Bitgood | Le Grande O. Hatfield |
| Howard Z. Bogert | Lawrence R. C. Hawley |
| Jack E. Bresenham | Bernhard F. Henschke |
| George B. Carpenter | Howard T. Humphrey |
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| John P. Dirksen | Richard E. Monnier |
| Jordan J. Dobrikin | Robert W. Newcomb |
| Donald L. Epley | James L. Palmer |
| Charles G. Ernst | Andy M. Prophet |
| Curtis Franklin, Jr. | Nicholas S. Szabo |
| Douglas A. Gray | Gordon B. Vail |

### ASSOCIATE MEMBER

James G. Kahle

---

*the recruitment picture*

**OCTOBER?**

The demand for engineers and scientists continued to climb in October, according to Deutsch & Shea, Inc., technical manpower consultants. The Engineer/Scientist Demand Index developed by the firm up to 116.2, almost 10 per cent above the September figure. This rise, according to company spokesmen, reflects sharply increased newspaper classified advertising by firms seeking professional men and may indicate increased urgency in the search for technical personnel.

The Engineer/Scientist Demand Index is based on information supplied by 27 newspapers in major market areas throughout the country, and by 16 technical journals in key technical fields.

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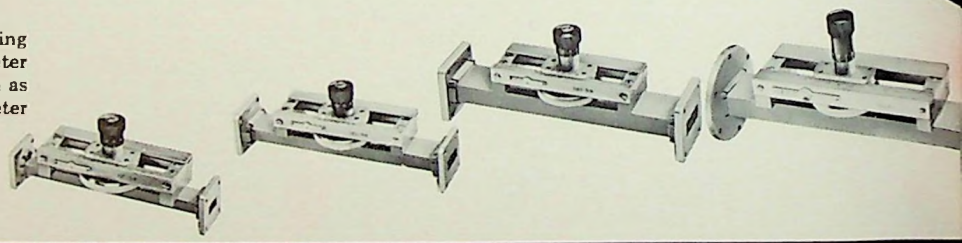

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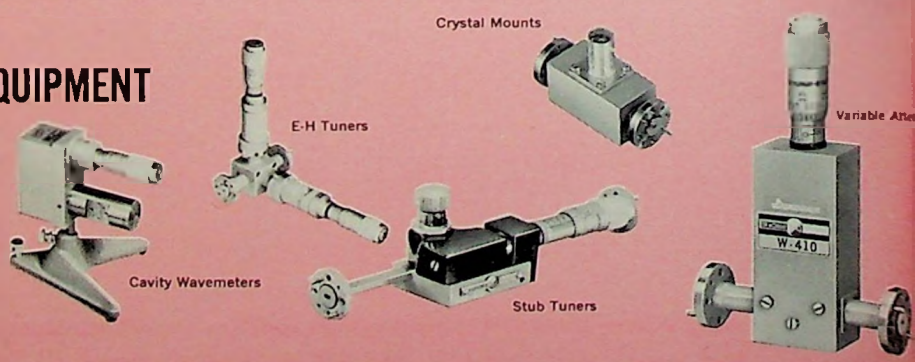

