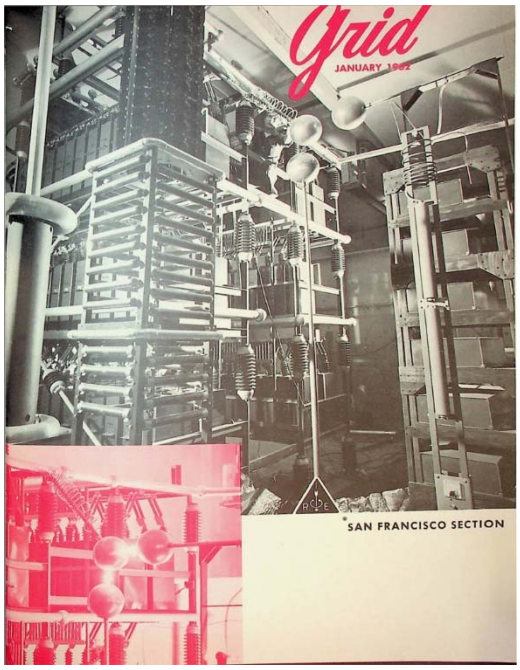
EDITOR'S PROFILE of this issue

from a historical perspective …

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



January, 1962:

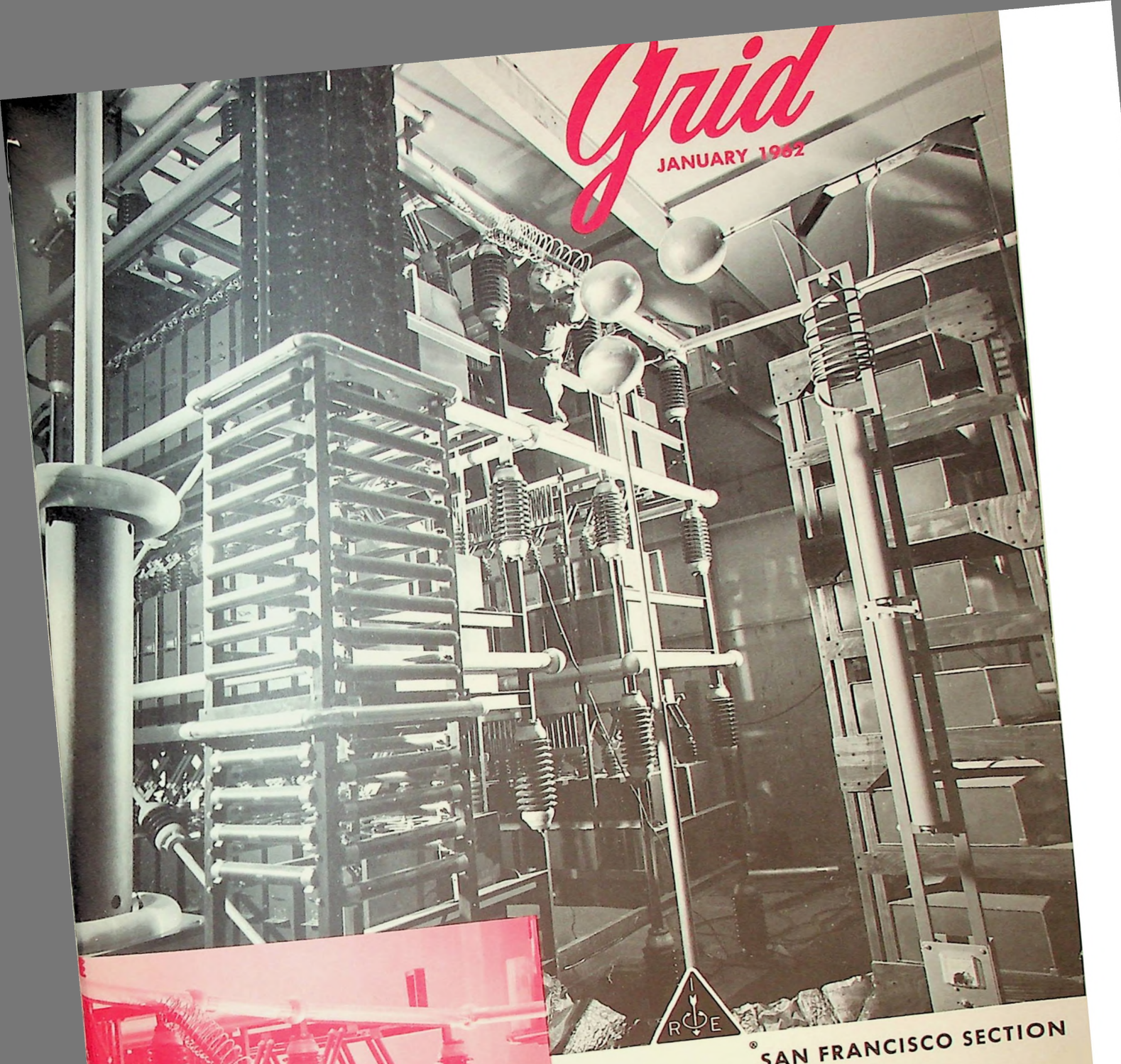
Cover: This is the crowbar protecting the 400 mc (MHz) 100,000-watt micro-second transmission pulse; the inset shows a pulse discharge. Made by Radiation-at-Stanford, it is part of the transmitter being installed at the 1,000-foot dish antenna in Arecibo, Puerto Rico. The output klystrons operate at 110,000 volts. It is further described on page 14.

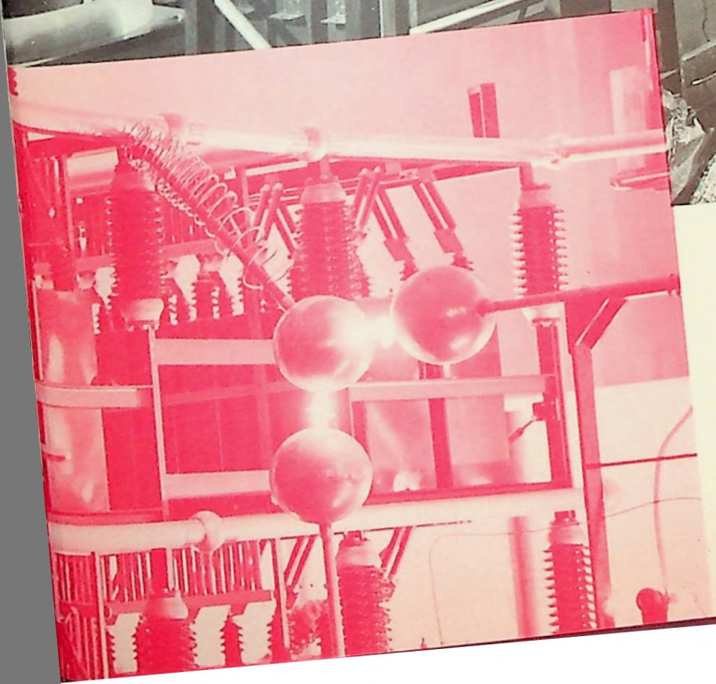
p. 22: Wolfgang Panofsky, a physicist at Stanford, is named director of the 2-mile-long linear accelerator project behind the campus; Ed Ginzton will continue as a consultant.

p. 22: Thomas Peterson of Cleveland, Ohio, gives $230,000 to Stanford to fund a materials science laboratory, which is then named after him; his company has set up a branch in the Stanford Industrial Park. I spent many hours in the classrooms and labs there as both a Teaching Assistant and a Graduate Assistant (helping PhD students with experiments and analysis) while working on my masters degree in Materials Science.

Grid

JANUARY 1962





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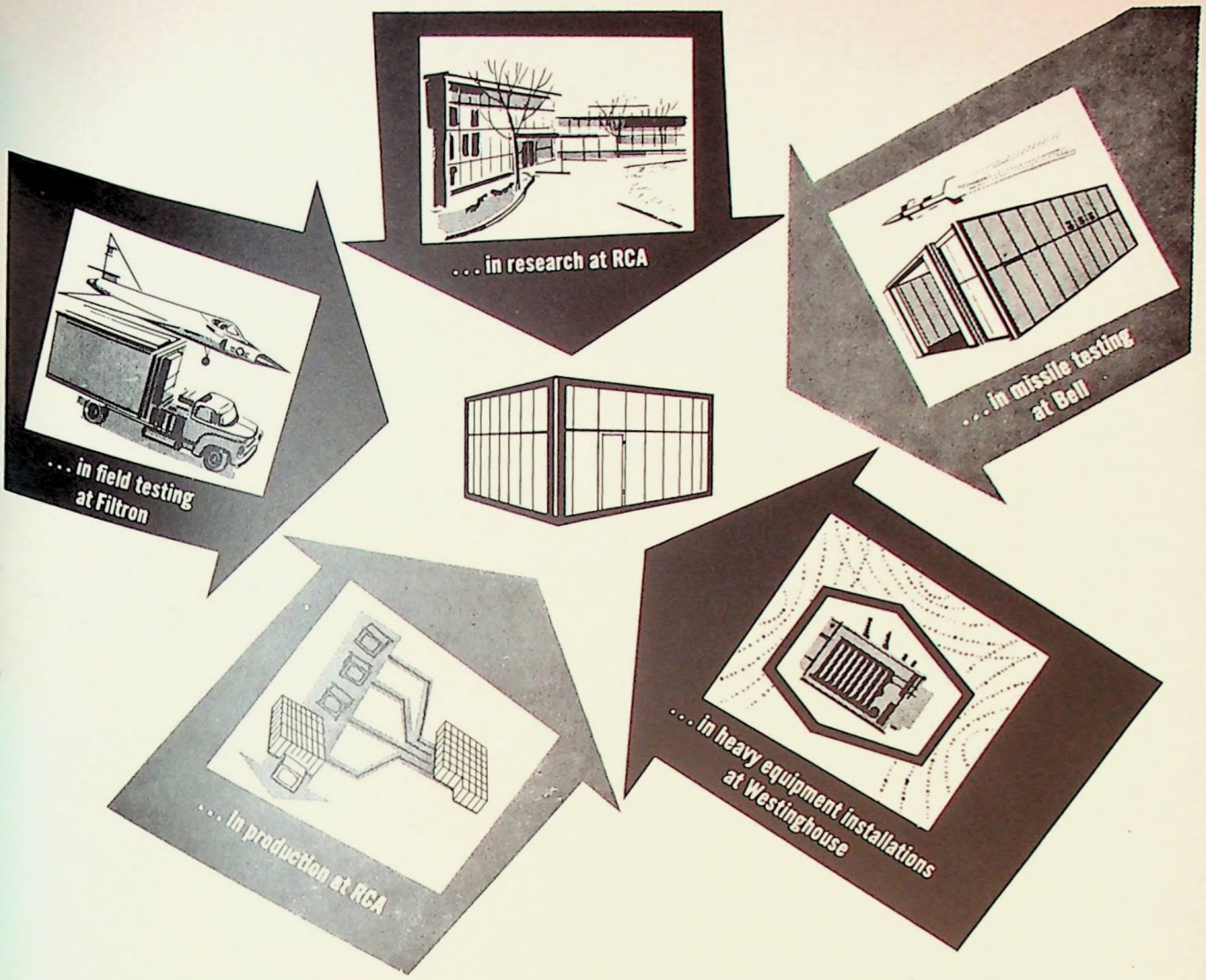

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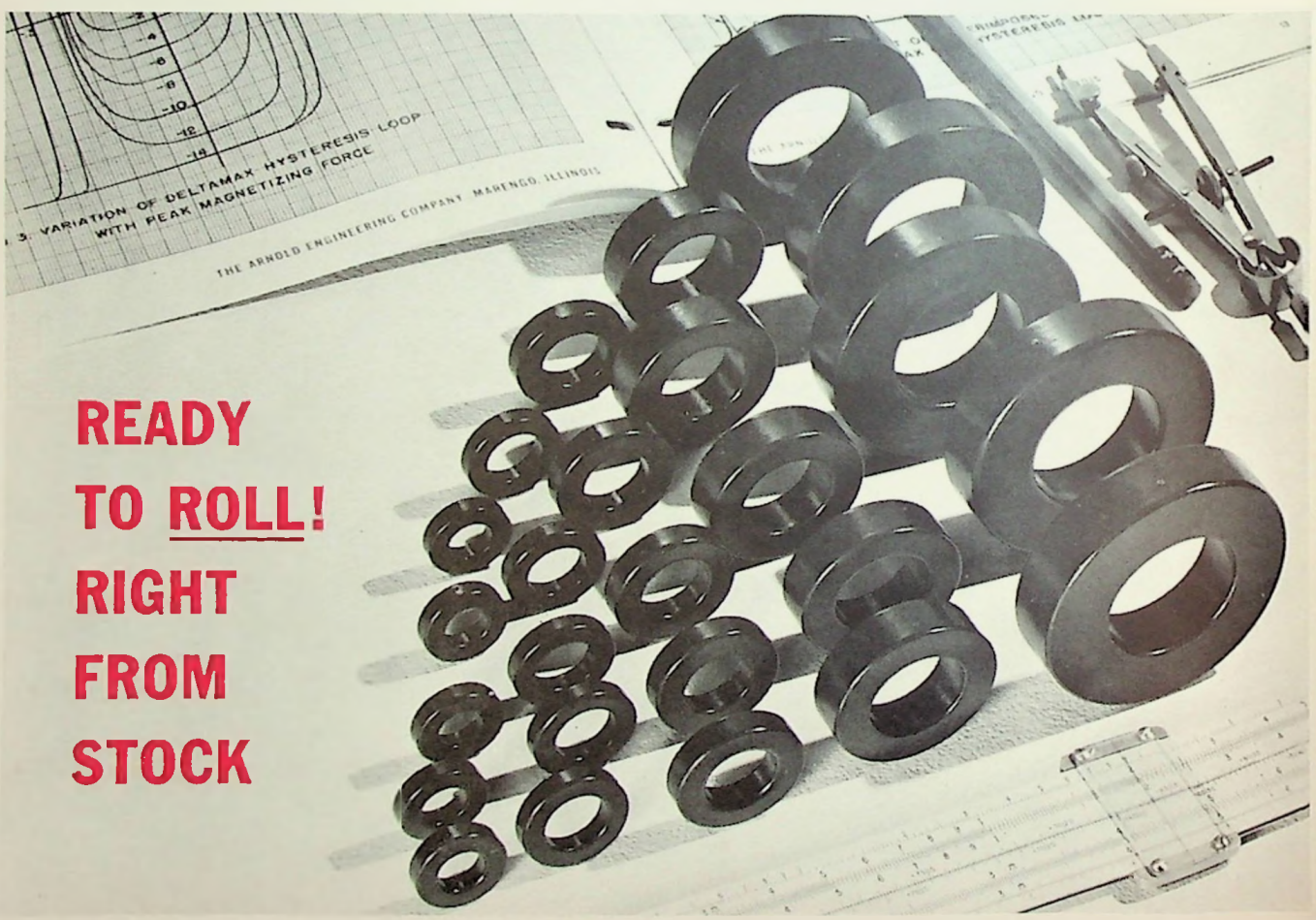

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Grid

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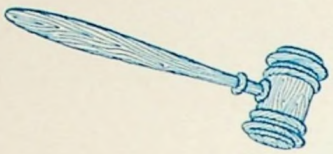
contents

cover

One of the Radiation-at-Stanford high-power transmitters described at the PGSET meeting reviewed in this issue appears on the cover together with a close-up of the electronic crowbar being fired. This device accomplishes fault diversion in a matter of microseconds.



from the chairs

Joseph G. Rubenson

EDUCATION, JG

Part of the responsibility of each IRE section is to strive for advancement of the theory and practice of electronics, radio, allied branches of engineering, and of related arts and sciences. I believe one positive way to accomplish this is to foster the needs of students at the secondary school level who have evidenced unusual interest and ability along these lines. By suitable recognition and assistance we can do much to encourage such students.

For this reason, the Committee on Secondary Education was formed in the San Francisco Section. Our goal is to promote interest in technical and scientific studies by providing technical stimulation and assistance through informal contacts with professional people and local industry, by providing assistance for student projects, and by enhancing the prestige of these students among their contemporaries. Since its inception, the committee has been meeting and discussing several worthwhile projects leading toward these goals.

Consideration is being given to an industry "adoption" program in which local companies will adopt outstanding students and make available to them a small panel of consultants to help them on special projects, or to expose them to a professional atmosphere by means of plant visits and individual discussions. Such a project will provide technical stimulation and guidance for the students and familiarization with technical people and work in industry. Besides encouraging some students to pursue a planned career in science or engineering, it will also enable others to decide whether such a career is really the one they want.

An assistance program for "Particle," a magazine covering all fields of science, written and published by and for high school and junior college students, is being discussed. The magazine provides recognition for science students by encouraging publication of their work. Concrete help on our part can be provided by volunteering a paper-review service and by consulting on publication techniques, publicity and advertising, and financial management.

Student recognition and inspiration can be encouraged with a simple award presentation program in which executives of local companies present student awards at schools, followed up with appropriate newspaper publicity. This is another worthwhile project that is being considered.

It is the intention of the committee to proceed slowly and carefully, with initial trial efforts being confined to just one or a few schools in our area. For even this modest start, the help of several additional IRE members is needed. Anyone who wishes to devote a small portion of time to this important and rewarding work should contact Joe Swanson at Radiation at Stanford, or the writer at Watkins-Johnson Co.