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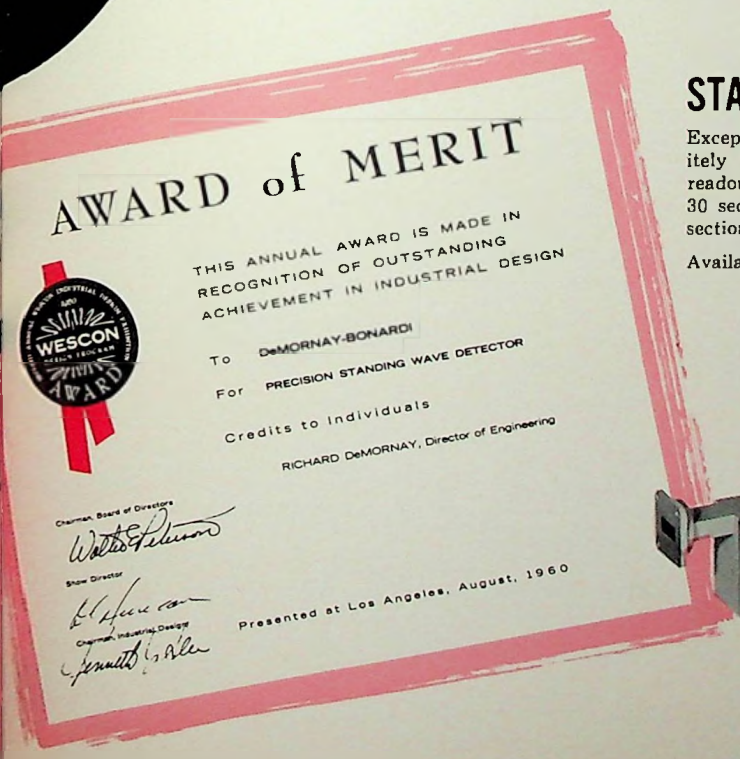


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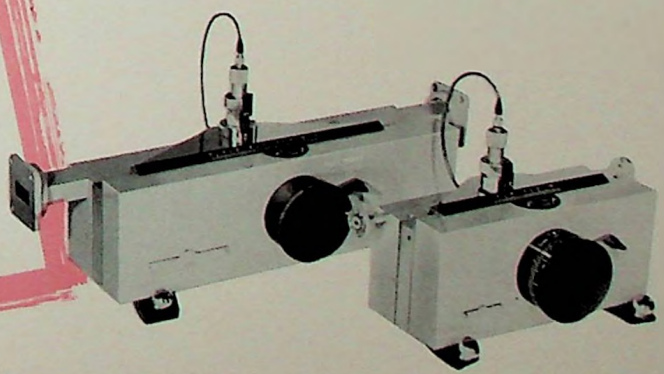

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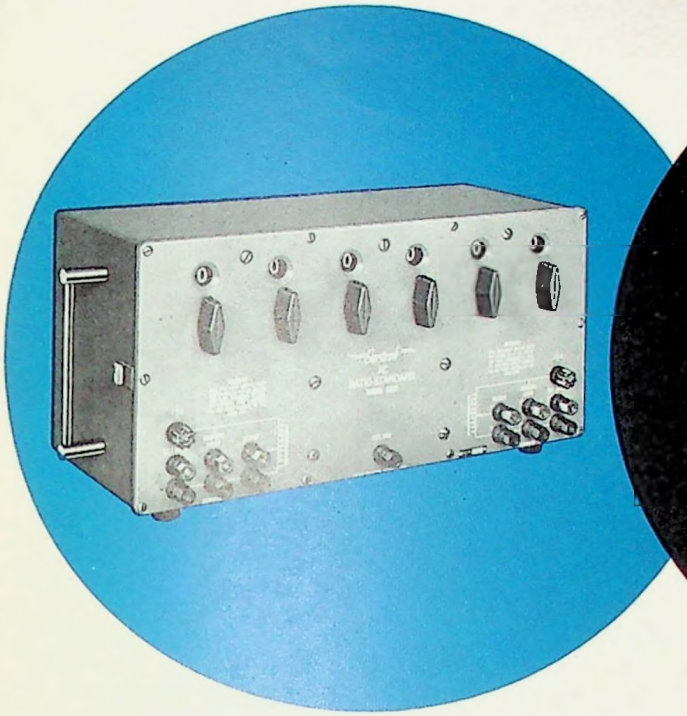