–JOSEPH G. RUBENSON, CHAIRMAN,
COMMITTEE FOR SECONDARY EDUCATION

High selectivity, unique convenience, extreme accuracy

hp 302A Wave Analyzer

easily convertible to a sweep oscillator-tuned voltmeter with this hp AC-97C Sweep Drive!

No calibration or stabilization is required with the hp 302A Wave Analyzer, a completely transistorized instrument which represents significant improvement in design. Operating as a highly selective tuned voltmeter, the instrument provides a front panel control which selects the frequency to be measured. Voltage then is read directly on the front panel meter. Basically, Model 302A separates an input signal into individual components so that each—the fundamental, harmonics and any intermodulation products—may be evaluated separately.

With the AC-97C Sweep Drive, the hp 302A is converted to a sweep oscillator-tuned voltmeter for automatic frequency response measurements, even in noisy systems. The AC-97C motor accessory permits sweeping the entire frequency range of the 302A, 20 cps to 50 KC; provides fast sweep for covering the spectrum rapidly, slow sweep for high resolution plot. The Sweep Drive with an X-Y recorder permits automatic plots of harmonics or intermodulation products. Model AC-97C attaches to the 302A panel, or may be bench mounted on an adjustable stand.

SPECIFICATIONS

hp 302A Wave Analyzer

Frequency Range:	20 cps to 50 KC
Frequency Calibration:	Linear graduation 1 division/10 cps. Accuracy ± (1% + 5 cps)
Voltage Range:	30 μv to 300 v, full scale, 15 ranges
Warm-up Time:	None
Voltage Accuracy:	± 5% of full scale
Residual Modulation Products & Hum Voltage:	Greater than 75 db down
IF Rejection:	Intermediate frequency in input signal rejected by at least 75 db down
Selectivity:	± 3½ cycle b.w. — at least 3 db down ± 25 cycle b.w. — at least 50 db down ± 70 cycle b.w. — at least 80 db down Beyond ± 70 cycle b.w. — at least 80 db down
Input Impedance:	Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on other ranges.
Dimensions:	20¾" x 12½" x 14½" (cabinet), 19" x 10½" x 13½" (rack mount)
Weight:	43 lbs. (cabinet), 35 lbs. (rack mount)
Price:	hp 302A (cabinet), $1,800.00 hp 302AR (rack mount), $1,785.00

hp AC-97C Sweep Drive

Sweep Range:	50 revolutions
Sweep Limits:	Any interval from 50 revolutions to 5 degrees
Sweep Speed with hp 302A:	170 cps/sec and 17 cps/sec
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MEETING CALENDAR

EAST BAY SUBSECTION

8:15 P.M. • Monday, Jan. 22

"European Adventures in Television"
Speaker: Joseph Roizen, Ampex Corporation
Place: Dublin Corral, Intersection of U.S. 50 and Hwy. 21, Dublin
Dinner: 6:30 P.M., Dublin Corral. Wives invited
Reservations: None required ($3.50 including tax and tip)

PROFESSIONAL GROUPS

Antennas & Propagation

8:00 P.M. • Wednesday, Feb. 14

(Tutorial series on millimeter waves—joint with PGED and PGMTT)
Lecture No. 1
"Generation of Power at Millimeter Wavelengths"
Speakers: William Brown, associate director of engineering; and Wesley Teich, staff assistant; Raytheon Spencer Lab, Burlington, Massachusetts
Place: Room 100, Physics Lecture Hall, Stanford University

Antennas & Propagation

8:00 P.M. • Wednesday, Feb. 21

Lecture No. 2
"Millimeter Propagation"
Speaker: Prof. A. Straiton, director of electrical engineering research lab, University of Texas
Place: Room 101, Physics Lecture Hall, Stanford University

Antennas & Propagation

8:00 P.M. • Wednesday, Feb. 28

Lecture No. 3
"Millimeter Transmission-Line and Antenna Design"
Speaker: Alan J. Simmons, Technical Research Group Inc., Somerville, Massachusetts
Place: Room 100, Physics Lecture Hall, Stanford University

Antennas & Propagation

8:00 P.M. • Wednesday, Mar. 7

Lecture No. 4
"New Techniques for the Generation of Millimeter and Sub-Millimeter Radiation"
Speaker: Paul Coleman, University of Illinois
Place: Room 101, Physics Lecture Hall, Stanford University

Electron Devices

8:00 P.M. • Wednesday, Feb. 14, 21, 28, March 7

(Tutorial series on millimeter waves—joint with PGAP and PGMTT, see above)

Engineering Writing & Speech

8:00 P.M. • Tuesday, Feb. 20

"Making Visual Aids Effective"
Speakers: Arch Cassingham and Ralph Simms, Sylvania RSL, Mountain View
Place: To be announced
Dinner: 6:00 P.M., The Red Shack Hofbrau, 4085 El Camino Way, Palo Alto
Reservations: James Weldon, 968-6211, Ext. 2344

Information Theory

8:00 P.M. • Thursday, Jan. 25

"Project West Ford"
Speaker: Dr. Robert M. Lerner, Lincoln Laboratory
Place: Conference Room B, Stanford Research Institute
Dinner: 6:00 P.M., Old Plantation Restaurant, 1030 N. San Antonio Road, Los Altos
Reservations: Mrs. Beryl Lelo, DA 6-6200, Ext. 2944 by noon, January 25

Grid reporters

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MEETING CALANDAR

Information Theory

8:00 P.M. • Thursday, Feb. 8

"Receivers for Randomly Varying Channels"
Speaker: Dr. Thomas Kailath, research specialist, jet propulsion laboratory, California Institute of Technology
Place: Conference Room B, Stanford Research Institute
Dinner: 6:00 P.M., Old Plantation Restaurant, 1030 N. San Antonio Road, Los Altos
Reservations: Mrs. B. Lelo, DA 6-6200, Ext. 2944 by noon, February 8

Instrumentation

8:00 P.M. • Wednesday, Jan. 24

"A Digital Voltmeter With High Common Mode Rejection"
Speaker: Robert A. Andersen, Dymec Division, Hewlett-Packard Co.
Place: Hewlett-Packard Company, 1501 Page Mill Road, Palo Alto
Dinner: 6:00 P.M., L'Omelette Restaurant, 4170 El Camino, Palo Alto
Reservations: Mrs. Renda Blackler, DA 1-7751

Microwave Theory & Techniques

8:00 P.M. • Wednesday, Feb. 14, 21, 28, March 7

(Tutorial series on millimeter waves—joint with PGAP and PGED, see above)

Military Electronics

8:00 P.M. • Tuesday, Feb. 6

"Applying the Pert Management System to Small Programs"
Speaker: James L. Halcomb, manager, military magnetics application, Varian Associates
Place: Auditorium, Bldg. 202, Lockheed MSD, 3251 Hanover St., Palo Alto
Dinner: 6:00 P.M., The Red Shack Hofbrau, 4085 El Camino Way, Palo Alto
Reservations: None required

Product Engineering & Production

8:00 P.M. • Tuesday, Jan. 23

"Milling, Drilling and Boring Operations Using a Tape-Controlled Milwaukee-Matic Milling Machine"
Speakers: Hal Hampel and Allan Watts, Hewlett-Packard Company
Place: Hewlett-Packard Company, 1501 Page Mill Road, Palo Alto

CHRONOLOGICAL RECAP

January 9—Broadcasting
January 10—Antennas & Propagation, Engineering Management
January 11—Audio, Electron Devices/Microwave Theory & Techniques
January 22—East Bay Subsection
January 23—Product Engineering & Production
January 24—Instrumentation
January 25—Information Theory
February 6—Military Electronics
February 8—Information Theory
February 14—Antennas & Propagation/Electron Devices/Microwave Theory & Techniques
February 20—Engineering Writing & Speech
February 21—Antennas & Propagation/Electron Devices/Microwave Theory & Techniques
February 28—Antennas & Propagation/Electron Devices/Microwave Theory & Techniques
March 7—Antennas & Propagation/Electron Devices/Microwave Theory & Techniques

Nicholas L. Pappas, chairman, PGI

Frank G. Marble, vice chairman, PGI

M. McWhorter, secretary, PGI

I. Wunderman, treasurer, PGI

meeting ahead

INSTRUMENT NOISE

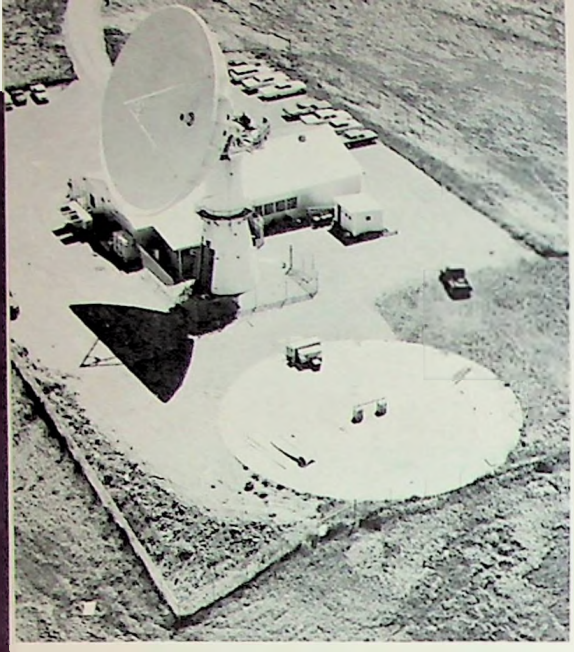
Details of a new digital voltmeter designed to overcome noise problems will be given by Robert A. Andersen, Dymec Div., H-P, at a late January meeting of PGI. The Calendar, page 9, has details.

Accuracy expected of a digital voltmeter is frequently not realized because of noise superimposed on the signal. In fact, some types of voltmeters will not settle, or issue a reading, in the presence of noise. Attempts to deal with the problem usually result in a loss of speed or accuracy.

In this presentation, two noise-reducing techniques will be described which combine to yield an effective common mode rejection of 140 db at any frequency including d-c. One of these, an input guard shield, holds superimposed noise to a minimum by keeping circulating ground currents out of the signal leads. Noise superimposed on the signal is then partially rejected by an active integration process which causes the voltmeter to read out the average of the voltage appearing at its input terminals during a prescribed sample period.

Andersen received a BS degree in physics from Oklahoma State University in 1950 and his MSEE degree from Stanford University in 1952. He worked in the field of radio-propagation measurements and instrumentation for four years with the National Bureau of Standards. In 1953 he joined Detroit Controls Division of American Standard as a research engineer in the field

(Continued on page 10)



California field site for MIT Lincoln Laboratory's communications experiments. See "Belts of Needles," below

MORE INSTRUMENTATION

of ordnance instrumentation, mercury switching, and magnetic-amplifier control instruments.

Since 1957 Andersen has been associated with Dymec, a division of Hewlett-Packard Co. where he is presently in charge of their analog digital instrument development group conducting research and development work on a variety of electronic measuring instruments.

Because the vice chairmanship of PGI was vacated by a job change shortly after the recent election, the administrative committee solicited the services of Frank G. Marble, Systron-Donner Corp. His acceptance of the position puts the Chapter programming in his hands. Other Chapter officers are Nicholas L. Pappas, Iconix, Inc., chairman; Malcolm M. McWhorter, Stanford, secretary; and Irwin Wunderman, H-P Associates, treasurer.

In another change, the PGI meeting schedule has been shifted from the earlier first-of-the-month date to the fourth Wednesday of the month. This appears to offer the least conflict with meetings of other professional groups and should allow greater meeting participation—particularly in view of the obvious overlapping nature of PGI with respect to the interests of many other professional groups.

meeting ahead

BELTS OF NEEDLES

Dr. Robert M. Lerner will address PGIT late in January. See Calendar, page 8. He will discuss Project West Ford, a new method of providing reliable intercontinental communication that Lincoln Laboratory has been investigating over the past three years. This method involves the use of belts of orbiting microwave dipoles as an artificial microwave-scattering medium. An initial study indicates that communication capacities of many tens, or perhaps hundreds of thousands, of bits per second can be achieved over distances of many thousands of miles. Two such belts can be used with highly directive microwave antennas to provide a multiplicity of high-capacity channels. These channels are expected to be time varying and highly dispersive.

Lerner was born in Worcester, Mass., in 1928, received his BS in 1948 and MS in 1950 from Worcester Polytechnic Institute, and received his ScD from MIT in 1959. He worked on speech processing at MIT's research laboratory of electronics prior to joining Lincoln Laboratory in 1952. There he has worked on the application of statistical techniques to radar-system design. Since 1957, he has been assistant leader of a communications system group concerned with the use of theoretical techniques in communication-system design and the development of acoustical components. Lerner is a member of the Acoustical Society of America, AIEE, Sigma Xi, and Tau Beta Pi, and a senior member of the IRE.

The Professional Group on Communications Systems will sponsor a field trip by bus to the west-coast receiving site of Project West Ford later in the season, as soon as arrangements can be made.

meeting ahead

RANDOMLY VARYING CHANNELS

Dr. Thomas Kailath of JPL will address the February meeting of PGIT on the subject "Receivers for Randomly Varying Channels." Details are in the Calendar, page 8. He will show how the concept of correlation detection of deterministic signals in additive gaussian noise can be extended in a natural manner to the detection of signals that are transmitted through a "gaussian" random channel and are also corrupted by additive gaussian noise.

Such signals are encountered in communication over scatter-multipath channels. In the deterministics case the receiver essentially cross-correlates the received noisy signal with the expected known waveform as modified by the known channel characteristics. When a random channel is present, however, this latter signal is not known at the receiver. But, knowing the statistics of the channel and of the noise, the receiver can make an estimate of it from the received signal on the hypothesis that a particular signal was transmitted. The optimum receiver then cross-correlates this estimate with the received. He will show how these considerations lead to reasonably complete derivations of the Rake and Kineplex communication systems.

meeting ahead

THE MILLIMETER WAVES

During February and March, a tutorial series of lectures on millimeter waves will be presented jointly by PGAP/PGED/PGMTT. The first of these will take place in mid-February and will include two speakers, as detailed in the Calendar, page 8, covering power generation.

W. W. Teich, of Raytheon, will describe the classes of devices for power generation and amplification at centimeter wavelengths and the nature of the problems encountered in scaling these devices to shorter wavelengths. Some of the novel solutions to these problems and other approaches to power generation that have been proposed will also be discussed. The emphasis will be placed on devices employing electron beams interacting with circuit waves, and intended for familiar radar and communications applications.

W. C. Brown, also of Raytheon, will deal with the possibility of generation of what is considered super power at millimeter wavelengths. He will describe, in particular, a crossed-field device having the properties of an electromagnetic amplifying lens. Some of the possible uses of this power will also be outlined.

Wesley W. Teich, staff engineer and assistant to B. G. Ryland, director of engineering of the microwave and power-tube division at Raytheon, coordinates engineering planning for Spencer Laboratory. He has been active in the development of microwave tubes since joining the company in 1945. Teich received his BS degree in electrical engineering from Iowa State University, Ames, Iowa, in 1945. He has since completed graduate courses in this field at the Massachusetts Institute of Technology.

Upon joining Raytheon as a junior engineer, he worked on the development of electronically tunable and high-power tunable c-w magnetrons. In 1950, as part of a laboratory reorganization, he became head of a section responsible for performance testing of development tubes, and in 1953 was appointed head of the laboratory test department. In this capacity, he was responsible for the development of many instruments and techniques for the measurement of microwave tube

(Continued on page 12)

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These two compact Tektronix Oscilloscopes ideally suit most general-purpose measurement applications in the dc-to-15 mc range. They display bright traces with excellent definition.

You may prefer the Type 515A Oscilloscope if you work exclusively with single-trace applications in the laboratory, in the field, or on the production line. Or, you may prefer the dual-trace facility of the Type 516 Oscilloscope. It offers you four operating modes and independent controls for each amplifier channel—enabling you to position, attenuate, invert input signals as desired.

Regardless of your selection of either of these precision tools, you will find your Tektronix Oscilloscope easy-to-operate and easy-to-keep-operating.

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Frequency Response from dc-to-15 mc (at 3 db down). *Risetime* of 23 nanoseconds. Sensitivity from 50 mv/cm to 20 v/cm in 9 calibrated steps, continuously variable uncalibrated from 50 mv/cm to 50 v/cm. *Constant Input Impedance* at all attenuator settings.

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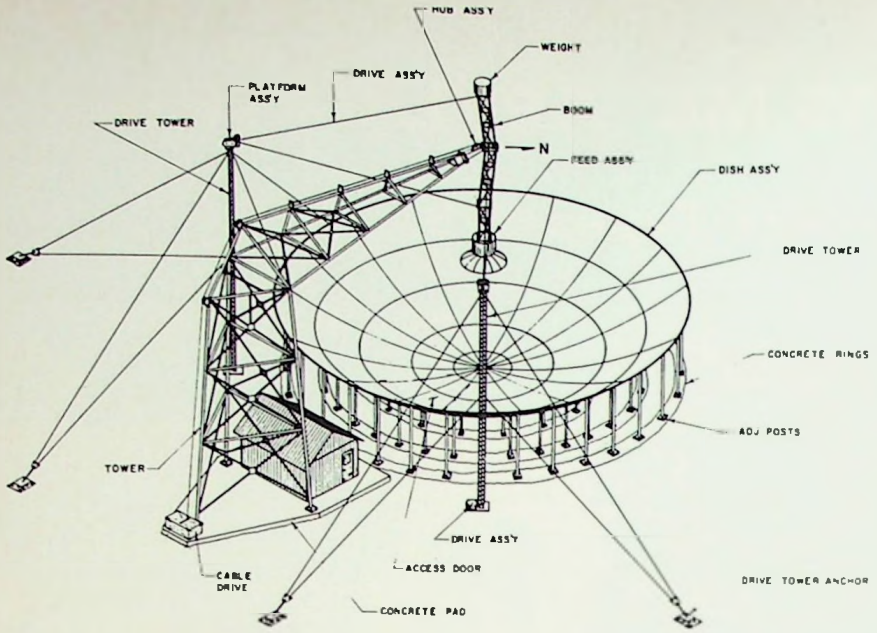

Schematic view of Lockheed 85-ft-diam spherical-reflector antenna, subject of December PGAP meeting

MORE TUTORIAL SERIES

parameters. He has served as a member of the IRE standards committee on operating measurements of microwave oscillators and more recently, as a member of the technical committee on electron tubes.