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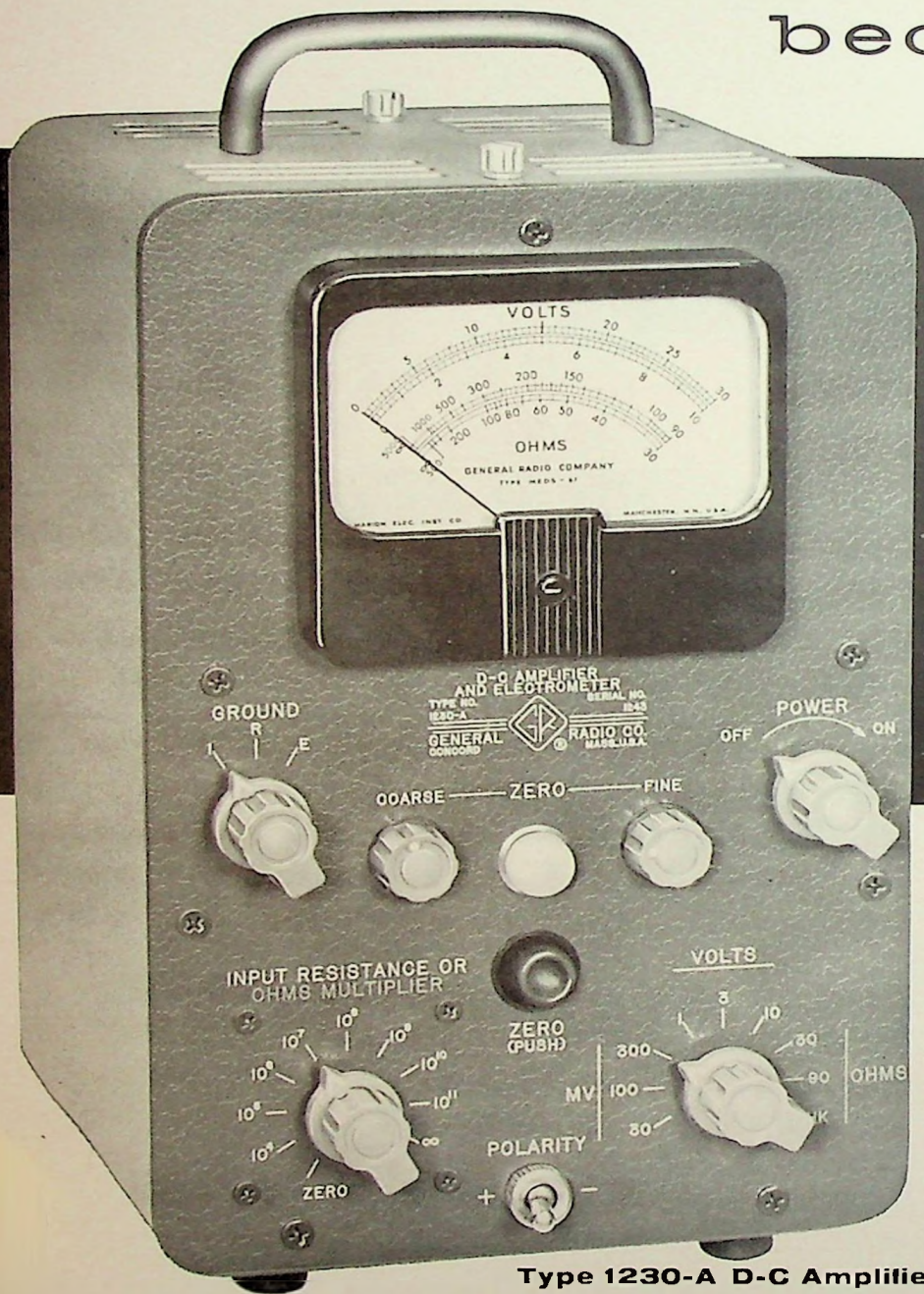


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**...it can also be used as a d-c amplifier with a current gain of over 16 x $10^9$ . . . use it as a "front end" to drive recorders and other instruments**

- ✓ True direct-coupled amplifier design — no choppers, vibrators, or reeds to give mechanical trouble or get out of adjustment.
- ✓ High input resistance: 100 mega-megohms — does not load down sensitive circuits. Input resistance can also be set by switch to other values from $10^4$ to $10^{11}$ ohms.
- ✓ Constant low voltage across unknown (9.1v) — no need for voltage coefficient corrections when making high resistance measurements.
- ✓ Output for 5-ma recorders.

**Type 1230-A D-C Amplifier and Electrometer....$440**

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