In 1958, Teich was appointed technical assistant to the manager of the microwave power tube research and development laboratory, and assisted with the organization and facility planning for Spencer Laboratory. He is a Senior Member of the IRE, and a member of the honorary societies: Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, and Pi Mu Epsilon.

William C. Brown is associate director of engineering for crossed-field devices, and manager of the laboratory for applied research on crossed-field devices. His experience in crossed-field devices at Raytheon totals sixteen years and embraces research, development, design, and production-engineering.

He has made a number of significant technical contributions to the microwave tube art, including the discovery of the Amplitron or platinotron principle and its reduction to practical use.

Brown's educational background includes BS in electrical engineering, Iowa State College, 1937; MS in electrical engineering, Massachusetts Institute of Technology, 1941; and miscellaneous graduate subjects taken at Northeastern University and Massachusetts Institute of Technology.

He is a Fellow of the IRE and a member of the Engineering honorary societies Tau Beta Pi and Eta Kappa Nu.

meeting review

ANTENNA UPS & DOWNS

At the December PGAP San Francisco Chapter meeting, which was held at the Stanford Research Institute main conference room, Robert F. Trainer and William M. Young described an 85-ft-diameter spherical-reflector antenna now nearing completion at Lockheed's Sunnyvale plant.

John Damonte, vice chairman and program chairman of the San Francisco Chapter, presided at the meeting and outlined plans for this year's tutorial series on millimeter waves. This series is to be held during February and March jointly with the local PGED and PGMTT Chapters.

Trainer, who is head of the antenna and propagation section of LMSC's electromagnetic research organization, first reviewed practical factors relating to selection of the type of large antenna to be employed. He noted that for radio astronomy and space tracking coverage of angles up to 70 degrees from the zenith is usually satisfactory. Accordingly, the Lockheed antenna was designed as an 85-ft-diameter segment of a 120-ft sphere with a steerable feed permitting observations down to angles as low as 20 degrees before aperture blocking becomes serious. With a horn feed, the first sidelobe is expected to be 18 to 20 db below the main lobe. The antenna will be initially used as a transit instrument with only limited feed positioning.

Young, who is engaged in the mechanical design aspects of the antenna, described the design factors and construction methods. A single cantilever structure supports the feed, including up to 700 pounds of equipment in a compartment. (see illustration.) The feed is positioned by cables from two drive towers.

One unusual problem was encountered in preparing the site for the antenna. Due to tidal effects, the two feet of adobe soil was found to have a vertical motion of one to three inches. However, the ground tilt was found to be less than 0.04 mils in the north-south direction and 0.02 mils in the east-west direction, producing a negligible effect on the antenna-beam positioning.

The reflector is mode up of individual spherical-segment panels, which were formed in a stretch press. Heliarc spot-gun welding was used for fastening the panels to supporting members. The corners of each of the panels are set to 10-20 thousandths of an inch with a dial gage swung on the feed tower. The rms surface variations are expected to be on the order of 0.1 inches.

—R. D. EGAN

December PGAP meeting scene shows John B. Damonte, chairman, with speakers Robert F. Trainer and William M. Young

meeting review

FOUR-WAY FINISH

The November meeting of PGPEP at Varian Associates in Palo Alto featured a panel discussion of coatings and finishes. Members of the panel consisted of Don Brown, sales service engineer for the Parker Rust Proof Co.; Harry Hall, West Coast manager of John L. Armitage & Co.; Kenneth King of the Hewlett-Packard Company and Cal Probst, industrial sales engineer for the Minnesota Mining & Manufacturing Co.

Probst started the presentation by quickly covering the subject of surface preparation by the use of coated abrasives. He pointed out that the combination of five minerals or abrasive materials, five backing materials and

(Continued on page 14)

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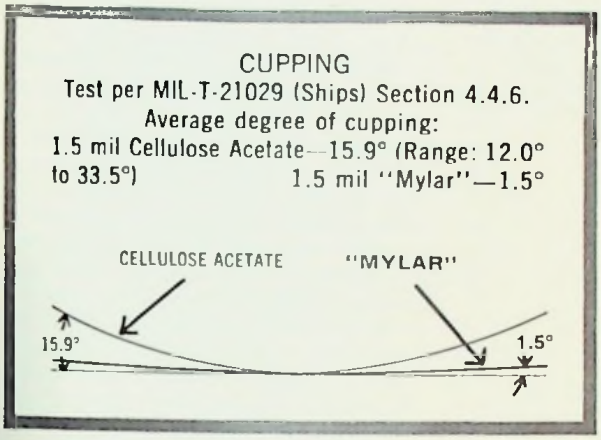

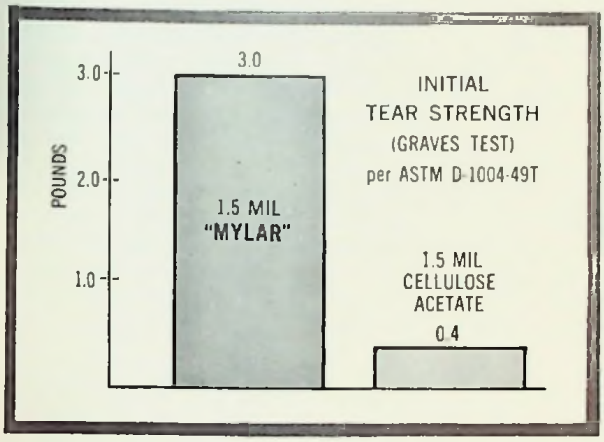

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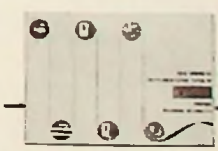

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Panelists from the November PGPEP meeting: Kenneth King, Cal Probst, Don Brown, and right, Harry Hall with the moderator and program chairman, T. E. Scatchard, second from right

—Harmon R. Traver photo

MORE FINISHES

five bonding agents along with the various shapes such as belts and discs makes possible 17×10^{17} different coated abrasives. Thus a product can be designed to do almost any metal-finishing job. The finish obtained is determined by the proper selection of grit, speed, contact-wheel hardness, elasticity of the contact wheel, and lubricant.

The subject of cleaning the surface and chemically treating it as either the final finish or as a base for painting was covered by Brown. The complete process consists of (1) cleaning the surface—either by sandblasting or chemically, (2) water rinse, (3) processing—depending on end result desired, (4) water rinse, and (5) chromic and phosphoric-acid rinse to remove any salts remaining from step 3.

Three basic processes are used under step 3. The first is Parco Lubrite consisting of a non-metallic oil-absorbing iron or manganese-phosphate coating. This is used for bearing surfaces on automotive and other parts. The second is Parco Compound, a rust-resisting iron or zinc phosphate used for coating screws and piping. The third process is Bonderite, composed of zinc or iron phosphate and chromate or chromic phosphate and oxide. It is used to resist corrosion and as a grease-free base for paint.

Continuing from where the surface had been prepared and cleaned, Hall discussed painting. Both surface protection and improved appearance are achieved by painting. Some of the industrial finishes used starting from about 1910 are lacquers, phenolics, vinyls, synthetic resins, acrylics, melamines, teflons, epoxies, and silicones. Considerable use is being currently made of vinyl dispersed in a plasticizer. It is made into a continuous film by heating to about 340 F after applying. The trend is toward materials that take higher temperatures for baking or curing. Pre-finished metals that can be sheared, punched, and formed without damage to their finish are gaining in importance. Pre-finished wood is also seeing a greater use in construction.

With the background thus presented, King discussed a recent problem concerning the finishing of electronic instrument cabinet parts. Some of the objectives were for a finish that would be color fast, abrasion resistant, able to withstand processing—such as spot welding, textured and not only uniform in color when applied at different times but also in different plant locations.

Some of the finishes considered were textured vinyl which requires a primer for adhesion, splatter-coat epoxies, alkyd over textured metal and textured vinyl bonded to aluminum sheets. At the present time the best solution appears to be the textured vinyl bonded to aluminum. Since this material is purchased from a central processing plant, it can be shipped anywhere in the world for fabrication and achieve the goal of uniformity of color and texture.

The panel discussion and the lively question-and-answer period following it were moderated by Thomas E. Scatchard, PGPEP program chairman and director of manufacturing for the Berkeley Division of Beckman.

—HARMON TRAVER

meeting review

SPOTTING THE MOON

At the November meeting of PGSET, Ernst R. Altschul of Radiation at Stanford described the design of two super-power transmitters. The x-band transmitter will be used on the Haystack project of Lincoln Laboratories and the second transmitter, in the 400-

(Continued on page 16)

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FEATURES

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FEATURES

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MORE TRANSMITTERS

mc range, will be used at the Arecibo, Puerto Rico, 1000-ft reflector installation.

A background was established by discussing the applications of space transmitters and the parameters that may be varied. Transmitter installations may be used for communication with a space vehicle, to study planets, and for communication between distant points on the earth. Parameters that may be varied to obtain satisfactory transmission are frequency, antenna configuration, transmitter power, and modulation method. Overall systems operate at about 35 per cent efficiency.

The Cornell University installation in Puerto Rico will operate on a single very-stable frequency of 430 mc with an average power of 100,000 watts. R-F pulse-rise time can be as short as 1 microsecond with pulses of various shapes and widths up to 10,000 microseconds. A feedhorn is located 430 ft above the 1000-foot dish, which produces a beam width of 1/6 degree. Output klystrons can operate at 110,000 volts with 30 amperes peak current available from the power supply. A capacitor bank provides 300,000 joules energy storage. The output stages and equipment are protected by an electronic crowbar that discharges the capacitor bank in case of an arc-over in the transmitter.

Lincoln Laboratories Haystack Hill unit will operate at about 10,000 mc with an average power of 100,000 watts. The transmitting system is housed in an 8- by 8- by 12-ft plug-in unit behind the 120-ft diameter antenna. This plug-in feature will allow quick changes to other units for different experiments. The signal from the plug-in is beamed through the center of the 120-ft dish to a 9-ft reflector near the focus of the main dish.

Radio energy is thus reflected to the main parabola which beams it in the desired direction. This overall arrangement reduces transmitter changeover time and long transmission paths. Output power is generated by 4 klystrons, each with its own radiating element. The phase difference between these outputs is held to less than 10 degrees. The equipment is also protected by an electronic crowbar that discharges the capacitor bank in case of an arc-over in the output klystrons, wave guide, or an excess of reflected power.

The overall system can produce a beam of 1/20 degree which will illuminate a spot on the moon approximately 500 miles in diameter and probably also be able to detect echoes from several of our planets including Mars, Jupiter, and Venus.

—JOE BARKLEY

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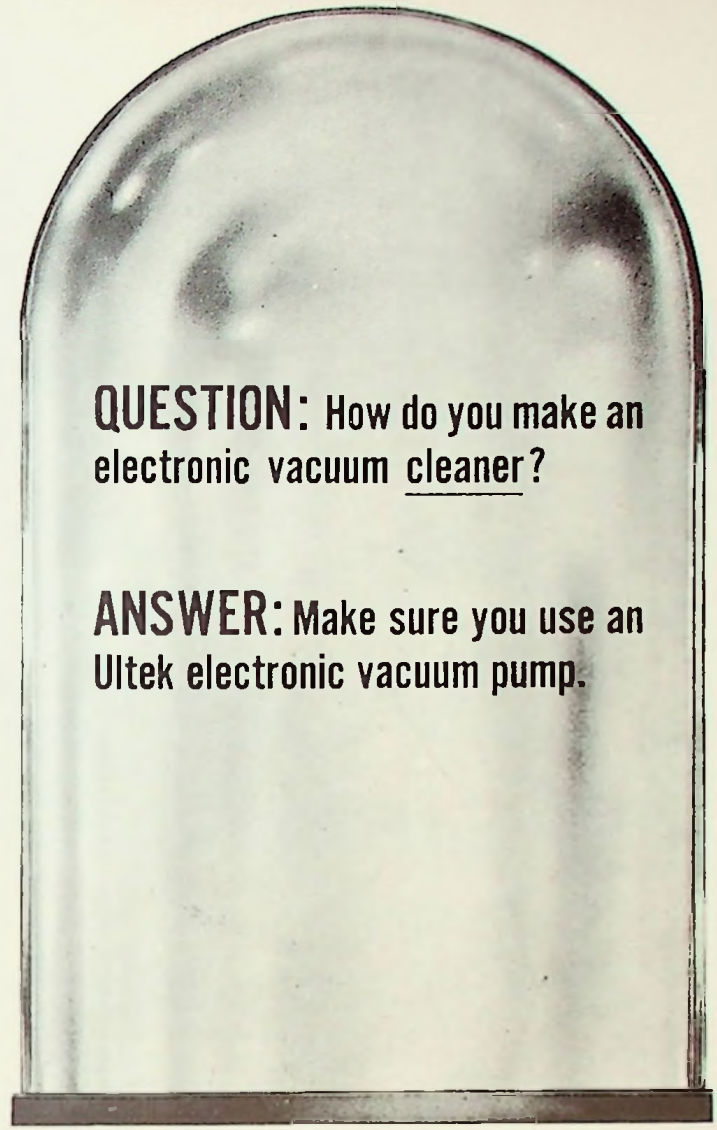

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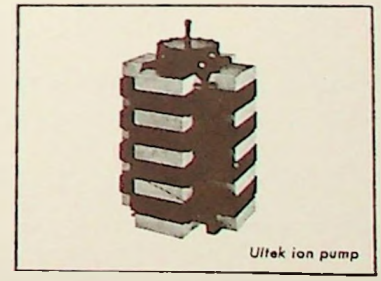
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meeting review

RELIABLE MAN VS RELIABLE SPACE

Dr. W. Wolman started his talk before the mid-November PGRQC meeting by describing various reliability-prediction techniques that are being employed throughout industry today. From these techniques he developed a probabilistic model that he felt was most appropriate for use in his work.

For the remainder of the meeting, Wolman, who is chief of analysis and methodology in the office of reliability of NASA Headquarters, Washington, D.C., showed application of this model to the Man-in-Space programs—for which his office has reliability-assessment responsibility. Specifically, he described the reliability-evaluation program that they were performing on the Saturn Booster and the Mercury Capsule.

—ROGER MC DONALD

meeting review

SMEARED SPECTRA

Dr. Nelson Blachman addressed the PGIT Chapter in November on the topic, "A Generalization of Woodward's Theorem on F-M Spectra." The meeting was held in the auditorium of the Lockheed Research Laboratories in Palo Alto, and thirty people braved the rain to attend; eighteen people attended the dinner preceding the talk.

The speaker began his talk with a "gedanken experiment" to demonstrate the content of Woodward's original theorem. The theorem concerns the power spectral density of a frequency modulated sinusoid such as

$$V\cos\left(\Omega t + \int M(t)dt\right)$$

which has as its instantaneous frequency $\Omega + M$. The experimenter is to consider measuring the spectrum of this signal by using a spectrum analyzer composed of a number of contiguous bandpass filters, each of width $\Delta\omega$. We expect the filter at ω to pass the signal only when $\omega < \Omega + M < \omega + \Delta\omega$. This occurs for a fraction of the time given by $\Delta\omega\, p(\omega - \Omega)$, where p is the probability density function of the modulation M. Then the measured spectrum should be simply proportional to $p(\omega - \Omega)$.

Blachman then pointed out by example that this cannot be the complete story. For the example of a sinusoidal modulation, the spectrum actually consists of lines, whereas the probability density for the modulation is a smooth curve. Thus the theorem "smears out" the fine details in giving an approximation to the spectrum. The smearing is analogous to the smearing that occurs in the experimentally measured spectrum when the analyzing filters are made wide enough that the quasi-stationary response is obtained; this occurs

Nelson Blachman, speaker at the November PGIT meeting
—James J. Spilker, Jr. photo

when $\delta\omega$ is large compared to the square root of the magnitude of the time derivative of the modulation.

The speaker then went through Woodward's derivation [2] of the theorem, showing the approximation that must be made to obtain the conclusion. The approximation requires the assumption that the autocorrelation function is small for values of τ of the order of the reciprocal of the square root of the modulation time derivative, and greater. The effect of this is to cause a smearing of the spectrum as if by an analyzer having a resolution bandwidth of the order of the square root of the time derivative of the modulation. For a sinusoidal modulation, this quantity is of the order of the geometric mean of the frequency excursion and the modulating frequency. Thus the theorem can give an accurate estimate of the spectrum only if the deviation ratio is quite large.

The theorem can be generalized by considering slow amplitude modulation as well as slow frequency modulation. This causes little change in the accuracy of the theorem, especially if the modulations are independent. An example of simultaneous amplitude and frequency modulation is the case of a sinusoid and a narrow band of additive gaussian noise. Woodward's theorem has little to say about the spectrum of such an example, because the frequency deviations and the modulation frequencies are comparable, so that the smearing effect is quite bad. However, if a high harmonic of this waveform is generated, the frequency deviations become much larger, and the theorem becomes useful. If a power-law device is used to generate the high harmonic, the estimate of the spectrum can be obtained explicitly in terms of the confluent hypergeometric function; for the m'th harmonic, generated by an n'th law device with an input signal-to-noise ratio of R, the power spectrum is proportional to

$$\frac{{}_1F_1\left\{n+3/2;\ 1;\ R/[1+(\omega-m\Omega)^2/m^2\rho^2]\right\}}{[1+(\omega-m\Omega)^2/m^2\rho^2]^{n+3/2}}$$

where ρ is a measure of the bandwidth

(Continued on page 20)

MORE SPECTRA

of the noise. Some notable features of this result are that the shape of the spectrum does not depend upon the details of the input spectrum shape, and that the discrete component due to the sine wave has been smeared out by the approximation. The strength of this line can be easily calculated separately, however.[3]

Blachman has just been notified that his paper on this subject has been accepted for publication in Information and Control.

References

1. P. M. Woodward, "The Spectrum of Random Frequency Modulation," British Telecommunications Research Establishment Memorandum No. 666, Dec. 1952.
2. N. M. Blachman, "Limiting Frequency-Modulation Spectra," Information and Control, 1, pp. 26-37, September 1957.
3. N. M. Blachman, "The Output Signal-to-Noise Ratio of a Power Law Device," J. Appl. Phys. 783-785, June 1953.

—FORREST F. FULTON, JR.

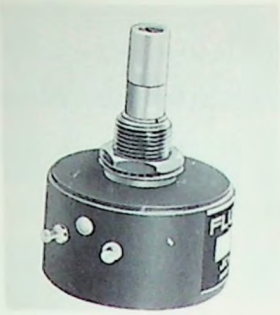
back to school

SPRING CLASSES

Twenty-one courses will be offered for electronic and electrical engineers by engineering and sciences extension, University of California, beginning in February. In addition, a wide variety of courses in related fields, such as mathematics, will be available.

Two morning classes mark the start of a program to provide for those who desire instruction early in the day. Electromagnetic Fields and Waves X8 117A will be offered on Wednesday and Friday mornings, 7:00-8:30 a.m., while Space Radio Propagation Phenomena will be given on Tuesdays, 7:00-9:00 a.m.

Among new courses being presented during Spring semester are Active Quantum Electronic Devices—dealing with maser-type devices; Solid State Energy Conversion—thermo-electric energy conversion techniques; Digital Computer Systems X 445DEF—an extension of the first course in this field. Television Tape Recording Technology—a comprehensive treatment of the techniques of video recording on magnetic tape; Magnetic Memory and Logic Circuits; Introduction to Network Synthesis; and Power System Analysis. The scheduling and descriptions of these and other courses can be found in the complete engineering and sciences catalogue which is available on request from engineering and sciences extension, University of Calif., Berkeley 4.



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IT IS REPORTED:

Varian Associates has announced a program of matching employee gifts to American colleges and universities. Under the new program, the company will match an employee's gift up to a maximum of $250 in any calendar year.

Precision Instruments Company has appointed four new group supervisors: **Frank Beeler,** engineering administration and services; **Todd Morcott,** miniature recorder development; **Dwight D. Wilcox,** standard product development; and **Al Wilson,** modification.

About People

Hobart W. Acker has been appointed production manager of **Granger Associates; Robert L. Edens** has joined **Moore Associates'** engineering staff as systems engineer; **David Simmons** has been appointed director of engineering of **Carad Corporation; L. P. Elbinger** has been named patent attorney for two **General Electric Company** peninsula operations, the traveling wave tube product section and the computer laboratory; **Fairchild Semiconductor** has announced the appointment of three new members to the laboratory's technical staff, **Jose Sandor, Peter Lauritzen,** and **Pierre Lamond; Jefferson R. Wilkerson** has joined the reconnaissance systems laboratory of **Sylvania Electric Products Inc.** as senior engineering specialist; **William A. Gross** has been named director, research department at **Ampex Corporation; Everett Teare** has been appointed sales manager of advanced technology sales, **Archie L. Holtgrewe** has been appointed manager of the western computer center, and **John A. Keyes** has been appointed manager of advanced systems sales at the Western development Laboratories of **Philco Corporation; George H. Ritter** has joined **Eitel-McCullough, Inc.,** as plant manager of the high power microwave division, and **Bernard A. Coler** has become microwave products manager for the company's marketing division.

Wolfgang K. H. Panofsky, Stanford physicist and a member of President Kennedy's science advisory committee, has been named director of the university's $114 million linear accelerator project being financed by the U.S. Atomic Energy Commission.

Edward L. Ginzton, who headed the two-mile accelerator project during its earlier stages, will continue as a project consultant to the university.

Noller Control Systems Inc., has appointed **Artwel Electric Inc.,** San Francisco, as sales representatives for their line of control and alarm systems.

The management of the **Secode Corporation** of San Francisco and **Magnetic Controls Company** of Minneapolis announced they have reached an agreement for the joining of the two companies under a plan of reorganization. Secode will continue to operate, under the same management, as a subsidiary of Magnetic Controls.

Stanford University has announced a pledged gift of $230,000 from **Thomas F. Peterson** of Cleveland, Ohio, for a materials science laboratory in the school of engineering.

Peterson is president of the **Preformed Line Products Co.** of Cleveland, which has established a branch in Stanford Industrial Park.

Robert A. Helliwell of **Stanford's** radioscience laboratory will direct a group of researchers in vlf studies of the upper atmosphere from the USNS Eltanin, America's first floating scientific laboratory.

Dri-Honing Service, Inc., has recently been appointed distributors of **Vacu-Blast** equipment for northern California and Nevada.

Upon completion of a training course, **Earl Goddard** will take over training of

(Continued on page 24)

MORE SWINGS

future marketing engineers at **Varian Associates.** Prior to joining Varian, Goddard was a senior project engineer for Radiation at Stanford, and is a former chairman of the Section.

Joseph H. Landells has been appointed manager of marketing for **Noller Control Systems Inc.** Landells was formerly vice president of Western Switchboard Co. and was general chairman of Wescon in 1953.

Landells *Denz*

The promotion of **A. R. Denz** to executive engineer has been announced by **B. R. Stack,** associate director of ITT Federal Laboratories. Denz has been with IT&T since 1950 and is presently in charge of the engineering section involved in work on special pattern recognition problems and applications of statistical decision theory.

About Companies

Morra Specialized Machining, Inc., San Carlos; **Amsco Electronics Division,** Palo Alto; and **Carco Electronics,** Menlo Park, have recently joined the **Western Electronic Manufacturers Association** (WEMA); and **Ultrasonic Systems, Inc.,** has established a branch office in Palo Alto.

The **Lenkurt Foundation** has granted $100,000 to establish a microwave laboratory at the **College of San Mateo** as part of the electronic curriculum.

Chaskin *Dimmick*

Formation of **Communicom,** communications, research and development organization, has been announced by **W. S. Chaskin** and **W. F. Dimmick,** cofounders. Chaskin is president of the new organization and Dimmick is executive vice president. Both Chaskin and Dimmick were formerly with ITT-Kellogg in Raleigh, N.C.

Morris *Levinthal*

Albert J. Morris, president of **Radiation at Stanford,** was elected to Radiation Incorporated's Board of Directors at the company's recent annual meeting. Also announced was the acceptance of **Elliott C. Levinthal's** resignation from the board.

Before becoming president of Radiation at Stanford, Morris served as senior vice president of engineering for the organization then under the name Levinthal Electronic Products.

About Representatives

T. Louis Snitzer Co., Sunnyvale, will represent **Coopertronix, Inc.,** Palo Alto; and **Eichorn & Melchior,** San Carlos, will represent **G-L Electronics,** Westville, New Jersey.

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The method of measurement with the Model 350 is similar to balancing a bridge: four knobs are set for minimum indication and the unknown voltage is read directly from a 4 to 5 digit NIXIE® in-line readout. The precision exceeds the stated accuracy by 5 to 10 times. **Price: $720.**

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Voltage Range..... 0.1 V to 1199.9 V	Frequency Range..... 50 cps to 20 kc
Accuracy. ¼%, 100 cps to 10 kc, 0.1 V to 300 V; ½% outside these limits	Max Crest Factor 2
	Input Impedance .... 2 MΩ shunted by 15 pF to 45 pF

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Happy Angelenos discuss show plans for the February National Winter Convention on Military Electronics: Don Larson, exhibits vice chairman; Ray Banks, Los Angeles Section business manager; and Walt Peterson, exhibits chairman

events of interest

IRE MEETINGS SUMMARY

Feb. 7-9—**3rd National Winter Convention on Military Electronics.** Ambassador Hotel, Los Angeles, Calif. IRE Business Office, 1435 La Cienega Blvd., Los Angeles 35, Calif.

Convention plans include: 91 papers covering such subjects as systems research, production, and implementation from both theoretical and hardware standpoints; a panel discussion on trends in weapons system development; exhibits; and several field trips.

Feb. 14-16—**International Solid-State Circuits Conference.** University of Pennsylvania and Sheraton Hotel, Philadelphia, Penna. No exhibits. Program: R. B. Adler, Room C-237, MIT Lincoln Lab, Lexington, Mass.

Feb. 19-21—**Institute of Aerospace Sciences,** National Symposium on Tracking and Command of Aerospace Vehicles. Jack Tar Hotel, San Francisco. Technical Sessions will include Operational Plans for Missiles and Spacecraft, Requirements and Specifications for Tracking and Command Functions, Equipment and Facilities for Aerospace Tracking and Command, and Advanced Techniques and New Developments.

NON-IRE LOCAL EVENTS

Jan. 27—**Seminar on Technical Writing and Editing,** Golden Gate Chapter, Society of Technical Writers and Publishers. Physics Lecture Hall, Stanford University, Palo Alto.

Speakers: Frederick E. Terman, Stanford; John P. Nash, Lockheed; Earl S. Herald, California Academy of Sciences; and C. F. Weigle, Stanford.

Panel participants: S. J. Reisman, Lockheed; Glenn Keitel, Philco; J. B. Gray, General Electric; C. W. McClelland, Varian; Monroe Winston, Lenkurt; C. A. Holstein, U.S. Navy; R. W. Crewell, FMC Corp.; C. E. Moore, Philco; W. D. Hamlin, Fairchild Semiconductor; S. L. Janofsky, IBM; M. L. Cohen, University of California; P. Tichenor, Stanford; H. A. Rogers, General Electric; D. Barnhart, Ampex; C. E. McCormick, Lockheed; James Weldon, Sylvania; J. E. Brinton, Stanford; and Frank Mansur, Lockheed.

Two special sessions, one on "Group Dynamics in Dynamic Groups" will cover links to the information source, the illustrator, and the printer. Second session on "Strength in Fundamentals Equals Professional Performance" will cover keys to: keeping others informed, effective equipment operation, and new business.

Feb. 15-17—**Golden Gate Metals Conference.** Theme: Materials Science and Technology for Advanced Applications. Comprises sessions on space-age-materials applications, electronic-materials applications, and nuclear power in the space age. Fairmont Hotel, San Francisco, Calif.

IRE PAPERS CALLS

Feb. 1—750-word abstracts and biographical sketch of author in triplicate for the 6th National Convention on Military Electronics (Washington, D.C.; June 25-27, 1962). Send to: John J. Slattery, Martin Co., Baltimore 3, Md.

Feb. 1—Six copies of 200- to 500-word abstracts for the Symposium on Thermionic Power Conversion (Colorado Springs, Colo.; May 14-16). Send to: Dr. Volney C. Wilson, chairman, program and publications committee, General Electric Research Laboratory, Schenectady, New York.

Mar. 15—500- to 1000-word summaries for the International Conference on Precision Electromagnetic Measurements (Boulder, Colorado; Aug. 14-16). Send to: Dr. George Birnbaum, Hughes Research Laboratory, Malibu, Calif.

INDEX TO ADVERTISERS

MANUFACTURERS/REP REFERENCE: see opposite page →

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For addresses and telephone numbers of reps listed, see opposite page

the section

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H. C. Stephens
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S. H. Zisk

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

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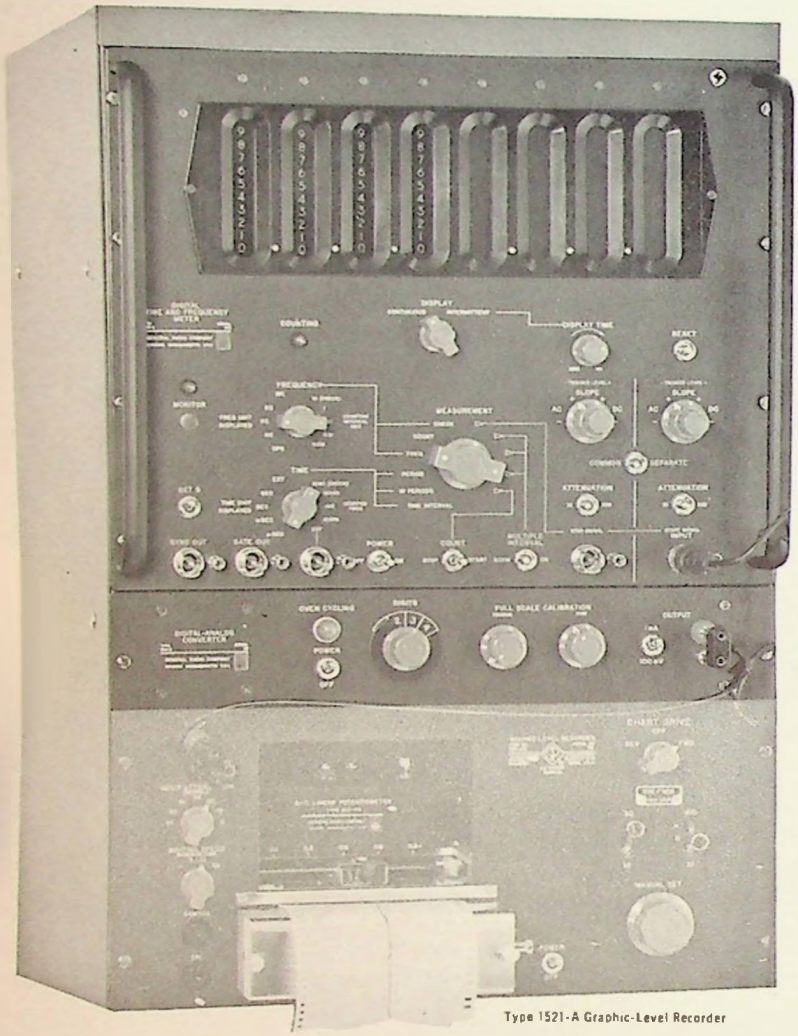

Type 1521-A Graphic-Level Recorder

The G-R Counter's unique storage circuits vastly simplify graphic analog recording. To decode the Counter's output to a d-c analog voltage you simply add G-R's all electronic Digital-to-Analog Converter.

For those desiring tabulated digital data, a Data Printer is available which connects directly to the Counter (no modifications or adaptor kits required).

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Measurement Ranges:
Frequency: dc to 10 Mc
Period: 10μsec to 10^7 sec
Time Interval: 1μsec to 10^7 sec
Also measures 10 periods, frequency ratios, phase shifts, pulse characteristics, and counts random events.

Display:
8 digits intermittent; 4 digits continuous readout (previous count displayed continuously during counting interval; changes to new value when count is completed).

Sensitivity: 0.25v rms

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Will drive any standard 1 ma (or 100 mv) recorder

- High Accuracy —
  Linearity: ±0.05% of full scale
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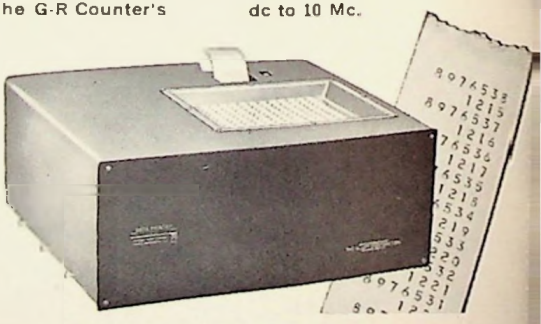
- All Electronic — No mechanical data printer required to convert counter output to steady analog signal. Operates directly from the G-R Counter's internal storage system.
- Either 1 ma or 100 mv output. Connects readily to most d-c strip-chart recorders.
- Records first 3, last 3, or last 2 digits of the G-R Counter's 4-digit continuous display which may be set to read any four consecutive digits of count over the range from dc to 10 Mc.

1132-A DATA PRINTER, $1450, for unattended measurements

Provides permanent printed records on adding machine tape. The printer has a 12-column register capacity, eight of which are used to print counter output. The remaining four columns can be used to display additional data such as time from a digital clock. Printing rate is adjustable from one print every twenty seconds to three prints per second. A keyboard and print-command bar allow numbers to be typed manually between automatic prints. An output for driving an IBM summary punch is available as a special option.



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